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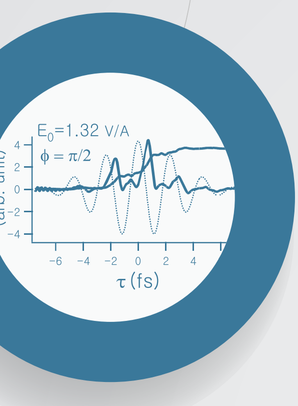

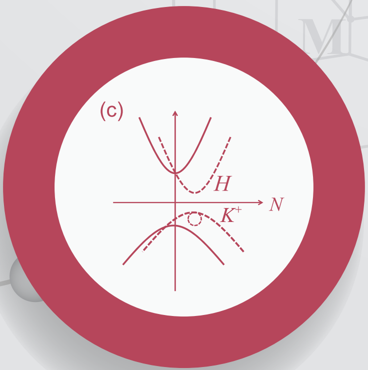

2016.10. 19 (수) - 21(금)

광주 김대중컨벤션센터

구두발표논문

Oral session abstracts

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 T1.01
2016.10.19 - 2016.10.21

2차원 물질의 기초 및 전자소자 응용 (Two-dimensional materials: fundamentals to applications)

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Abstract:
그래핀과 전이금속 디칼코겐화물과 같은 2차원 물질은 기존의 물질이 가지고 있지 못한 새로운 특성의 발견을 가능케 하여 이에 대한 연구가 최근 전세계적으로 활발하게 이루어지고 있다. 2차원 물질은 결정구조의 특이성 및 원자층 수준의 두께로 인해 특별한 밴드구조를 가지고 양자구속효과의 영향을 크게 받아 새로운 물리적인 발견을 가능케 하였다. 2차원 물질의 기초적인 물성의 탐구에서 시작한 연구는 합성, 물성 제어, 상변이, 소자 응용연구까지 광범위한 부분으로 파급되고 있으며 이제는 이 물질을 상용화하기 위한 글로벌 기업들의 경쟁이 활발하게 이루어지고 있다. 따라서 2차원 물질의 효율적인 연구를 위해서는 기본적인 특성의 이해부터 최근 연구동향의 파악을 통한 응용연구까지 이루어져야 하고 이를 위해 학문의 경계를 초월한 다양한 접근방법을 통한 연구의 확장이 필수적이다. 본 강연에서는 2차원 물질의 연구를 위해 필수적으로 알아야 할 기초 특성부터 소재의 합성법 및 분석 방법을 소개할 것이다. 여기에 반데르발스 이종구조를 이용한 응용소자 연구 및 2차원 물질로 가능한 새로운 응용 분야를 소개하여 2차원 물질 연구자들의 이해도를 높이고 새로운 연구방향을 제시하고자 한다.

Keywords:
two-dimensional materials, graphene, transition metal dichalcogenide, MoS_2, hBN, van der Waals heterostructure

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2016.10.19 - 2016.10.21

Thermodynamics of Langevin systems with velocity-dependent forces

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Abstract:

Thermodynamics of Langevin systems has been well established over the last 150 years. The notion of equilibrium bears no ambiguity, characterized by its fundamental propereties such as the fluctuation-dissipation theorem, detailed balance, no energy dissipation as well as entropy conservation. Recently, it is shown that these properties are completely equivalent to each other, implying that any of them can not be violated unless all are not satisfied simultaneously. However, in the presence of velocity-dependent forces, many of conventional knowledge should be overturned due to the breakage of the microscopic reversibility. In this talk, some surprising and interesting results based on the stochastic thermodynamics will be reported in Langevin systms with velocity-dependent forces, which can apply to a fundamental theory of electromagnetic forces as well as many phenomenological models for cold damping and active matter systems.

Keywords:

nonequilibrium process, thermodynamics, Langevin system, velocity-dependent force

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A1.02*
2016.10.19 – 2016.10.21

Initial ensemble dependence of Jarzynski equality in the thermodynamic limit

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Abstract:
We investigate the initial ensemble dependence of the Jarzynski relation for nonequilibrium work performed on a classical system in the thermodynamic limit. It is shown that the Jarzynski equality holds also for a microcanonical ensemble only if the work process is quasi statically slow. If work is performed by a rapid perturbation, the average of exponentiated work expanded on a microcanonical system markedly deviates from the Jarzynski equality. Such deviation in fact quantifies the ratio of the energy distributions of nonequilibrium states in relative to equilibrium distribution. We exemplify these points in a simple model system both for the cases of deterministic and stochastic dynamics. [1] E. Jeon, Y. W. Kim and J. Yi, J. Phys. A: Math. Theor. 48, 305002 (2015).

Keywords:
Jarzynski equality, ensemble dependence, nonequlibrium fluctuation,thermodynamic limit

Physical ageing of the fractional Arcetri model

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Abstract:

Building on an analogy between the ageing behaviour of magnetic systems and growing interfaces, the Arcetri model, a new exactly solvable model for growing interfaces has been introduced in J. Stat. Mech P05022 (2015). Considering the recent work by Sethuraman (Commun. Math. Phys. (2016) 341: 625) on fractional stochastic Burgers equation, we generalise our Arcetri model to a fractional Arcetri model. The long-time behaviour of the interface width and of the two-time correlators and responses is analysed. In one dimension, we extract the different behaviours depending on the value of the fractional parameter and derive the scaling functions and ageing exponents.

Keywords:
Growth process, long range interaction, exactly solvable model, fractional derivative

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A1.04
2016.10.19 - 2016.10.21

Anormalous behavior of the synchronization stability on power-grid networks

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Abstract:
We explore the transition pattern of the synchronization stability on power-grid networks. The synchronization between power-grid nodes is usually unstable at low coupling strength (intermediate stability) before the power-grid achieves the unity of synchronization with the coupling strength that is large enough. We find that the unity is achieved even at the intermediate phase abnormally. In addition, we identify that the transition pattern of synchronization stability depends on the damping coefficient. For the numerical simulation of stability, we construct the power-grid networks from the real data of Chilean power-grid. We briefly cover the process of converting the real power-grid to a simple network model and simulation results on it.

Keywords:
synchronization, stability transition,power grid, comlex network

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A2.01*
2016.10.19 - 2016.10.21

Manipulating photon statistics using second-order interference between two mutaully incoherent laser beams

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Abstract:

Observations and manipulations of photon bunching properties of light has been studied widely not only for its fundamental interest but also for the potential of bunching, and anti-bunching light as resources for application. In this work we introduce a scheme to manipulate photon statistics of light using the second-order interference of two mutually incoherent laser beams. In our scheme a light source comes out from one of the two interferometer's output is post- selected by the photon detection event from the other output when the second-order intensity cross-correlation of both outputs satisfies a certain condition. We theoretically check the second- order intensity correlation of the post-selected light using Hanbury-Brown-Twiss interferometer to observe the bunching property of it. Under low photon number regime we theoretically derive conditional g (2)(0) by considering the photon number state up to 10. By increasing the intensities of the two mutually incoherent input laser beams up to the point tat the approximation is valid, we show that the conditional g(2)(0) increases. Furthermore, we quantitatively show that the light sources with anti-bunching properties (i.e., g (2)(0) 〈 1) cannot be generated by this method. We believe that our research will contribute many applications that making use of the photon bunching effect by providing an efficient way to manipulate photon bunching rate only by increasing the intensity of laser sources.

Keywords:
Second-order intensity correlation, mutual incoherence,photon bunching effect

Characterization and optimization of single qubit operations in superconducting transmon qubit system

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Abstract:

Characterizing the error rate of a quantum gate and improving it is essential to develope quantum computation technique. Although randomized benchmarking (RB) is an efficient tool to estimate the average gate fidelity of quantum gates, it does not include any further information on the quantum operations. On the other hand, quantum process tomography (QPT) which contains much more extensive information always suffers from inevitable SPAM (state preparation and measurement) errors. In order to characterize and optimize single qubit operations in our system, superconducting transmon qubit in 3D cavity, we performed two types of calibration protocols, i.e., amplitude calibration and DRAG (derivative removal via adiabatic gating) calibration by utilizing pulse sequencies suitable for amplifying specific types of errors of interest. We have also tried gate set tomography (GST) which has been developed recently to overcome the drawbacks of QPT and is supposed to be free from pre-calibration protocols. We present the result of implementation of GST on our system and how it helps to rectify the quantum operations.

Keywords:

quantum operations, fidelity, superconducting transmon qubit

Power robust qubit preparation using a shaped Gaussian pulse

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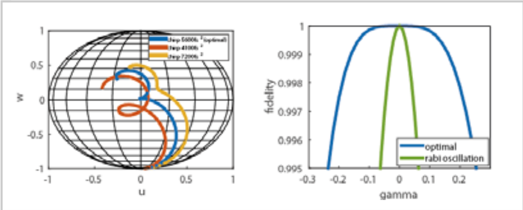
Abstract:



Ultrafast quantum control of atomic qubit state is considered to implement power robust qubit state preparations. To estimate robustness of fidelity, we numerically calculate real part of Fubini-Study metric as function of control parameters, such as detuning, chirp rate, and pulse area used in our experiments. Calculation gives the optimal qubit trajectory (the middle curve with a cusp in the left figure) as a function of the laser power that allows the up-to second-order robustness (the right figure). The qubit trajectory with lower or higher chirp has a loop or a loosened cusp, respectively, making the qubit control less robust than the optimal shape. The preliminary experiment performed with the rubidium 5S-5P 2-level system support that shaped ultrafast Gaussian laser pulses significantly improve the robustness compared to unshaped laser pulses and these pulse can prepare arbitrary qubit states from ground state.

Keywords:
Robust quantum control, femtosecond pulse

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2016.10.19 - 2016.10.21

이온트랩 기반의 양자 메모리 칩과 동위원소 이온 냉각을 통한 저장시간 향상

권영대[1], 안준식[2], 홍석준[1], 이민재[1], 박윤재[1], 조동일[1], 김태현[*2]
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Abstract:
이온트랩을 기반으로한 양자정보처리 소자는 칩 위에서 구현될 수 있기에 앞으로 있을 large-scale quantum computing device를 만드는데에 큰 이점을 가진 도구이다. 칩 위에서 이온트랩을 구현할 때의 한 가지 문제점은 칩 표면의 전기적 잡음 등에 의해 큐빗(qubit) 이온이 쉽게 열을 전달 받아 이온의 운동 에너지가 칩 밖에서보다 더 빠르게 증가한다는 점인데, 이는 sympathetic cooling을 사용해서 해결할 수 있다. 흔히 sympathetic cooling에는 서로 다른 종류의 이온이 사용되며, 따라서 이를 구현하려면 레이저나 렌즈, 필터 등의 광학장치들이 각각의 이온에 맞도록 따로따로 준비되어야 하므로 셋업이 복잡하고 비싸진다. 우리는 다른 종류의 이온이 아닌 동위원소 이온 쌍을 사용하여 sympathetic cooling을 구현하였는데, 동위원소끼리는 에너지 레벨이 서로 비슷하기 때문에 한 세트의 광학장치만으로도 위의 셋업이 가능하였다. 다만, 에너지 레벨이 너무 비슷한 경우에는 cooling을 위한 레이저가 qubit에도 영향을 줘서 양자 결맞음이 너무 빨리 깨질 수 있다. 우리는 qubit 이온으로 ^{171} Yb^{+} 을 사용하고, cooling 이온으로 동위원소인 ^{170} Yb^{+} 를 사용하였을 때에 10초 이상 양자 결맞음이 유지됨을 보였다.

Keywords:
이온트랩, 양자컴퓨터, 양자통신, sympathetic cooling

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Quantum indistinguishability of entangled many photons in coherent state

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Abstract:

We investigate entangled many photons using polarization degree of freedom and coherent state. Due to the duality in entanglement of many photons, one cannot observe the entanglement in both variables at the same time. We propose a generation scheme of polarization-coherent state entanglement. After sorting the entangled state in each variable, we explore the degree of entanglement by means of quantum information protocol.

Keywords:
many photons, entanglement, duality

Generation of the NIR correlated photon pairs in optical nano-fibers

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Abstract:

The correlated photon pair sources find its importance in quantum information processing, quantum communications and photonic quantum computation protocols. In a typical sense, correlated photon pair sources have been studied in $\chi^{(2)}$-based nonlinear crystals, $\chi^{(3)}$-based atomic species and standard optical fibers via the optical parametric process such as spontaneous parametric down conversion (SPDC) and spontaneous four-wave mixing (SFWM). In recent days, the optical nano-fiber has become one of the prospective photon sources to generate the correlated photon pairs due to its future applications in long distance quantum communications and direct integration into micro- or nano-scale photonic devices. In a paper, the generation of photon pairs with telecom/NIR wavelengths was experimentally performed in optical nano-fiber[1]. In our work, we demonstrate here the generation of correlated photon pairs in optical nano-fibers via spontaneous four-wave mixing (SFWM) process. The fiber diameter determines the dispersion property. So, we first calculated the group velocity dispersion(GVD) and propagation constants of the fundamental mode for the proper fabrication. Based on the theoretical calculatoin, we generated the degenerate photon pair in NIR regime by using two different wavelength pump photons simply materialized by a broad-band pulsed laser. [1] Liang Cui, Xiaoying Li, Cheng Guo,Y. H. Li, Z. Y. Xu, L. J. Wang, and Wei Fang, “Generation of correlated photon pairs inmicro/nano-fibers”, Opt. Lett. 38, 5063 (2013).

Keywords:
SFWM, Optical nanofiber, Photon pair generation

Defect-free preparation of two-dimensional single atom arrays by feedback control

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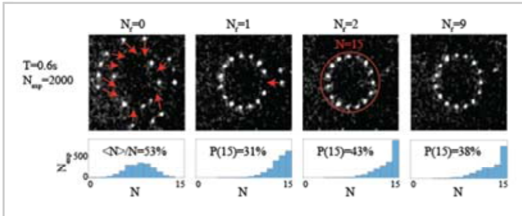

Abstract:
With their intrinsic characteristics as qubits and spin particles, single neutral atom arrays are considered as one of the most promising platforms for quantum computing and quantum simulation in recent years. However, despite their high scalability compared to other systems, trapping of single atoms, so far, has yielded only a partial filling probability; up to 85%, typically 50%, with which loading full trapped arrays of N atoms is nearly impossible as N becomes large. Here, we demonstrate unity filling of single atom arrays with N atoms by a newly devised feedback rearrangement scheme using programmable holographic traps. Rigorous and real-time path planning has been achieved by Hungarian matching algorithm, and atom moving loss was minimized by superposition phase algorithm without much loss of efficiency. We have achieved defect-free N=15 atom arrays with near 50% probability. It is hoped that this method enables wide variety of quantum demonstrations with guaranteed initial states of the arrays.

Keywords:
atom trapping, single atom arrays, quantum computing

Operation of Rechargeable Li-O_2 Cells without CO_2 Evolution

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Abstract:

The Li-O_2 battery has attracted considerable because of their high capacity and potential application in electronic vehicle. However, so far, Stability of component materials against parasitic reactions is a paramount challenge, in particular carbon dioxide (CO_2) evolution has been an unavoidable event for operation of Li-O_2 cells. The origin of CO_2 evolution has been understood as the oxidative decomposition of carbonates which are formed by decomposition of both electrode carbon and electrolyte solvent. While carbon has been used as a common electrode material for Li-O_2 cells, its reactivity toward oxidation and catalytic role for other parasitic reactions make it challenging to be used for practical applications. This talk will present a simple but potent approach to eliminate carbon dioxide evolution by using an ionic solvation. We show that the solvate leads to deactivation of the carbon against parasitic reactions by electrochemical doping of nitrogen into carbon. Detailed methods and mechanistic studies will be discussed throughout the talk.

Keywords:
Graphene, N-doped Graphene, DEMS, Li-Air battery

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Photoelectrochemical water splitting with InGaN/GaN core-shell nanowire for solar hydrogen generation

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Abstract:

The development of a simple structure and well-designed semiconductor photoanode to improve the photoelectrochemical (PEC) water splitting (WS) performance by producing a higher photocurrent density together with the efficient hydrogen energy production may be considered a challenge. Among the semiconductor materials used in PEC WS, GaN showed a superior performance due to its good corrosion resistivity in acidic solutions and its band gap controllability by alloying with InGaN that can cover a large portion of the entire solar spectrum. In this study, we developed InGaN/GaN core-shell nanowires to improve the PEC WS performance based on controlling the structural parameters of InGaN MQWs on the nanowire sidewall. The experiments revealed that this nanoscale photoanode can convert up to 8.6% of the illuminating light into photocurrent that can be utilized for the facile generation of hydrogen fuel with a 0.21% solar-to-hydrogen conversion efficiency, which is comparable to that of the natural photosynthesis. Further enhancement of the conversion efficiency was achieved by tuning the thicknesses of GaN and InGaN shells. Samples with lower QW thickness showed a large onset potential and a low photocurrent density that led to low incident-photon-to-current conversion efficiency (IPCE). As the QW thickness approached 6 nm, negligible localization as well as improved photoemission quality were achieved, which lead to a small overpotential and a high IPCE of approximately 15%. The result demonstrated that the efficient photoanode requires a high crystal quality and weak localization, which can be achieved through the careful structural optimization. The result opens up new possibility of utilizing semiconductor nanowires for reliable and efficient photoanodes of solar hydrogen generation.

Keywords:
photoelectrochemical, water splitting, InGaN, nanowire

Active hydrogen evolution in a pristine $MoTe_2$ single crystal

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Abstract:

Engineering surface atoms of layered transition metal dichalcogenides (TMDs) is a promising way to design catalysts for efficient electrochemical reactions including the hydrogen evolution reaction (HER) (ref. 1, 2). However, materials processing based on TMDs, such as vacancy creation[3], edge exposure[1,2,4], or mechanical strain[5], has resulted in insufficient atomic-precision homogeneity over a wide area. Here, we report a durable and effective HER in a pristine metallic $MoTe_2$ single crystal with intrinsic turnover frequency of 0.14 s^{-1} at 0 mV overpotential, which is similar to that of platinum. The rate-determining step of the HER on the $MoTe_2$, hydrogen adsorption, drives Peierls-type spontaneous lattice distortion that, together with a surface charge density wave, unexpectedly enhances the HER. Moreover, exceptional HER performance, with a Tafel slope of 22 mV per decade and an exchange current density of 1.0 mA/cm^2, was realized by hybridizing the $MoTe_2$ with platinum, thus paving the way for a hydrogen economy.

Keywords:
Hydrogen evolution, MoTe2, 2D materials

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Energy interactions in two-dimensional crystals-based heterostructures

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Abstract:

The next generation electronics need to not only be smaller but also be more flexible and transparent. To meet such demands, van der Waals (vdW) heterostructures using two dimensional (2D) atomic crystals such as graphene, hexagonal boron nitride (h-BN) and transition metal dichalcogenides (TMDCs) have been attracted intensely. In particular, the ultraclean interface between stacked 2D atomic crystals should be guaranteed for high performance of vdW heterostructures device. Furthermore, dipole-dipole interaction between 2D crystals and conventional semiconductors is also an attractive issue for energy harvesting studies. In this talk, I will present the vdW heterostructure field effect transistors (FETs) toward performance enhancement and graphene semiconductor quantum well (QW) heterostructure for investigating resonance energy transfer behaviors.

Keywords:
graphene, 2D materials, semiconductor quantum wells, resonance energy transfer

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Overcoming radiation trapping effect by a cuboid slot

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Abstract:

We show resonant plasmonic modes of a single cuboid slot can overcome radiation trapping to a high refractive index material. By coupling dipole emitter's radiation into specific resonance mode of the slot, it is possible to obtain highly directional radiation from a single dipole emitter either to the dielectric substrate (with higher refractive index) or to free-space (with lower refractive index). Tuning resonance at the air-slot interface and that of dielectric substrate-slot interface allows controlling radiation directional gain. We show that over 90% of total radiation coupled to far field can be directed to free-space. Even with the surface plasmon loss generated owing to the slot, the radiation power and directionality can be enhanced compared to an isolated single quantum emitter on the same dielectric substrate. We classified the plasmonic modes by varying the thickness of a slot antenna to search for the conditions of radiation power and directional gain. The Up-to-Down (U/D) ratio, defined by the integrated power ratio between radiations into the air and into the substrate, ranges from 11.2dB to -9.7dB depending on the geometry of the slot antenna in the visible spectrum.

Keywords:

Plasmonics, Optica Antenna, Metamaterial

Single photon emission of InAs QD with GaAs/Air-gap based Distributed Bragg Reflector

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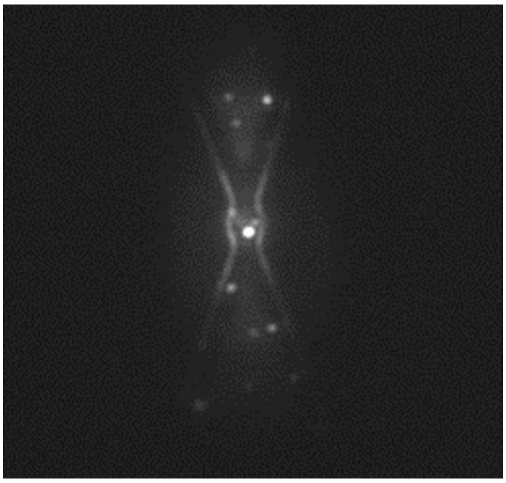

Abstract:

The Fabry-Perot optical micropillar cavities using GaAs/AlAs Bragg reflector pairs have played a major role in single photon emission of InAs quantum dot(QD). They provide relatively high Q factor and can incorporate electrical driven device. Since the small difference of refractive index between GaAs and AlAs, a large number of layer stack (typically 20 to 40) is essential at GaAs/AlAs based micropillar to provide high Q factor and involves relatively long cavity length. The several challenging to reduce the effective cavity length due to light penetration depth have been reported. A double GaAs/air DBR microcavity with integrated quantum wells maximizes the difference of refractive index between DBR stacks and features Q factors exceeding 3000. We study the single photon emission of InAs quantum dot with a GaAs/air DBR structure. A GaAs/Air DBR was simulated by FDTD method and then fabricated by MBE growth and photolithography process. The structure like a bow-tie and selective etching process allows stable GaAs/air DBR region with sub-micron sized microcavity. The single photon emission of InAs QD with a GaAs/air DBR was confirmed with a HBT experiment.

Keywords:
Single photon emission,Quantum Information,Nanocavity

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Directional-coupler-type polarization beam splitter with a bridged silicon wire waveguide for high polarization extinction ratios

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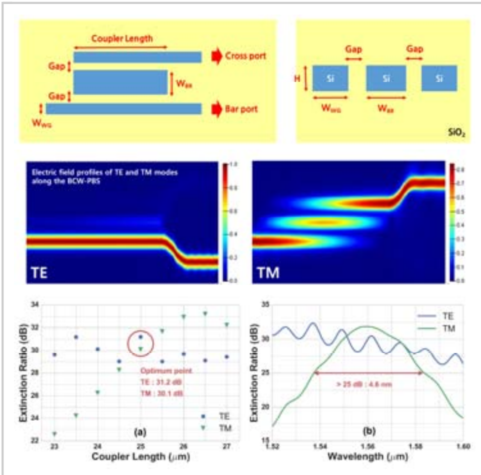
Abstract:

Integrated-type polarization beam splitters (I-PBSs) are very important devices for photonic integrated circuits because silicon photonic devices have an inherent polarization sensitivity [1]. Various approaches to high performance I-PBSs have been reported based on directional coupler (DC), plasmonics, and photonic crystal. However, most of the PBS devices have either a low polarization extinction ratio (PER) below 30 dB or a complicated device structure. In this paper, we present numerically calculated results on integrated directional-coupler PBS structure with a single bridged silicon wire waveguide on a silicon-on-insulator (SOI) wafer providing a high PER value above 30 dB for both TE and TM polarization modes. Basic operation principle of our bridged-coupled-waveguide-type PBS (BCW-PBS) is based on the different phase matching condition between the TE and TM polarization modes in the coupled waveguides. Three waveguides of the bridged coupler excite three TE and TM modes which are two even (A, B) and one odd (B) modes. From the mode beating (MB) theory, an optical beam power is coupled into the other coupled waveguide from the incoming waveguide when the propagation vectors of the thee modes satisfy a phase matching condition ($2\beta_C - \beta_A - \beta_B = 0$) [2]. While the TM mode is in a phase-matched condition, the TE modes are out of phase matching ($\beta_A >> \beta_B \approx \beta_C$). This means that the TE mode passes along the initial input waveguide without coupling to the other waveguide during its propagation over the coupling region, while the TM mode couples into the other coupled waveguide and exits out from the crossed output port. An initial SOI scheme of the BCW-PBS has been demonstrated experimentally to deliver a PER performance greater than 22 dB in an air clad condition [3]. We have performed detailed numerical simulations on the phase matching condition of the BCW-PBS formed on a SOI wafer of 220-nm-thick Si layer with an upper SiO_2 clad for various parameter conditions of the waveguide width, bridge width and gap. Effective indices of the excited modes in the three waveguides and the phase matching condition for the TM mode are calculated with the finite difference eigenmode (FDE) method, and used to determine an optimized condition of the BCW-PBS (waveguide width = 500 nm, gap = 400 nm and bridge width = 511 nm). The maximum PER values calculated with finite-difference time-domain (FDTD) method are 31.2 dB and 30.1 dB for TE and TM modes, respectively, at 1,550 nm wavelength with a coupler length of 25 μm. The corresponding insertion losses are 0.1 dB and 0.2 dB for TE and TM modes, respectively, and the wavelength bandwidth for PERs above 25 dB is 4.6 nm. 1. T. Barwicz, et al., Nature Photonics 1, 57-60 (2007) 2. D. W. Kim, M. H. Lee, Y. K and K. H. Kim, Optics Express 23, 998-1004 (2015) 3. J. P. Donnelly, IEEE J. Quantum electron. QE-22, 610-616 (1986)



Keywords:
Integrated optics devices, Silicon photonics, Polarization Beam Splitter, Waveguide

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Semicondutor type dependent role of metal nanoparticle in metal/semiconductor nanostructured junction

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Abstract:

Hybrid nanostructures have attracted attention due to many novel properties that are lacking in any one material. Among hybrid nanostructures, semiconductor with metal nanomaterials have been more exploited because metals and semiconductors have different properties that, in combination, result in unique electrical and optical properties. Localized surface plasmon resonance (LSPR), which is one of the novel properties of metal nanoparticles (NPs), has been used as a good strategy for increasing the opto-electric performance in semiconductors. In this presentation, improvement of the opto-electronic properties of non-single crystallized nanowire (NW) devices with space charges generated by LSPR is demonstrated. The photocurrent and spectral response of single polypyrrole (PPy) NW devices are increased by electrostatically attached Ag nanoparticles (NPs). In particular, it is also proved the space charge generation by LSPR of Ag NPs by means of characterizing current-voltage (J-V) dependence and finite-differential time domain (FDTD) simulation on the NW devices. Moreover, semiconductor type dependent role of metal NP in metal NPs decorated semiconductor NW is demonstrated by using light irradiated Kevin probe force microscopy.

Keywords:

Surface plasmon, metal/semiconductor junction, Kelvin probe force microscopy

Broadband and Strong Optical Absorption in Diameter-modulated Silicon Nanowire Arrays

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Abstract:

Through controlling the geometry of nanostructure, the tight light confinement in semiconductors can be achieved to realize the broadband and strong optical absorption, which is essential for improving the efficiency of photovoltaic devices. Here, we present a periodically diameter-modulated silicon nanowire array formed by using common semiconductor fabrication method, showing strong and closely spaced optical resonances to enhance absorption over a wide spectral range. For a broadband wavelength range from 400 to 900 nm, the reflectance of the diameter-modulated silicon nanowire arrays on silicon substrate are decreased by 61.7% compared with that of the planar bulk silicon, and multiple resonance peaks are clearly observed over the wide spectral range. More interestingly, a substantial proportion of the Poynting vector points in the transverse direction, corresponding higher-order mode excitations, which is dominant in diameter-modulated nanowire, while the single-diameter nanowire shows parallel Poynting vector points to the axis of the wires. To understand the resonance modes that are responsible for the closely spaced absorption, we analyzed leaky guided modes in the diameter-modulated nanowire through 3D finite-difference time-domain (FDTD) simulations. Our finding is that the stronger and more closely spaced resonant peaks originate from these substantial transverse components of the Poynting vector, giving rise to enhanced coupling with the higher-order mode resonances by means of the variable diameter. Our results suggest that the shape engineering of silicon nanostructure can pave the way not only for the optimization of light absorption but also for enhancing the performance for future nanostructure-based optoelectronic devices.

Keywords:
nanowire, broadband absorption, leaky guided mode, semiconductor

An optical slot antenn as a magnetic dipole

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Abstract:

Recently, an optical nanoantenna has already been established as a useful device in the control of electromagnetic waves, and are used for the detection and directional radiation of resonant light in the subwavelength scale. In addition, it has been shown that various antenna designs can be used to a basic unit for metasurfaces, which are subwavelength structures that control the amplitude, polarization, and phase of light at the interfaces with several submicrons. Most of reported antennae have been composed of metal rods and worked as electric dipoles. Here, we first demonstrate that an optical slot antenna can be regarded as a magnetic dipole comparted to an optical rod antenna. The measured Fourier-space image of a single metal slot clearly shows a dipole radiation and we find that the resonance wavelength is related with a slot length linearly as like the rod-type antenna. Using 3-dimensional finite-difference time-domain (3D FDTD) simulation, we find that this Fourier-space image is identical to the far-field radiation pattern from a magnetic dipole. Additionally, this slot antenna can be combined with another plasmonic elements fabricated on the metal plane and we expect that it will be an essential component in plasmonic integrated circuits in the future.

Keywords:
optical slot antenna, electric dipole, magnetic dipole, metasurface

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2016.10.19 - 2016.10.21

전반사 감쇠법을 이용한TiN의 플라즈모닉 특성 연구와 메타물질 응용

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Abstract:

메타물질(metamaterial)과 플라즈몬 소자(plasmonics)들의 상용화에 있어서 해결해야하는 중요한 과제는 메타물질과 플라즈몬 소자에 주로 사용되는 금이나 은이 가시광선 파장대에서의 손실이 크다는 것이다. Titanium nitride (TiN)와 같은 전이금속-질화물은 금에 비해 광학적 손실이 적고, 가시광 영역 근처에서 유전상수의 실수부의 크기가 일반적인 금속에 비해 작다. 근 적외선 영역에서 유전상수의 실수부가 음수이므로 이 영역에서 메타물질과 플라즈몬 소자들에 사용되기에 적합하다. 표면 플라즈몬(Surface plasmon polariton)은 일반적으로 음의 유전 함수를 갖는 금속과 양의 유전 함수를 갖는 매질의 경계면을 따라 진행하는 파로 금속 표면 전자들의 밀도 진동현상을 말한다. 본 연구에서는 타원편광분광계를 이용하여 TiN 박막의 유전상수 스펙트럼을 측정하고 거기에 바탕 하여 전반사 감쇄가 일어나는 파장영역을 확인하였다. 실험에서는 전반사 감쇠법(Attenuated Total Reflection, ATR)을 사용해서 TiN의 표면 플라즈몬을 여기시킴으로 TiN의 가시광선-근적외선 영역에서의 플라즈몬 소자와 메타물질에서의 적용 가능성에 대해 보이려고 한다.

Keywords:
전반사 감쇠법, TiN, 표면플라즈몬, 메타물질

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2016.10.19 - 2016.10.21

Identification of Surface Plasmon, Hyperbolic Dispersion and Interference Effects on Spontaneous Emission near Metamaterial Nanostructures

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Abstract:
Surface plasmon polariton, hyberbolic dispersion of energy and momentum, and emission interference are known to provide opportunities to control photoluminescence properties. However, the regimes where each of them dominates or overlaps with one another remain to be clarified to fully understand and take advantage of these phenomena in optoelectronic applications. Here, we investigate, both experimentally and theoretically, broadband effects of hyperbolic metamaterial (HMM) multilayer structures on the spontaneous emission of selected organic chromophores of which emission spans across the UV-vis spectral range. The spontaneous emission lifetime of chromophores embedded in a polymer matrix located on top of HMM nanostructures is shown to vary in a non-monotonous way when the chromophore-to-surface distance is progressively adjusted. We identify surface plasmon polaritons, hyperbolic dispersion and emission interference dominant regions as a function of the emitters HMM substrate separation. We also show that the spontaneous emission lifetime is similarly affected by transverse positive and transverse negative HMMs. Finally, we provide theoretical calculations to better understand the involved mechanisms. We employ a dimensionless parameter to identify these three regions and as a formalization tool for further studies. Calculations and experimental results are in good agreement and the former are used to predict the photophysical responses, which could be observed when varying further the HMM nanostructures. This work has broad implications on the rational design of functional photonic surfaces to control the luminescence of organic semiconductor chromophores.

Keywords:
HMM

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2016.10.19 - 2016.10.21

Gate controlled Photothermoelectric Effect in Topological insulator.

LEE Seungmin[1], KHO Byung Woo[2], PARK Jun[1], KIM Ho Il[2], LEE Jekwan[1], CHA Soonyoung[1], PARK Sungjoon[1], SHIN Hoseung[1], KIM Jun Sung[2], CHOI Hyunyong[*1]

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Abstract:

Three-dimensional topological insulators (TI) are considered a promising material for a new generation of ultrafast photonics and optoelectronics because of their novel two-dimensional surface state (TSS) described by 2D Dirac equation. In general Dirac material, such as graphene and carbon nano tube, photothermoelectric effects lead to asymmetric six-fold photovoltage pattern as a function of top - bottom gate voltages at p-n junction. Recent experiment work, however, has not shown photothermoelectric effect in TI with dual gate sweep. Applying back gate voltage (V_{BG}) and top gate voltage (V_{TG}) as opposite polarity can induce p-n junction at the interface of p-type and n-type regions in bulk TI. With gate tuning, fermi energy (E_F) can be tuned reaching the charge neutrality point (CNP) but in TI, at room temperature, thermal activated carriers screening the natural transport characteristic of TSS. In this study, we report gate voltage controlled photothermoelectric effect in dual gate TI p-n junction device with temperature dependence experiment. We can see photothermoelectric current flip the sign as V_{TG} polarity change at edge of the top gate. It can be described in the thermoelectric current relation of $I_{PT} = (S_2 - S_1)\,\Delta T$ where S is thermoelectric power (Seebeck coefficient) in the bottom and dual gate regions and ΔT is laser - induced temperature gradient proportional to the electron temperature difference between optical excited top - gate edge region and surrounding. From the Mott relation, we can see seebeck coefficient is proportional to the derivatives of the density of states d[D(E)]/dE near the E_F. But seebeck coefficient in TI has an abnormal temperature dependence because of thermal activated carrier in bulk valance band. Therefore, map of photocurrent versus top and bottom gate has different asymmetric folding pattern depend on temperature.

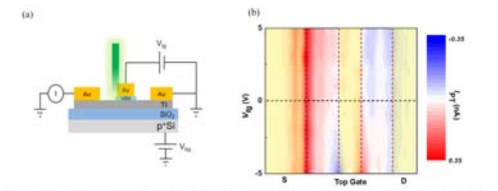

Figure 1. (a) Schematic of the dual gate TI device (b) Photocurrent mapping with the top gate voltage dependence along the x-axis (Source to Drain axis) in room temperature. Photocurrent sign at edge of the top gate flip according to top gate voltage polarity change.

Keywords:
Topological insulator, Photothermoelectric current, seebeck effect, Scanning photocurrent microscopy, BSTS

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2016.10.19 - 2016.10.21

Gate-tunable infrared photodectors based on a graphene-Bi_2Se_3 heterostructure with high responsivity at room temperature

PARK Sungjoon[1], KIM Jaeseok[1], JANG Houk[1], KOIRALA Nikesh[2], LEE Jae-bok[1], KIM Un Jeong[3], ROH Younggeun[3], LEE Hyangsook[4], SIM Sangwan[1], CHA Soonyoung[1], IN Chihun[1], PARK Jun[1], LEE Jekwan[1], MOON Jisoo[2], SALEHI Maryam[5], SUNG Ji Ho[6], JO Moon-Ho[6, 7], OH Seongshik[2, 8], AHN Jong-Hyun[1], HWANG Sungwoo[3], KIM Dohun[*9], CHOI Hyunyong[*1]

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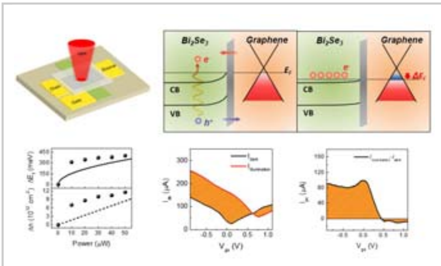

Abstract:

Broadband infrared photodetection is at the heart of various practical applications such as imaging, sensing, and telecommunications. Graphene which has ultrabroad absorption characteristics covering ultraviolet, visible, and infrared is an attractive material candidate for the ultrabroadband photodetectors. Since the infrared absorption characteristics can be selectively achieved in several low bandgap materials, graphene is believed to be an emerging building block, possibly for replacing the conventional narrow band gap semiconductor compounds. However, the responsivity of graphene-based photodetectors has been limited in tens of mAW^{-1} due to the unique quantum absorption characteristic and the absence of an additional gain mechanism. Here, we report a high responsivity infrared photodetector covering near- and mid-infrared (IR) regimes based on a vertically-constructed graphene-Bi_2Se_3 heterostructure. Bi_2Se_3—a representative topological insulators (TIs)— is a low bandgap material, where the Dirac-like surface state coexists with the low-bandgap bulk state. The advantages to use of TIs for infrared detectors are that TIs have a very small band gap (0.3 eV in the case of Bi_2Se_3) which can absorb regime of the mid-infrared range and the TI surface states preserve the coherence of the electronic states up to room temperature thanks to the spin-momentum locking. Thus, in our device, Bi_2Se_3 is used as not only a light absorption layer for infrared regime but also a layer supplying photoinduced charges into an active graphene layer. In addition, because of the naturally formed surface oxidation of Bi_2Se_3, the interface between graphene and Bi_2Se_3 forms an effective tunneling junction even if a designed barrier is not inserted between the two materials. The intrinsically-formed tunneling junction between Bi_2Se_3 and graphene can function for separating two types of hot-carriers between Bi_2Se_3 and graphene. The built-in potential due to the work function difference of the two materials also accelerate the selective hot-carrier tunneling, leading to build-up of the hole charges. Therefore, under light illumination, photoexcited electrons(holes) are transferred to Bi_2Se_3 (graphene). The moved electrons are trapped in Bi_2Se_3 states and accumulate. As a result, these trapped charges play role as a negative gate bias and make Fermi-level of graphene downward which is called photogating effect. Strong photogating effect across the tunneling barrier and builit-in potential enables the internal quantum efficiency larger than 100%. Under a gate bias condition through high capacitive ion-gel with photogating effect, the photoresponsivity of graphene channel increases up to ~1.97 AW^{-1} in the mid-infrared regime (λ = 3.5 μm) and ~7 ... regime (λ = 1.30 μm) at room temperature. Our demonstration provides a novel ...k for developing high-responsivity photodetectors.

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Keywords:
Photodetector, Heterostructure, Topological insualtor, Graphene, Photogating effect

Ultrafast control of plasmon-phonon coupling using topological phase transition in $(Bi_{1-x}In_x)_2Se_3$

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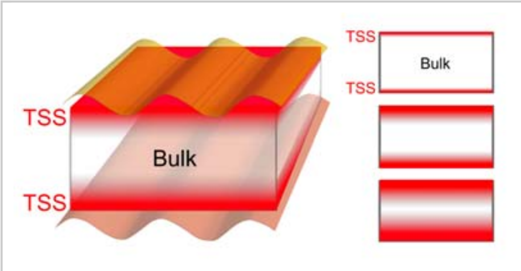

Abstract:

A topological insulator (TI) is a unique electronic system where gapless Dirac surface states coexist with normal insulating bulk. Recent studies have reported that the surface plasmon in TIs strongly interplays with bulk lattice vibration modes in the terahertz (THz) range, which give rise to unique spectral profiles for various photonic and optoelectronic applications. However, a technology for controlling the plasmon-phonon interaction is still lacking, which significantly restricts the applicability of TI-based plasmonic devices. As a new strategy for controlling the plasmon-phonon interaction, we consider a tunable system where the topological quantum phase transition (QPT) is possible. $(Bi_{1-x}In_x)_2Se_3$ is a representative example where the quantum phase transition can be manipulated by controlling indium atom concentration (x). While the TSS (red regions) can exist due to strong SOC at $x < 0.06$, the system enters into the non-topological phase due to the weak SOC when x is larger than a critical value (~ 0.06). Here, it is important to note that the TSS wavefunctions penetrate into underlying bulk more deeply with increasing x in the topological phase ($x < 0.06$). In this work, by utilizing both static and ultrafast THz measurements, we show that the plasmon-phonon interaction can be controlled by manipulating the spatial overlap between TSS and bulk in micro-ribbon array structures of $(Bi_{1-x}In_x)_2Se_3$. The static indium-concentration-dependent THz spectroscopy shows that the increased TSS-bulk spatial overlap leads to enhancement of the strength of the plasmon-phonon interaction in the topological phase. Ultrafast THz measurements reveals that that the robustness of interaction is induced by the controlled large spatial overlap between TSS and bulk at $x = 0.04$, which sustains the Fano-type interaction of plasmon with phonon even under strong optical excitation. Our study provides a novel methodology for controlling plasmon-phonon interaction in the potential TI-based plasmonic devices.

Keywords:
topological insulators, plasmonics, ultrafast terahertz spectroscopy, plasmon-phonon interaction,topological phase transition

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2016.10.19 - 2016.10.21

Fano coupling of Dirac surface plasmon and phonon in topological insulator Bi_2Se_3 microslits

IN Chihun[1, 2], SIM Sangwan[1], PARK Jun[1], KIM Jaeseok[1], PARK Sungjoon[1], KOIRALA Nikesh[3], BRAHLEK Matthew[3], MOON Jisoo[3], SALEHI Maryam[4], OH Seongshik[3], CHOI Hyunyong[*1]

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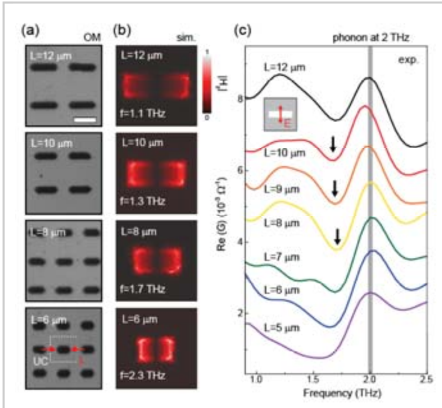
Abstract:



One of the exotic surface properties of topological insulators (TIs) is that the electrons in the TI surface are immune to the non-magnetic defect scattering. Compared to the conventional plasmonics based on noble metals, TI plasmon is expected to provide two-dimensionally confined collective charge oscillations. The THz properties of TIs are important, partly because the THz conductance is supported by two-dimensional electron gas and also because of the spectral overlap with bulk phonon oscillation. Here, we directly fabricated microslit structures on the surface of Bi_2Se_3 topological insulator thin films, and investigated the coupled interaction between plasmon and phonon resonances. Upon changing the dimension of Bi_2Se_3 microslits, the plasmon frequency is gradually modulated from 1.1 THz to 2.7 THz. For the sample preparation, Bi_2Se_3 thin films were grown by molecular beam epitaxy on 0.5-mm-thick sapphire (Al_2O_3) substrate. The thickness of thin film was 25 quintuple layers (that is, ~25 nm). Figure 1(a) shows the optical microscopic (OM) images of the fabricated microslits, where the slit length L was increased from 5 um to 12 um, the width was fixed to 4 um, and the unit cell dimension was L+4 um by L+4 um. For the terahertz time-domain spectroscopy, ultrashort laser pulse emitted from regenerative amplifier (Coherent 9050) was employed. THz frequency ranging from 0.5 THz to 3 THz was generated by optical rectification in a ⟨110⟩-oriented ZnTe crystal. The transmitted THz beam through Bi_2Se_3 microslit was collected in another ⟨110⟩-oriented ZnTe crystal where the electro-optic sampling reads the amplitude of THz electric field. For the surface plasmon excitation, the polarization of THz electric field should be perpendicular to the long direction of microslits. Figure 1(b) shows the simulated z-component of magnetic field magnitude $|H_z|$ on TI microslits induced by the incident THz electric field. With decreasing L from 12 um to 6 um, the resonance frequency shifts from 1.1 THz to 2.3 THz. Since the plasmon resonance is supported by the anti-dipole oscillation along the long direction of microslit, the decreased length of slit results in a higher THz frequency resonance. Figure 1(c) presents the real part of the microslit conductance. Along with the intrinsic in-plain phonon resonance residing around 2 THz, a broad background plasmon resonance is observed. When the long length of microslit is reduced, the plasmon frequency is shifted to a higher frequency. Having elucidated the length-dependence of THz plasmons in the TI microslits, we discuss the hybridized effect of plasmon-phonon response. When the plasmon resonance is overlapped with the intrinsic TI phonon resonance, a conductance dip emerges between the plasmon and phonon frequencies (L=10 um, 9 um, 8 um), i.e. Fano-like destructive interference. The vertical arrows in Fig. 1(c) indicate the coupled response of plasmon and phonon excitation. In conclusion, we performed the THz time domain spectroscopy on the Bi_2Se_3 microslits. Controlling the length of long direction of slits, we obtained the modulated plasmon spectral responses. The hybridized effect of plasmon-phonon interaction is understood by the perturbative interaction.

Keywords:
topological insulator, plasmon, terahertz, phonon

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Tuning resonant second harmonic generation of monolayer MoS_2 by selenium doping

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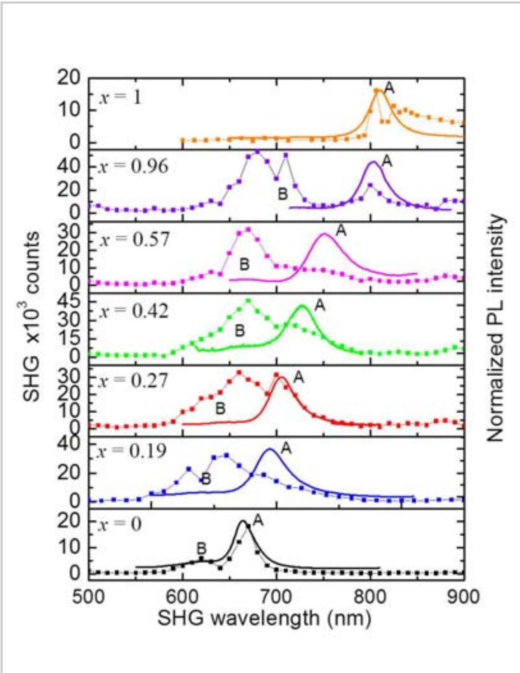

Abstract:

Spectral tunability of exciton states is achieved in monolayer transition metal dichalcogenides (TMDCs) via alloying, which in turn provides broader spectral access of second harmonic generation (SHG) and enhancing second-order nonlinear optical susceptibility, $\chi^{(2)}$ for nonlinear optical applications. In this study, SHG of $MoS_{2(1-x)}Se_{2x}$ alloy prepared by chemical vapor deposition over a wide Se doping range is systematically investigated under picosecond pulsed laser excitation. Sample quality of monolayer alloy is verified by atomic force microscopy, Raman spectroscopy, and photoluminescence analysis. Both polarization and wavelength-dependent SHG (fundamental wavelength λ=1000-1800 nm nm) measurements also reveal that the monolayers are high quality as evidenced by excellent SHG response. The tunability of resonantly enhanced SHG is demonstrated in accordance with band-gap-engineered A- and B-exciton states with significant spectral broadening. The controllability of manipulation of $\chi^{(2)}$ dispersions of TMDC monolayers via alloying is well revealed, where the underlying crystal symmetry essentially remaining intact. This further implies a possibility to spectrally stretch SHG resonance through an artificial van der Waals material by vertically stacking the series of alloyed monolayers.

Keywords:
Mo(S,Se)2 alloy monolay, second harmonic generation,second-order nonlinear optical susceptibility

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Efficiency enhancement of perovskite solar cells with nanostructured photoactive layers

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Abstract:
Organic-inorganic halide perovskite materials have recently emerged as light-harvesting materials with high efficiencies driven by the large absorption coefficients and long-range balanced electron and hole transport lengths. In this study, we have fabricated mixed halide perovskite solar cells with periodically-nanostructured photoactive layers by a nanoimprint lithography technique. Nanoimprinted photoactive layers with various periodicities from 300 nm to 800 nm were characterized by measurements of atomic force microscope images and transmission spectra. The perovskite solar cell with 1D periodic nanostructure shows improvement of device performances such as a short circuit current and a power conversion efficiency compared to those of a conventional device with a planar photoactive layer. Hence, the photoactive layer with an appropriate periodicity can enhance absorption of light, thereby increasing the photocurrent and the power conversion efficiency.

Keywords:
Perovskite, solar cell, nanoimprint lithography

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Visible-wavelength distributed feedback laser from formamidinium lead halide perovskites thin films

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Abstract:
가시광 영역에서의 높은 흡수율, carrier의 diffusion length와 lifetime이 길다는 점, 그리고 높은 PL 양자효율 등의 이유로 methylammonium lead halide perovskite 물질은 차세대 light emitter의 한 대안으로 대두되어 현재 활발한 연구가 진행 되고 있다. 본 연구에서는 halide stoichiometry를 통한 가시광 영역에서의 파장변화가 가능하다는 점을 이용하여 bromine과 iodine의 조성비를 조절함으로써 600 nm 파장대 발광이 가능한 $CH(NH_2)_2(I_{0.4}Br_{0.6})_3$ thin film을 간단한 spin-casting 방법을 통해서 구현하였다. 나아가 이러한 active medium을 passive 구조인 1차원 광자결정 구조에 결합 시켜 단일 파장에서 구동하는 레이저를 구현하였다. 실험에 이용된 1차원 광자결정구조의 경우 laser interference lithography (LIL) 방법을 통하여 대면적에 1차원 distributed feedback (DFB) 레이저 구조를 구현 하였다. 특히, 동일한 구조 내에서 간단한 구조적 parameter의 변화만으로 서로 다른 편광 방향에서 발진하는 레이저를 구현하였다. 이러한 passive 구조와 active 물질의 결합을 통한 hybrid photonics는 미래 광소자 분야에 폭넓게 응용이 가능할 것으로 기대를 하고 있다.

Keywords:
formamidinium, halide perovskite, photonic crystal, DFBlaser, optoelectronic applications

Electronic structures and excitation spectra in correlated spin-orbit oxides: Sr_2IrO_4 and Na_2IrO_3

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Abstract:

Sr_2IrO_4 and Na_2IrO_3 are referred to as J_{eff}=1/2 Mott insulators, in which the strong spin-orbit (SO) coupling and the Coulomb correlation interaction stabilize the insulating states by splitting $5d^5$ shell into half-filled J_{eff}=1/2 and fully-occupied J_{eff}=3/2 states. The strong SO couplings in these systems induce intriguing physical properties, which do not appear in conventional 3d Mott insulators, such as SO exciton peaks in the resonant inelastic scattering (RIXS) spectra. Furthermore, they exhibit a bit different low energy excitation feature from each other. The optical spectrum s(w) in Sr_2IrO_4 shows two peaks, while s(w) in Na_2IrO_3 shows a single broad peak. We have investigated their optical and RIXS spectra using the model multiplet-structure calculations as well as the density-functional theory (DFT) band calculations. We have also addressed their insulating nature, Slater-type or Mott-type, by examining their temperature-dependent electronic structures on the basis of a combined scheme of the DFT and the dynamical mean-field theory (DMFT). We have shown that the insulating state for Na_2IrO_3 persists even above the N ́ eel temperature, which reveals the Mott-type insulating nature.

Keywords:
J_{eff}=1/2 Mott insulators;spin-orbit coupling, Coulombcorrelation interaction;opticalspectrum;RIXS spectrrum

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Infrared study on the electronic response of $(Sr_{1-x}La_x)_3Ir_2O_7$

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Abstract:

Since the discovery of the effective total angular momentum J_{eff}=1/2 Mott state, Ruddlesden-Popper series irdiates $Sr_{n+1}Ir_nO_{3n+1}$ have been attracting a great deal of attention as a 5d counterpart of the high-T_c cuprates. Studies on the electrodynamics of the charge-carrier-doped $Sr_{n+1}Ir_nO_{3n+1}$ are essential to search for exotic correlation-induced phenomena. In this talk, I will present infrared spectroscopic data of electron-doped $Sr_3Ir_2O_7$, $(Sr_{1-x}La_x)_3Ir_2O_7$. Our data showed that electron doping led to an insulator-metal transition that is reminiscent of the Mott transitions in strongly correlated 3d/4d transition metal oxides. We observed a spectral weight transfer from high energies to the ingap region to fill the charge gap of the parent compound. The intraband conductivity of the electron-doped compounds was found to be composed of a coherent and an incoherent responses. The sum rule and the extended Drude model analyses data revealed a substantial mass enhancement of the charge carriers in the metallic compound. Our results demonstrate a critical role of electronic correlations in the charge dynamics of the $(Sr_{1-x}La_x)_3Ir_2O_7$ system.

Keywords:
$(Sr_{1-x}La_x)_3Ir_2O_7$, iridates, infrared spectroscopy, electronic correaltions

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Band Gap and Physical Parameters of the Kitaev Material α-$RuCl_3$

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Abstract:
양자 스핀 액체 상태를 구현할 수 있을 것으로 예상되는 벌집 격자 Kitaev 모델이 제안된 이후, 이 모델의 대상이 될 수 있는 물질들에 대한 연구가 시작되었다. Na_2IrO_3, Li_2IrO_3 등의 벌집 격자 이리듐 산화물에서 시작된 관련 연구는 최근 새로운 후보물질인 α-$RuCl_3$의 발견으로 다시 활발히 진행되고 있다. 그러나 α-$RuCl_3$의 성공적인 자성 연구들과는 대조적으로, 이 물질의 전자 구조에 대한 연구는 상대적으로 부족한 상황이다. 이 발표에서는 광전자 분광학과 역 광전자 분광학 방법을 이용해 분석한 α-$RuCl_3$의 전자 구조에 대해 이야기할 것이다. 이 물질의 밴드 갭은 지금까지 추측되던 것보다 훨씬 큰 1.9 eV로 측정되었다. 또한 이 밴드 갭을 이용한 국소 밀도 근사 계산을 통해 이 물질의 부도체 특성이 스핀-궤도 결합 없이 Coulomb 상호작용에 의해 설명될 수 있다는 것을 보였다. 그러나 측정된 밴드 갭의 크기를 재현하기 위해서는 스핀-궤도 결합이 반드시 고려되어야 한다는 것을 동시에 확인했다. 또한 국소 밀도 근사 계산으로 설명되지 않는 스펙트럼의 특징들을 설명하기 위해 짜임새-상호작용 계산을 수행했으며, 이를 통해 Kitaev 모델과 관련된 여러 파라미터를 성공적으로 얻어내었다.

Keywords:
α-$RuCl_3$, Kitaev model, Inverse photoemission spectroscopy

Genome editing using CRISPR nucleases and its applications

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Abstract:

Genome editing with engineered nucleases such as ZFNs (zinc finger nucleases), TALENs (transcription-activator-like effector nucleases), and CRISPR/Cas9 or CRISPR/Cpf1-derived RNA-guided endonucleases (RGENs) is broadly useful for biomedical research, biotechnology, and medicine. Unlike ZFNs and TALENs whose DNA specificities are determined by DNA-binding proteins, CRISPR nucleases use complementary base pairing to recognize target sites. Now, CRISPR nucleases are widely used due to the ease of use and inexpensive cost; researchers can induce gene editing at different sites by simply altering the guide RNAs. However, CRISPR nucleases cleave not only on-target sites but also off-target sites that differ by up to several nucleotides from the on-target sites, causing unwanted off-target mutations and chromosomal rearrangements. Here I present a web-based CRISPR design tool, CRISPR RGEN Tools (www.rgenome.net), including a novel CRISPR design tool and a genome editing assessment tool. These tools are indispensable for gene mutation in human cells, animals and plants. Furthermore, I would like to introduce versatile applications of CRISPR nucleases such as one-step transformation of Chlamydomonas reinhardtii by the DNA-free CRISPRnuclease and the detailed mechanisms and kinetics of Cas9-guide RNA complex revealed by single-molecule FRET assay.

Keywords:
CRISPR-Cas system, Cas9 nuclease, genome editing, single-molecule FRET

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LPS의 TLR4/MD2 복합체로의 전달에 관한 구조 및 형광 연구

류제경[1, 2], 김수진[3], 나상현[1, 2, 7, 8], 강지인[3], 정희은[3], 이흥규[3, 4], 이지오[5], 박범석[6], 윤태영*[1, 2, 7, 8], 김호민*[3, 4]
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Abstract:
내독소 (LPS)가 톨-유사 수용체 4 (TLR4) 와 MD2의 복합체에 결합하면 선천성 면역반응이 일어난다. LPS는 그람음성균에 존재하는 지질로, LBP와 CD14 등을 통해 TLR4/MD2 복합체로 전달된다. 우리는 전자현미경과 전반사 형광 기법들을 이용하여 LPS 전달 과정에 관여하는 단백질에서 중요한 역할을 하는 부분들과 그 역학을 확인하였다. 이 결과들은 선천면역반응의 유도의 이해에 중요할 것으로 기대된다.

Keywords:
선천면역, 내독소, 전자현미경, 단분자 형광

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Simultaneous kinetic analysis of multiple states of EGFR in a living cell using Single-molecule diffusivity

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Abstract:
Reaction progress kinetic analysis (RPKA) is widely used method to understand the complex and multi-step chemical reactions. However, currently available tools have limitations to simultaneously monitor dynamic variations in multiple complex states at the single-molecule level to apply RPKA in cells. Here, we developed single-particle tracking-based Reaction Progress Kinetic Analysis (sptRPKA) to analyze the sub-minute kinetics of multiple complex states in the crowded membrane of living cells. We quantitatively extracted the subpopulation ratio of different states from the diffusion coefficient distribution rapidly acquired by particle tracking using super-resolution microscopy. Using sptRPKA, we investigated a series of molecular mechanisms of EGFR induced by specific antibody, cetuximab. By comprehensively measuring the rate constants and cooperativity of the molecular reactions of four EGFR complex states, we identified a previously unknown intermediate state that represents the rate-limiting step is responsible for the selectivity of cetuximab-induced EGFR endocytosis to cancer cells.

Keywords:
Reaction Progress Kinetic Analysis (RPKA), Single-particle tracking, EGFR, Cetuximab induced endocytosis

Effects of Transcription-Translation coupling on stochastic gene expression

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Abstract:

Unlike eukaryotes, transcription and translation in bacteria happen on the same space simultaneously due to the lack of nuclear envelope. It has been reported that the transcription elongation rate is tightly controlled by translation rate of ribosome. However, it is still unknown how these transcription-translation coupling affects stochastic gene expression. Using single-molecule fluorescent in situ hybridization (smFISH), we quantify mRNA copy number distributions depending on translation in order to investigate the effects of transcription-translation coupling on gene expression. We find that mRNA expression level is enhanced 30-fold by translating ribosomes at fully induced conditions. The observed difference in mRNA level comes from the variation in transcription rate and DNA on-off switching rate. This suggests that transcription-translation coupling play a crucial role in gene expression in bacteria.

Keywords:
Fluorescence imaging, Gene expression

A single-molecule analysis of CRISPR/Cpf1-derived RNA-guided Endonuclease

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Abstract:
CRISPR/Cpf1 is an adaptive immune system of archaea and bacteria, and can be also used as the genome editing tool as CRISPR/Cas9. As part of its essential functions, Cpf1 recognizes target-DNA and generates a double-strand break in DNA using guide RNA, but the underlying mechanisms are still unclear. Here we use single-molecule fluorescence assay that monitor critical steps of interactions between RNA-Cpf1 and target-DNA in real-time: PAM-proximal binding, cleavage-competent intermediates, DNA cleavage and release. Our observations reveal unexpected intermediates for DNA double strand break. Kinetic analysis of the reaction steps for various off-target DNA sequences provides a molecular basis for DNA target specificity of Cpf1.

Keywords:
CRISPR Cpf1 Single-molecule

Unveiling the pathway to Z-DNA in protein-induced B-Z transition

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Abstract:

Left-handed Z-DNA is an extraordinary conformation of DNA, which can form by specific sequences under special biological, chemical, or physical conditions. Human ADAR1, prototypic Z-DNA binding protein (ZBP), binds to Z-DNA with high affinity. Despite compre- hensive structural studies for ZBP-DNA interactions, physical and energetic details on their interactions still remain largely elusive. Utilizing single-molecule assays that measure thermodynamic popula- tions of ADAR1-bound DNA conformations in both GC and TG repeat sequences and a statistical physics model, we determined quantita- tively the affinities of ADAR1 to Z-DNAs formed by these sequences as well as B-DNA. We also revealed what pathways it takes to induce the B-Z transition in those sequences.

Keywords:

Z-DNA, Z-DNA binding protein, B-Z transition, smFRET

Advances in in situ X-ray photoemission spectroscopy at SOLEIL: from "fast photoemission" to near ambient pressure measurements

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Abstract:

X-ray photoelectron spectroscopy (XPS) is a powerful technique giving crucial information not only on the nature of the chemical bond at surfaces and interfaces, but also on the electronic structure (band diagram), a point that is generally not emphasized enough. In situ XPS experiments, that monitor interface modifications as a function of time, gas dose, or any temperature schedule, are readily implementable with conventional electron analyzers operated up to ultra-vacuum conditions ($<10^{-6}$ mbar), especially in the context of synchrotron radiation sources, due to the fast acquisition of "chemically meaningful" spectra enabled by the high photon flux. We shall give few illustrative examples of the latter, taken from the chemistry of silicon surfaces and obtained at TEMPO beamline, SOLEIL, the French synchrotron source. Since the implementation, a decade ago, of analyzers working under gas pressures in the tens of mbar range, entirely new avenues are opened for in situ XPS experiments. Of special interest are solid/gas, solid/liquid and liquid/gas interfaces relevant to material processing, catalysis, electrochemistry and environmental sciences. Since its installation at TEMPO beamline in 2013 and its opening to the national and international users, the near ambient pressure XPS (NAP-XPS) setup was used to perform in situ, real-time experiments in a very broad scientific field. Their selection emphasizes the "raison d'être" of NAP-XPS, that is, the absolute necessity of forming an interface between a condensed phase and a gas phase. Illustrative examples will be shown in the field of catalysis, water solution (sodium halides) and mineralogy (clays, double hydroxide layers), linking the chemical (bond making) and physical aspects (band energies, electrochemical potential, work function) when relevant. Future implementations at TEMPO beamline that fully exploit fast acquisition (as used with the conventional analyzer) and "pump (laser)-probe" experiments will be also delineated.

Keywords:
in situ X-ray photoelectron spectroscopy (XPS), ambient pressure XPS, In Operando

in situ observation of electrochemical processes at electrode/electrolyte interfaces for energy conversion

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Abstract:

In energy conversion devices such as rechargeable batteries and fuel cells, various interesting processes take place at electrode/electrolyte interfaces. Understanding of those processes can allow us to design highly efficient and durable materials. We have utilized various x-ray techniques using synchrotron radiation light sources to investigate those interfacial processes under electrochemical potential control in situ. In this talk, (1) in situ XAFS studies on molecular catalysts confined within molecular layers on semiconductor surfaces and (2) on oxygen reduction reaction electrocatalysts for polymer electrolyte membrane fuel cells, and (3) development of an in situ electrochemical XPS apparatus for the solid/liquid interfaces will be presented.

Keywords:
in situ electrochemical XPS, energy conversion devices,

On the observation of CO adsorption at Pt(111) surface in formic acid oxidation via ambient-pressure XPS

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Abstract:
Understanding on CO poisoning of Pt surface has been a crucial issue in electrooxidation of small organic molecule. Many studies of formic acid oxidation on well-defined Pt surface under UHV condition are conducted for better understanding on Pt surface poisoning in small organic molecule oxidation. However, it is questionable whether the observations from this surface science studies under UHV condition could be compatible to the results of electrochemical measurements due to extreme difference in environment. This context motivates an in situ surface science study at a higher pressure environment closer to electrochemical situation. Here, we report on the adsorption of CO and H_2O on Pt(111) single crystal observed with operando X-ray photoelectron spectroscopy (XPS) by the exposure of formic acid (HCOOH) at a higher HCOOH pressures, which is closer to the environment of electrochemical experiment set up.

Keywords:
AP-XPS, CO adsorption, Pt(111), Formic Acid

Transient Simulation Using a Deterministic Boltzmann Equation Solver

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Abstract:

Deterministic Boltzmann equation solvers are alternative to the conventional Monte Carlo method for solving the semiclassical Boltzmann transport equation. Recently, there have been significant improvements in this field. It can perform not only the steady-state analysis but also small-signal and noise analyses. However, compared to the traditional semiconductor device simulatiors such as the drift-diffusion simulators, the transient simulation capability with an implicit time derivation method is still a missing feature. Lack of the transient simulation capability restricts its application area significantly. Since the stabilization scheme for the deterministic Boltzmann equation solver introduces difficulties for the transient simulation, a thorough investigation on the stabilization scheme is required. In this work, our recent effort to address this issue is presented. After introducing the deterministic Boltzmann equation solver briefly, the numerical problem in the transient simulation is explained. It is shown that a proper interpolation scheme for the distribution function is mandatory to make a stable transient simulation possible. An interpolation scheme which conserves the carrier density is proposed and numerically tested. The graphene sheet and graphene transistor are chosen as examples. In our in-house simulator, the intrinsic phonon scatterings and the remote phonon scattering are considered. In addition to the steady-state simulation results, the small-signal mobility and the step response of the graphene sheet at the terahertz frequency range are presented. Moreover, the preliminary results for the graphene transistor are reported. * This work is supported by the Samsung Research Funding Center of Samsung Electronics under Grant SRFC-IT1401-08.

Keywords:
Semiconductor device simulation, transient simulation, deterministic Boltzmann equation solver, Boltzmann transport equation

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Formation of Intact Schottky Junction with Graphene Diffusion Barrier

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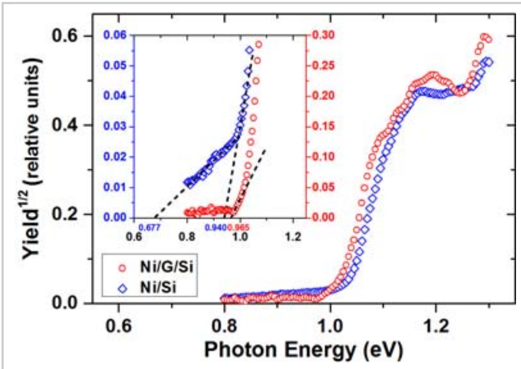

Abstract:

We report the systematic experimental studies demonstrating that a graphene layer inserted at Metal/n-Si(001) interface can turn leaky Schottky junctions into ideal non-leaky ones. Based on high-resolution transmission electron microscopy (HRTEM) images and current-voltage (I-V) measurements, it is concluded that an inserted graphene layer minimizes interfacial reactions and efficiently protects the Schottky junction from unwanted changes in electrical properties. The reverse-bias leakage current of Metal/Graphene/n-Si(001) junction is noticeably smaller than that of Metal/n-Si(001) junction, which strongly supports the role of graphene insertion layer as an efficient barrier for atomic diffusion at interface. The internal photoemission (IPE) measurements show unambiguously that the Schottky barrier of Metal/Graphene/n-Si(001) junction is almost independent of metal work-function, implying very strong Fermi-level pinning at interface. The atomically-impermeable and electronically-transparent aspects of the graphene insertion layer can provide a reliable experimental method to make the interface intact for all semiconductor Schottky junctions in general.

Keywords:
Schottky Junction, Graphene, Diffusion Barrier, Fermi-Level Pinning, Internal Photoemission

Interface Characteristics of Graphene-Si Heterostructures

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Abstract:
그래핀은 탄소 동위원소로 이루어진 이차원 평면물질로써 매우 독특한 전기적 특성을 가지고 있기에 미래소자에 적용될 가능성이 매우 높은 물질이다. 그래핀은 K 위치에서 선형 에너지 분산관계를 가지고 있어 반금속적(Semimetal)이라 불리고 있다. 현재까지 그래핀과 반도체 접합구조에 대한 수많은 연구가 진행되고 있지만, 그래핀과 실리콘 계면에 대한 자세한 연구는 많이 이루어지지 않고 있다. 본 연구에서는 그래핀-실리콘 계면을 Femtoammeter와 Impedance spectroscopy를 통해서 알아보았다. 우리는 그래핀-실리콘 접합구조에 전압을 인가한 상태에서 빛을 인가시켰을 때, 광유도 역전층(Photo-induced inversion layer)이 실리콘의 공핍영역(Depletion region)에서 나타나는 것을 알아내었다. 또한 그래핀-실리콘 접합구조에 광원을 노출시키면서 그래핀의 홀효과(Hall effect)을 알아보았다. 그 결과, 그래핀-실리콘 계면이 광원에 의해 변화한다는 것을 알아내었다. 추가적으로 전류밀도-전압(J-V) 특성을 분석하여 확산전위(built-in potential), 이상계수(ideality factor), 이산화 실리콘의 자연산화막 두께를 알아내었다. 이 연구는 향후 실리콘 기반에 그래핀 접합구조 소자로써 활용되는 다이오드, 광전자 소자들의 계면특성을 이해하는데 많은 도움을 줄 것이라 생각된다.

Keywords:
그래핀, 실리콘, 광유도역전층, 홀효과

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Analysis of threshold switching characteristics of Tellurium-based chalcogenide material alloy.

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Abstract:
We report the characteristics of threshold switching behaviors by using tellurium (Te)-based chalcogenide material alloys. In order to reduce defect sites in the tellurium-metal alloy, each device was prepared with a low power sputtering process ranging from 5W to 10W. Control of the precise thickness and annealing temperature of a tellurium-metal alloy had a profound impact on the electrical features. The optimized tellurium alloy-based selector device reveals highly stable switching performance with bidirectional rectifying properties including a low off current level of 6.2×10^{-7} and a high on/off ratio of $\sim10^{4}$. All of the electrical properties were carried out by using Keithley 4200-Semiconductor Characterization System (4200-SCS) with 4-probe system. To observe the structural properties, Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) were conducted to investigate surface roughness and morphologies

Keywords:
Threshold switching, Selector, Chalcogenide, Tellurium

Direct integration of semiconductor photonic nanocavities with paper substrates

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Abstract:
Developments in electronics over the past few decades have made electronic devices indispensable in our daily lives. Electronic devices such as mobile phones, personal computers and tablets are not only consumed by nearly every individual but are frequently replaced with newly released models. These short lifetimes bring about environmental issues, as discarded semiconductors are not degradable and are sometimes even toxic. Therefore, 'Green electronics' have emerged as a solution with the goal of providing eco-friendly electronics. Among diverse materials, paper especially has attracted the most attention because it is abundant, inexpensive and renewable. It has also a great advantage due to certain mechanical characteristics, such as flexibility, bendability and low weight. However, electronic devices are expected to reach limitation in terms of bandwidth and integrability. Therefore, photonic devices are rapidly growing by virtue of their ability to handle massive amount of data with a compact size. These photonic devices are expected to gradually replace electronic devices. As the widespread electronics faced environmental issues, this will also inspire developers of photonic devices actively to investigate new substrates for photonic components. Here, we propose and demonstrate a semiconductor optical nanocavity on a paper substrate. The nanocavity showed lasing action, which is the first observation of a photonic device operating directly on paper. We also experimentally observed a wavelength shift of the nanocavity after water infiltration, indicating that this device can be utilized as a sensor.

Keywords:
photonic crystals, paper, semiconductor lasers, sensors, eco-friendly devices

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2016.10.19 – 2016.10.21

Growth, transport and thermoelectric properties of $SnSe_{1-x}S_x$ (0 x 1) single crystals

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Abstract:
$SnSe_{1-x}S_x$ (0 x 1) single crystals were fabricated using the temperature gradient method. The crystal structure was investigated by SEM and XRD. They indicated that fabricated $SnSe_{1-x}S_x$ single crystals have layered structure with lattice constants change gradually following Vegard's law. Transport properties were synthesized by physical properties measurement system (PPMS). We observed that the electrical resistivity decreases with increasing of Se content and for x = 0.2, $SnSe_{0.8}S_{0.2}$, electrical resistivity and Seebeck coefficient are 0.52 Ωcm and 639.36 μVK^{-1} at 270 K, respectively, which result in the power factor of 0.78 $\mu WK^{-2}cm^{-1}$.

Keywords:
Tin (II) sulfide, solid solution, thermoelectric

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Thermoelectric properties of n-type polycrystalline SnSe doped with Bi

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Abstract:

SnSe is IV-VI compound layered semiconductor with the orthorhombic structure whose thermoelectric properties as polycrystalline has not been cleared yet. Herein, we reported about thermoelectric properties of non-equilibrium state doped n-type polycrystalline SnSe doped with various Bi content prepared by melting and hot-pressing technique. Beside the anisotropic transport properties with the bipolar conducting mechanism, our samples exhibited the intrinsically low thermal conductivity down to 0.571 W m^{-1} K^{-1} at 773 K. A prefer orientation of grain is observed. The highest power factor value of 0.174 μW/cm-K^2 and a maximum ZT value of 0.023 have been obtained at 723 K along parallel to the pressing direction for the sample with 6% Bi-doped which is the optimal doping concentration. These values are small due to the low electrical conductivity and Seebeck coefficient of samples.

Keywords:

SnSe polycrystalline, thermoelectric properties

A Weyl metallic state in the $Bi_{0.96}Sb_{0.04}$ alloy and its anomalous electronic transport

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Abstract:

The $Bi_{1-x}Sb_x$ is a classical system, which has been studied for several decades because of its interesting band structure. Recently, this system has become an intensive focus of research in the context of three-dimensional (3D) topological insulator (TI) since the discovery of its non-trivial topological structure for $x > 0.07$ [1]. In this talk, we introduce a 3D Weyl metallic state realized in $Bi_{1-x}Sb_x$ and its chiral anomaly at $x \sim 0.03$, where a topological phase transition occurs from a band insulator for $x < 0.03$ to the "3D TI" for $x > 0.03$. After explaining some peculiar features of this state, we discuss anomalous electric transport phenomena originating from chiral anomaly [2], together with similar observations in other Dirac and Weyl metals. Liang Fu and C. L. Kane, Phys. Rev. B 76, 045302 (2007). Heon-Jung Kim et al., Phys. Rev. Lett. 111, 246603 (2013).

Keywords:

Topological metal, $Bi_{1-x}Sb_x$, chiral anomaly, anomalous electric transport

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Phase transitions driven by interlayer electronic ordering in van der Waals solids

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Abstract:

Layered materials form solids by the weak van der Waals interaction. Van der Waals solids include important classes of materials such as transition metal dichalcogenides, organic superconductors, and iron-based superconductors. They show complex electronic phase diagrams covering metal, insulator, and superconductor phases, depending on temperature, pressure, and doping. Because of strong 2D electronic order and the weak layer binding, the origins of the phase transitions are usually sought in the two-dimensional (2D) electronic order. In this talk, I show that, contrary to the common understanding, the phase transitions in some van der Waals solids (specifically 1T-TaS_2) are driven by the interlayer ordering of the 2D electronic order, not by the 2D order itself.

Keywords:

Van der Waals solid, Phase transition, Metal-insulator transition, Interlayer ordering

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Valley-symmetric transport in ballistic mono- and bi-layer graphene

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Abstract:

Recent progress in preparing a high-quality graphene layer, by encapsulating a sheet of graphene between two pieces of hexagonal boron nitride crystals, enables one to investigate the intrinsic carrier transport in the material. Here, we present our recent studies on gate-defined valley-symmetric one-dimensional (1D) carrier guiding in ballistic monolayer graphene [1] and valley-symmetry-protected topological 1D transport in ballistic bilayer graphene [2]. For the first topic, successful carrier guiding was realized by inducing a high distinction (~ more than two orders of magnitude) in the carrier density between the region of a quasi-1D channel and rest of the regions in ballistic monolayer graphene. Conductance of a channel shows quantized values in units of $4e^2/h$, where the factor 4 comes from the valley and spin degeneracy. For the second topic, the topological 1D conduction was realized between two closely arranged insulating regions with inverted band gaps, induced under a pair of split dual gating with polarities opposite to each other. The maximum conductance showed $4e^2/h$, again the factor 4 arising from the valley and spin degeneracy. Results of these studies pave a useful pathway for the valley-symmetry-preserved carrier guiding in graphene, which is essential for valleytronics applications of graphene but has always been hindered by the absence of gap and the intervalley scattering at the edges in a constricted geometry of the material. If time allows I will also briefly introduce the carrier guiding by the negative electron refraction across a p-n interface in a ballistic monolayer graphene sheet [3]. M. Kim, J.-H. Choi, S.-H. Lee, K. Watanabe, T. Taniguchi, S.-H. Jhi, and H.-J. Lee, Nature Physics DOI:10.1038/Nphys 3804 (2016). J. Lee, K. Watanabe, T. Taniguchi, and H.-J. Lee, submitted. G.-H. Lee, G.-H. Park, and H.-J. Lee, Nature Physics 11, 925 (2015).

Keywords:

Valley-symmetric transport in ballistic mono- and bi-layer graphene

The Long and Winding Road of an International Civil Servant Trained in Physics

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Abstract:

Korean society today is a rapidly evolving multicultural and international environment. People of foreign nationality are easily encountered and are now almost common place in metropolitan areas and in Korean media. In turn, Koreans also have had the opportunity to work, study and visit foreign countries on all five continents. For a select few individuals, there are opportunities for them to work directly on behalf of international relations and cooperation. A large number of these opportunities are within intergovernmental or international organizations. These organizations require the contribution of professionals from diverse fields and backgrounds including physicists, and some international organizations specializing in science and technology will hire more physicists or engineers than the rate in the general public. Nevertheless, jobs and opportunities for physicists are not limited to technical areas. The skill set that people trained in physics possess is useful and applicable to many areas within an international organization. The speaker will present information and lessons from his own experience working at the International Atomic Energy Agency and his more recent work interacting with the ITER International Organization, as well as general lessons for those who plan or are interested in a career in international civil service. (The presentation will be delivered in English or Korean as requested by the session chair.)

Keywords:
International Organizations, international civil service, career development

New Results from RENO

SEO Seon-Hee*[1], KIM Wooyoung[2], PARK Seongwoo[2], PARK Ingon[3], JANG Jeeseung[4], PAC MyoungYoul[5], CHOI Juneho[5], JANG Hanil[6], GWON EunHyang[1], KIM Sangyong[1], KIM Soo-Bong[1], SEO Hyunkwan[1], YANG Jeongyeol[1], LEE Dongha[1], LEE Yongchang[1], LEE Hyeonki[1], KIM Jonggeon[7], KIM JongHyeon[7], YANG Janghee[7], YU Intae[7], CHOI Youngil[7], ROTT Carsten[7], KIM Hyunsoo[8], KIM Baro[9], KIM Seungchan[9], KIM Jaeyool[9], MOON Dongho[9], PARK Ryeonggoon[9], SHIN Changdong[9], YEO Insung[9], JOO Kyungkwang[9], LIM Intaek[10]

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Abstract:

A main purpose of RENO experiment is to measure the smallest neutrino mixing angle theta13 in the PMNS matrix. The first measurement of the theta13 with ~5 sigma was successfully done in 2012 using 220 days data opening a golden era in the future neutrino physics. Recently RENO has updated the theta13 and also measured delta_m2_ee using spectral analysis based on 500 days data. In this talk we present new results on the theta13 and delta_m2_ee using ~1600 days data. There are several other very interesting new results to be presented as well: They are an independent measurement on theta13 using IBD n-H data, our first measurement on the absolute neutrino flux, an improved (9 sigma) measurement on the 5 MeV excess, and our first measurement on the sterile neutrino search assuming 4 neutrino oscillation scheme.

Keywords:

neutrino oscillation, PMNS matrix, theta13, absolute neutrino flux, 5 MeV excess, sterile neutrinos

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Energy dependent disappearance of reactor antineutrinos with neutron capture on hydrogen at RENO

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Abstract:
RENO has been taking data since August, 2011 and successfully measured the smallest neutrino mixing angle, theta13. This measurement was based on observed reactor neutrino events with neutron captures on gadolinium (n-Gd) in the target detector region. RENO also successfully measures the mixing angle from a reactor neutrino sample with neutron captures on hydrogen (n-H) in the gamma-catcher region. Due to a large accidental background in the n-H data sample, the analysis requires additional reduction of backgrounds . This independent measurement provides a valuable systematic cross-check of the theta13 measurement using the n-Gd sample. And We has started about 500 live days of data to observe an energy dependent disappearance of reactor electron antineutrinos by comparison of their prompt signal spectra.In this talk, we present the results from the n-H analysis using the 500 days of data sample.

Keywords:
RENO, Neutrino, Oscillation, 중성미자, Nuclear

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Search for sterile neutrinos at RENO

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Abstract:
The RENO experiment was designed to measure a neutrino mixing angle, theta13, by detecting electron antineutrinos emitted from the Hanbit nuclear reactors in Korea, and succeeded to measure theta13 from the disappearance mode in three neutrino frame. We investigate the possibility of sterile neutrinos existence at RENO experiment and compare data with Monte Carlo generated in four neutrino frame. In this talk, we present some recent results using chi-square analysis method. The probability deficit curve as a function of an effective baseline and the excluded contour plot in sin^2(2theta14) - Delta(m41)^2 space will be shown.

Keywords:
reno

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2016.10.19 - 2016.10.21

Precise measurement of reactor neutrino flux and spectrum at RENO

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Abstract:

The RENO experiment has been taking data since Aug. 2011 to measure the smallest neutrino mixing angle theta_13 at Hanbit nuclear power plant. It is essential to compare the observed and expected fluxes of reactor antineutrinos for determining the neutrino disappearance probability. The expected reactor neutrino flux is calculated from the reactor thermal power and the fission rate of individual fuel isotope. It is also essential to measure the reactor neutrino spectrum precisely for extracting neutrino oscillation parameters from energy-dependent neutrino disappearance. We made our best efforts on understanding of non-linear energy response of the detector and measured the unprecedentedly accurate reactor neutrino flux and spectrum using the near detector. In this presentation, we describe how to obtain the expected reactor neutrino fluxes and spectra at near and far detectors and report an excess near 5 MeV at RENO.

Keywords:
Neutrino, oscillation, reactor, RENO

Search for a sterile neutrino at short baseline

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Abstract:
An energy spectrum of the inverse beta decays from reactor anti-electron neutrinos has been measured at a 24 m distance from a reactor core in Hanbit nuclear power plant. A comparison of the data with existing reactor neutrino flux models shows no strong evidence of short baseline oscillation. An excess around 5 MeV in the prompt energy is observed at this short baseline as in the θ_{13} experiments. Most of the candidate parameter space in $(sin^2 2\theta_{14},\ \Delta m^2_{41})$, proposed by the so called reactor anomaly, is excluded with higher than 95% confidence level.

Keywords:
neutrino, reactor, oscillation, short baseline, flux model

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2016.10.19 - 2016.10.21

Axion dark matter search with toroidal resonant cavities.

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Abstract:
The present experiments for halo axion search emply cylindrical resonant cavities in solenoidal magnetic field. We, the Center for Axion and Precision Physics research (CAPP) of the Institute for Basic Science (IBS), also pursue a toroidal design for axion search. Toroidal geometry provides several advantages, two of which are a large volume for a giben space and greatly reduced frange fields which interfere with our preamps. We made a very small toroidal resonant cavity as a precursor for definite axion search with a toroidal geometry. A small scale experiment has been setup as a first step toward the planned large scale toroidal cavity experiments.

Keywords:
AxionToroidal Cavity

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A14.07
2016.10.19 - 2016.10.21

Noise in axion cavity experiments: Comparison of linear amplifiers and single-photon techniques

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Abstract:

The axion is an attractive dark matter candidate which can be detected directly at haloscope experiments via its conversion in a strong magnetic field. As haloscopes operate at increasingly lower temperatures, a "last boundary" starts to emerge: Quantum limits on the detection noise. Here we investigate two categories of methods for the detection of axion-generated photons: Linear quantum amplifiers (e.g. SQUIDs), which are bounded by the Standard Quantum Limit, and the promising single-photon counting techniques (e.g. excitation of Rydberg atoms), bounded by the Quantum Noise Limit. We examine the noise sources involved in each method and compare their performance in various regions of the experimental specifications.

Keywords:
Elementary particles, axion, haloscopes, noise

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2016.10.19 – 2016.10.21

Performance Profiling using Brachytheraphy in Geant4

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Abstract:
These days, Geant4 is used at various field. Especially, in medical part. One of the cancer therapy is applying a particle beam radiated from accelerator. To investigate the effect of the beam Geant4 is used before applying human body. For this reason, performance profiling of the simulation code is important to plan computational resource and to find bottle neck of the algorithm. In this talk, the profiling code using brachytherapy and its result will be presented.

Keywords:
Geant4 Simulation brachytherapy profiling

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2016.10.19 - 2016.10.21

A status of an array of ultra low background HPGe detectors at the Yangyang underground laboratory (Y2L).

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Abstract:
The Center for Underground Physics (CUP), IBS has developed in collaboration with CANBERRA an ultra low background instrument composed of two arrays, facing each other, with 7 HPGe detectors each for a total of 14 p-type coaxial HPGe detectors with 70% of relative efficiency. This instrument has been designed to have the lowest possible intrinsic background through the selection of all the building materials. The contribution to the instrument background due to the contamination in primordial radionuclide of all the raw materials has been evaluated by performing Monte Carlo simulations. The bottom part of the Array has been delivered to the Y2L underground laboratory this summer and has been installed and tested. The system will be optimized for low background measurement by using a dedicated shielding and a dedicated DAQ system; furthermore the lab will be provided by Rn free air.

Keywords:
HPGe detector, low background gamma spectroscopy measurement

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A15.01*
2016.10.19 - 2016.10.21

The Modified Deformed Woods-Saxon Potential for Neutron Rich and Light Nuclei

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Abstract:
One can use a Woods-Saxon potential which is a phenomenological approach to calculate the mean field potential in the nuclear structure. However, the neutron rich nuclei, far from the valley of beta stability line, can be unstable and deformed. In addition, near the neutron drip line, the last nucleons will be weakly bound. Therefore, to study the properties of these nuclei we can consider the deformation effect. For this reason, we can use the deformed Woods-Saxon potential and their parameters such as potential depth and diffuseness can be adjusted for these nuclei. The deformation parameters, beta_2 and beta_4 values, are chosen by taking the value giving the minimum total energy. In this presentation, we show the change of shell structures by the deformation parameters along the neutron dripline and compare with other calculations.

Keywords:
deformed Woods-Saxon potential, optimized parametersdeformed nuclei, deformation, β_2, β_4, light nuclei, total binding enegy

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A15.02
2016.10.19 - 2016.10.21

Finite nuclei in chiral QMC model

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Abstract:

Ground state properties of stable nuclei are revistied in the chiral quark-meson coupling (CQMC) model, based on a mean-field description of non-overlapping nucleon bags with pion cloud. The effects of nucleon structure and chiral symmetry are discussed in comparison with the relativistic Hartree results.

Keywords:
Finite nuclei, chiral symmetry, nucleon structure,relativistic mean field theory

Effects of deformation and neutron-proton pairing correlations on the Gamow-Teller transition for light N=Z nuclei by a deformed QRPA

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Abstract:
We investigated deformation effects on the Gamow-Teller (GT) transition of light N = Z nuclei, 24Mg, 28Si, and 32S by taking into account neutron-proton (np) pairing correlations. Our calculation is performed within a deformed quasi-particle random phase approximation (DQRPA) which explicitly includes the deformation at the BCS and RPA stage. In this work, we include the np pairing as well as neutron- neutron (nn) and proton-proton (pp) paring correlations to the DQRPA and apply it to the GT transition of sd-shell N = Z nuclei. The np pairing effect is found to affect more or less the GT distribution of these nuclei. But the deformation effect turned out to be much larger than the np paring effect because of the shell evolution by the deformation. Correlations between the deformation and the np pairing are also discussed with the comparison to experimental GT transition data.

Keywords:
deformed QRPA, Gamow-Teller transition

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2016.10.19 - 2016.10.21

KIDS nuclear energy density functional: 1st application in nuclei

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Abstract:

Inspired by an effective field theory of a dilute Fermi system, we propose a new nuclear energy density functional (EDF), which we call KIDS (Korea: IBS-Daegu-Sungkyunkwan) EDF model. The model consists of a systematic expansion in powers of the Fermi momentum. Parameters of the KIDS model are divided into two parts; one part for the symmetric nuclear matter (SNM), and the other part for the pure neutron matter (PNM). Parameters for the SNM part are determined from the saturation density, binding energy, and the compression modulus of the nucleon in the symmetric nuclear matter at the saturation density. Parameters for the PNM part are fitted to the equation of state of pure neutron matter calculated in [A. Akmal, V.R. Pandharipande, D.G. Ravelhall, Phys. Rev. C 58 (1998) 1804]. In order to apply the KIDS model to nuclei, we extract Skyrme-type interactions corresponding to the KIDS EDF. Solving Hartree-Fock equations, we obtain the energies per particle and charge radii of closed nuclei such as 16O, 28O, 40Ca and 60Ca. This model is found to successfully reproduce the experimental data for 16O and 40Ca, and we present predictions for 28O and 60Ca with the optimized parameters of the model.

Keywords:
nuclear energy density functional, effective field theory, Skyrme force

KPS 한국물리학회 The Korean Physical Society

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2016.10.19 - 2016.10.21

EURICA Experiments at RIKEN: Shape Transitions of Neutron-rich Zr-Mo Isotopes

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Abstract:
EUroball-RIKEN Cluster Array(EURICA) project was launched on 2011, and the project has performed a variety of experiments including studies on the nuclear structure of neutron-rich isotopes. Especially, neutron-rich isotopes around the atomic mass of 110 (A=110) isotopes have their conspicuous nature about shape evolution. Main goal of the current work is to reveal the phenomenological description of the shape transition of Zr-Mo isotopes and ultimately find the signatures of the tetrahedral symmetry of Zr isotopes, ^{108}Zr and ^{110}Zr. In this presentation, status of the EURICA project, and issues in Zr-Mo isotopes are introduced.

Keywords:
nuclear stucture, neutron-rich isotopes

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2016.10.19 - 2016.10.21

Screening of Nucleon Electric Dipole Moments in Nuclei

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Abstract:
A partial screening of nucleon electric dipole moments (EDMs) in nuclear systems, which is related to the Schiff mechanism known for neutral atomic systems, is discussed. It is shown that the direct contribution from the neutron EDM to the deuteron EDM is partially screened by about 1% in a zero-range approximation calculation.

Keywords:
Electrid dipole moments, deuteron

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 A15.07
2016.10.19 - 2016.10.21

Nuclear structures and β-decay schemes for the Sb, Te, and I nuclides beyond N=82

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Abstract:

The EURICA Campaign at RIBF in RIKEN for the decay spectroscopy has been successfully finished in the spring of this year. Nuclear structures and β-decay schemes for newly found nuclides have been assigned from the EURICA Campaign for last 5 years and there still remian abundant nuclides that have not been confirmed from this campaign. The experimental results are exhibited based on the β-delayed γ-ray spectroscopy for the Sb, Te, and I nuclides beyond N=82. We provide for the first time the internal level structures of ^{140}Te, ^{140}I, and ^{142}I, as showing the beta-decay lifetime measurements of the corresponding decay processes. The observed level structures and decay schemes will be discussed briefly systematically with the help of the shell model calculations. The strength of Gamow-Teller transition will be also discussed.

Keywords:

^{140}Te, ^{140}I, ^{142}I, EURICA, shell model, β-delayed γ-ray spectroscopy, nuclear structure, Gamow-Teller transition

The puzzle of self-assembly and the self-assembly of puzzles

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Abstract:

A holy grail of nano-technology is to create truly complex, multi-component structures by self-assembly. Most self-assembly has focused on the creation of `structural complexity'. In my talk, I will discuss `Addressable Complexity': the creation of structures that contain hundreds or thousands of distinct building blocks that all have to find their place in a 3D structure. Recent experiments have demonstrated the feasibility of making such structures. Simulation and theory yield surprising insights that can inform the design of novel structures and materials [1]. [1] William M. Jacobs and Daan Frenkel, Self-Assembly of Structures with Addressable Complexity, J. Am. Chem. Soc., 2016, 138 (8), pp 2457–2467

Keywords:
self-assembley

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The Effective Temperature Concept Tested in an Active Colloid Mixture

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Abstract:
The concept that effective temperature can exceed thermal temperature in nonequilibrium systems where consumption of external energy fuels motility could extend the deep understanding of statistical thermodynamics to messy nonequilibrium systems where classical statistical thermodynamics cannot hold strictly. Its predictive value has been unclear. Here, in an active colloid system designed so that external drive energizes each particle equally in analogy to equipartition of energy in thermal systems, we find quantitative agreement with phase diagrams predicted from classical thermodynamics. With Janus colloids swung in circles by external drive, returning to the same position periodically except as collisions dictate, experiments and computer simulations at the same stroboscopic times confirm the classical 2D Ising phase diagram with the known equilibrium-phase critical exponents, Gaussian displacement distributions, fluctuation-dissipation relations, and capillarity, provided that effective temperature is considered to be the average number of collisions experienced per circular orbit. Admittedly the analogy is not exact but the intriguing quantitative analogies to equilibrium expectations, observed in this decidedly nonequilibrium system, constitute an existence proof from which to compare future theories of nonequilibrium thermodynamics. This work was performed in collaboration with Prof. Erik Luijten, Northwestern University.

Keywords:
active system, nonequilibrium

Proteins as non-equilibrium learning matter

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Abstract:
DNA genes code for 3D nets of amino acids that make functional proteins. We will discuss how this mapping, between the many-body physics within the protein and evolutionary forces acting on the gene, distinguishes proteins as a unique class of non-equilibrium learning matter. In particular, evolution selects a tiny fraction of functional sequences in an enormous, high-dimensional space, which makes protein a non-generic, information-rich matter, outside the scope of standard statistical methods. Therefore, although the structure and physical forces within a protein have been extensively studied, the fundamental question as to how a functional protein originates from a DNA sequence is still open. To address this question, we will introduce a simple physical model for the evolution of protein function. We model protein as amorphous matter made of amino acids. The connectivity of the amino acids is encoded in a 'gene', and by evolving the gene, the protein 'learns' to induce specific mechanical modes. Such large-scale conformational changes - where big chunks of the protein move with respect to each other - are known to be central to protein function. This evolutionary learning process projects the high-dimensional sequence space onto a low-dimensional space of mechanical modes, in accord with the observed dimensional reduction in the space protein function. Spectral analysis reveals a strong signature of the protein's structure and function within correlation 'ripples' that appear in the space of DNA sequences. These findings propose a testable basic principle of the protein as amorphous matter whose dynamics encode the evolutionary learning process. Tlusty, Libchaber & Eckmann, Physical model of the sequence-to-function map of proteins (arXiv:1608.03145)

Keywords:
Protein,

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Preparation of a Cold Atomic Ensemble for Quantum Memory Experiment

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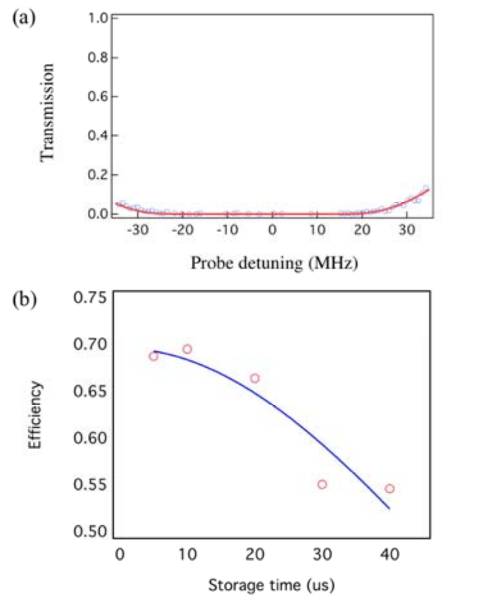
Abstract:

Optical quantum memory finds its importance in long-distance quantum communication and photonic quantum computation protocols. A cold atomic ensemble prepared by magneto-optical trap (MOT) has been an ideal platform for studying quantum memories due to its strong interaction with single photons and negligible Doppler broadening effects. In atomic quantum memory applications, the ultimate parameter determining memory efficiency is optical depth (OD), which is defined as $T = \exp^{-OD}$ where T is the light transmission through the medium. The higher the OD, the stronger the absorption of light, increasing the memory efficiency. Because the OD is proportional to the atomic density and the sample length, there have been many approaches to increase the density or grow the sample size [1,2]. Another important parameter of quantum memories is coherence time of the medium, defined as the exponential decay time of the memory retrieval efficiency. Two main factors suppressing the coherence time are unwanted magnetic fields around the cold atoms and atomic motions. To overcome these effects, there have been substantial works to turn off MOT coils quickly and suppress the atomic motion with optical dipole trap [3]. Here, we report our recent achievement of high OD up to 363 and coherence time of 75 us for rubidium cold atoms as shown in Fig. 1. We achieve the values with several techniques such as four pair cooling beams, magnetic field compression, temporal dark MOT, depumping, an insulating coil holder and a fast turn-off circuit. [1] Hsiao, Y.-F., Chen, H.-S., Tsai, P.-J. & Chen, Y.-C. "Cold atomic media with ultrahigh optical depths", Phys. Rev. A 90, 055401 (2014). [2] Sparkes, B. M. et al. "Gradient echo memory in an ultra-high optical depth cold atomic ensemble", New J. Phys. 15, 085027 (2013). [3] Zhao, R. et al. "Long-lived quantum memory", Nature Phys. 5, 100 – 104 (2009).



[Fig.1] (a) Two-level transmission of OD 363. (b) Memory retrieval efficiency with coherence time of 75 us.

Keywords:
Cold atoms, Quantum Memory, Electromagnetically-induced transparency.

Intensity properties of a coherently pumped cavity–QED microlaser

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Abstract:
We report an experimental study on intensity properties of a coherently pumped cavity–QED microlaser. It is a microscopic laser pumped by numerous atoms with a synchronized atomic phase and exhibits distinct properties such as inversionless lasing and thresholdless growth of intensity proportional to the square of atom numbers. We realized such a laser by controlling the position and the internal state of atoms precisely using a nanohole array aperture technique. By this technique, we could control not only atomic position in a high–finesse cavity in nanometer scale but also its internal state as a quantum superposition state of ground and excited states with a synchronized phase, and therefore in–phase atom–field interaction was realized. We observed a peak in laser intensity with an atomic inversion angle of 0.67π and a nonlinear thresholdless intensity growth with a log–log slope of 1.42. The experimental details and the latest data will be presented and discussed.

Keywords:
cavity–QED, superradiance, thresholdless laser

Enhanced Optical Responses in Bilayer Lattice Systems of Dense Atomic Dipoles

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Abstract:

Experimental achievement of enhanced coupling between atom and light has been a long sought goal. In particular, understanding light interaction with a dense atomic system attracts lots of interests both in theoretical and experimental investigations due to many potential applications in quantum information, metamaterials, and nano-optics in recent years. In the present study we propose an experimental scheme to enhance optical response of the system by illuminating linearly polarized plane wave light with low intensity. We numerically calculate optical transmission, absorption, and energy densities in bilayer atomic dipole systems of lattices from classical electrodynamics formalism, exhibiting optimal optical absorption at a specific lateral structure of the system with fairly small dipole numbers. We also find abrupt changes in spectra at a particular atomic spacing, which may be used for implementing a photonic gate with high-fidelity.

Keywords:
Optical ResponseBilayerLattice SystemDense Atomic Dipoles

UHV glass chamber with mirrored windows to form a Fabry-Perot cavity

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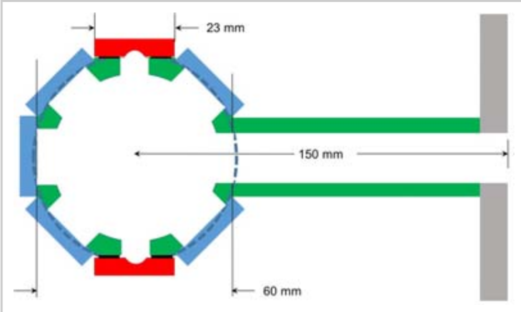

Abstract:

A Fabry-Perot cavity provides an optical lattice with a well-defined and stable mode compared with a lattice formed by a retro-reflecting mirror. It also produces deep potential wells from the resonant power buildup. It is challenging, however, to put the cavity inside a vacuum chamber without compromising ultrahigh vacuum required for experiments like Bose-Einstein condensation or quantum information processing. Placing the cavity mirrors outside a chamber complicates the situation with windows between the mirrors. We report our construction of an octagonal glass chamber, whose diagonally placed windows have engraved mirrors at the center to form a Fabry-Perot cavity. The mirror has 3.25 cm radius of curvature and reflectivity of 98% at 980 nm. They are attached to the octagonal chamber by using UHV-compatible glue (EPO-TEK H77). We achieved pressure as low as 5*10^(-11) Torr. We trap a few million rubidium atoms to the lattice formed by the cavity. The lifetime is longer than 4 s and we will report further progress.

Keywords:
1D optical lattice, cavity

Efficient ionization of tin atom assisted by N-type multiphoton Raman resonances

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Abstract:
We report experimental results of laser ionization spectroscopy of tin using a three step laser excitation technique in conjunction with an atomic beam apparatus. Typically, laser ionization efficiency is limited for certain elements whose ground state is split into several states due to a pronounced fine structure. We show that the efficiency can be increased by adding an additional laser light to cover the thermal distribution over the different states. In particular, N-type multiphoton ionization has been utilized to enhance the ionization efficiency in a tin atomic beam.

Keywords:
tin, laser ionization spectroscopy, ionization efficiency

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B2.06
2016.10.19 - 2016.10.21

Development of a light pulse-atom interferometer for inertial sensing

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Abstract:
We have developed a light-pulse atom interferometer for inertial sensing. In our device, cold 87 rubidium atoms that are launched in parabolic trajectories using moving molasses are interacting with a horizontal Raman beam. Three pulses in a large-size single Raman beam realize an atomic Mach-Zehnder interferometer with an enclosed area of 0.57 mm^2. With a spatial selection of atomic clouds in detection, interference fringes of which contrasts are 31 % are observed as a function of phase of the third Raman pulse. We discuss measurements of rotation and acceleration in our setup.

Keywords:
Atomic interferometer, Atomic gyroscope

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B2.07
2016.10.19 - 2016.10.21

Quantum sine-Gordon dynamics on analogue curved spacetime in a weakly imperfect scalar Bose gas

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Abstract:

We show that the sine-Gordon model on an analogue curved spacetime arises as the effective quantum field theory for phase fluctuations of a weakly imperfect Bose gas on an incompressible background superfluid flow when these fluctuations are restricted to a subspace of the single-particle Hilbert space. We consider bipartitions of the single-particle Hilbert space relevant to experiments on ultracold bosonic atomic or molecular gases, including, e.g., restriction to high- or low-energy sectors of the dynamics. By assuming full unitary quantum control in the low-energy subspace of a trapped gas, we show that (1) appropriately tuning the particle number statistics of the lowest-energy mode partially decouples the low- and high-energy sectors, allowing any low-energy single-particle wave function to define a background for sine-Gordon dynamics on curved spacetime and (2) macroscopic occupation of a quantum superposition of two states of the lowest two modes produces an analogue curved spacetime depending on two background flows, with respective weights continuously dependent on the corresponding weights of the superposed quantum states.

Keywords:

analogue gravity, sine-Gordon, weakly interacting Bose gas

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B2.08
2016.10.19 – 2016.10.21

Population transfer between bound states via continuum states observed by attosecond lighthouse measurement

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Abstract:
Tunneling ionization is a dominant process for atoms exposed to intense laser field whose field strength is comparable to the binding potential of an atom [1]. The electron is emitted near the peak of every half cycle of the laser field. When the sign of the laser field is changed in the next half optical cycle, the liberated electrons may revisit the atom. Then, they are re-scattered by the ionic core elastically in above threshold ionization (ATI), or inelastically in non-sequential multiple ionization (NSMI), or accompanied by radiative capture in high-order harmonic generation (HHG). Here, we discuss frustrated tunneling ionization (FTI), which is another exit of the tunneling triggered phenomenon. We observe the FTI process using attosecond lighthouse technique [2]. In contrast to other experiments showing FTI process [3], our observation is based on all optical method. Furthermore, we can obtain phase information of electron liberated through the tunneling and recaptured into higher-lying bound states. We demonstrate the experimental results using ab-initio calculations, quantum mechanical SFA model and semi-classical model. [1] L. V. Keldysh, Zh. Eksp. Teor. Fiz. 47, 1945 (1964) [Sov. Phys. JEPT 20, 1307 (1965)]. [2] K. T. Kim, C. Zhang, T. Ruchon, J.-F. Hergott, T. Auguste, D. Villeneuve, P. Corkum, and F. Quere, Nat. Photonics 7, 651 (2013). [3] Nubbemeyer, T., Gorling, K., Saenz, A., Eichmann, U. & Sandner, W. Strong-field tunneling without ionization. Phys. Rev. Lett. 101, 233001 (2008).

Keywords:
Tunneling ionization, Frustrated tunneling ionization, Attosecond lighthouse

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B2.09
2016.10.19 – 2016.10.21

Gaussian wave packet dynamics with re–initialization in Gabor frame as a time–dependent Schroedinger equation solver

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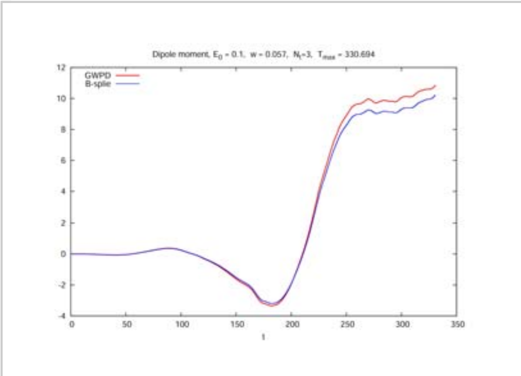

Abstract:

Gaussian Wave Packet Dynamics (GWPD) has great advantages as a tool for time–dependent approach to semiclassical dynamics: 1. the evolution of GWP is determined by classical equations of motion, 2. no boundary conditions are needed to be imposed at asymptotic regions, and 3. there is a possibility of avoiding the exponential increase of computational resource as the degrees of freedom of a system grow. However, GWPD suffers from severe limitations: it is valid only for a limited short time, and it cannot describe the classical forbidden processes such as tunneling. These are owing to the broadening of GWP as time goes on, which breaks the validity of GWPD based on quadratic approximation to the potential. As a solution to this problem, it has been suggested to re–initialize the GWPs, i.e., to transform the broadened GWPs to linear combinations of the initial GWPs with a narrow width after evolving in every short time–interval. We develop a GWPD with re–initialization in a Gabor frame. Our method has been shown to work well for a system with tunneling through a static potential barrier. Now we demonstrate the validity and advantages of the method as a time–dependent Schrődinger equation solver by applying to the higher–harmonic generation spectrum and the above–threshold ionization spectrum of the one–dimensional atomic model exposed to ultrafast strong laser pulses.

Keywords:
Gaussian wave packet dynamics, time–dependent Schroedinger equation,

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B3.01
2016.10.19 - 2016.10.21

Electrical and Thermoelectric Transport by Variable Range Hopping in Thin Black Phosphorus Devices

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Abstract:
I will talk about the mechanism of electrical and thermoelectric transport in 10−30 nm thick black phosphorus (BP) devices by measurements of electrical conductance and thermopower (S) with various temperatures (T) and gate-electric fields. The T dependences of S and the sheet conductance of the BP devices show behaviors of $T^{1/3}$ and $\exp[-(1/T)^{1/3}]$, respectively, where S reaches ~0.4 mV/K near room T. This result indicates that two-dimensional (2D) Mott's variable range hopping (VRH) is a dominant mechanism in the thermoelectric and electrical transport in our examined thin BP devices. We consider the origin of the 2D Mott's VRH transport in our BPs as trapped charges at the surface of the underlying SiO_2 based on the analysis with observed multiple quantum dots.

Keywords:
black phosphorus,electrical conductance,thermopower,variable range hopping

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B3.02
2016.10.19 - 2016.10.21

Atomic scale defects for high performance of bulk thermoelectrics

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Abstract:

The practical use of thermoelectric technology is constrained by a low conversion efficiency of thermoelectric systems depending largely on the performance of thermoelectric bulk materials. It has been demonstrated that the dimensionless figure of merit, ZT of bulk alloys can be enhanced by reducing lattice thermal conductivity through nanoscale defect engineering, which has been exclusively focused on the installation of nanosized inclusion or precipitates and modification of grain structure to stimulate phonon scattering. Recently, all-scale hierarchical architecturing of thermoelectric bulk alloys was reported as a new approach to enhance the ZT of bulk alloys over threshold number of 2.0. However, this approach is rather difficult to apply to the all state-of-the-art materials such as Bi-Te and Co-Sb systems. Thus, we introduce an uncontroversial approach in which the independent control of scattering mechanism for phonon and electron is possible via the engineering of atomic scale defects of bulk thermoelectric materials. This approach can be a general way for “beyond nanostructuring and hierarchical architecturing” to enhance the ZT of all thermoelectric bulk materials using scalable sintering processes. For an example, the dislocations at grain boundary in p-type Bi-Sb-Te system, leading to a record-high value around 2.0 at 320 K will be introduced [3]. This achievement was realized with the reduced lattice thermal conductivity originated in the formation of highly dense dislocation arrays at grain boundaries. Further, the atomic defects in high temperature thermoelectric materials enhancing the performance of materials will be introduced for half-Heusler and filled-skutterudite alloys.

Keywords:
Thermoelectric device, Semiconductor, Superconductivity

Solution-Processed p-Type Doping for Graphene

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Abstract:

Low work function (WF ~4.4 eV) and high sheet resistance (R_{sh} > 300 ohm/sq) of pristine graphene should be modified for practical use of graphene anode in flexible optoelectronics. We developed a simple solution-processed chemical p-type doping of graphene using trifluoromethanesulfonic acid (CF_3SO_3H, TFMS) that satisfies essential requirements for an ideal flexible graphene anode: i) high optical transparency, ii) low R_{sh}, iii) high WF, iv) smooth surface, and iv) air-stability at the same time. The TFMS-doped graphene improves electrical conductivity, surface WF, and air-stability of graphene. We also employed polymeric acid (perfluorinated polymeric sulfonic acid, PFSA) as a novel p-type dopant to maximize doping stability of graphene. Our novel doping strategy using macromolecule which is completely non-volatile achieved extremely high air- /chemical-/thermal stability. The PFSA-doped graphene also showed low R_{sh} and high surface WF as well. By using novel p-type chemical dopants, we fabricated flexible OLEDs that are superior to those with pristine graphene and indium-tin-oxide anode.

Keywords:
graphene; p-type doping; stability

Graphene based nanogenerators for wearable electronics

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Abstract:
Long-term operation is a key requirement for the widespread use of wearable devices and systems. Typical energy-storage and harvesting approaches relying on rigid materials and device structures hinder conformable integration on soft and wrinkled human skin. In this talk, I report two types of graphene based nanogenerators enabled by piezoelectric and triboelectric behaviors. These devices can form directly on human skin and operate wearable devices without recharging process. The conformal nanogenerators formed on human skin generated electricity by contact with various clothes or the human body. Their performance depended on the effective contact area and enabled self-powered touch sensors for an assistive communication system by converting analogous information of human motions to digital signals. Thus, graphene based nanogenerators have potential applications in a wide range of future wearable electronics.

Keywords:
Graphene, Nanogenerators, Wearable electronics

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B4.01
2016.10.19 - 2016.10.21

Two is better than one: multi-mode optomechanics

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Abstract:

The field of cavity optomechanics studies interaction between photons inside an optical cavity (i.e. cavity mode) and the motion of a mechanical oscillator (i.e. mechanical mode). In cavity optomechanics, typically one cavity mode couples to one mechanical mode through a linear interaction. This enables a number of interesting quantum measurements over the last few years including ground state cooling, photon-phonon entanglement, and quantum back-action evasion. When multiple cavity modes couple to multiple mechanical modes, however, more striking quantum effects can be realized such as non-linear optomechanical interaction, quantum non-demolition (QND) measurement, quantum many-body dynamics and topological phenomena in mechanical oscillators. In this talk, I will present two examples of recent studies in the field of multi-mode optomechanics. First, two cavity modes couple to a single mechanical mode via quadratic optomechanical interaction which paves a way to realize QND measurement of cavity photons and phonons. Second, two mechanical modes couple to a single cavity mode which enables topological energy transfer between the mechanical modes via exceptional points.

Keywords:

Cavity optomechanics, multimode optomechanics, quantum non-demiolition measurement, topological exceptional points

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B4.02
2016.10.19 - 2016.10.21

Quantum measurements with nanomechanical oscillators

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Abstract:

Nanomechanical oscillators have been utilized as sensitive detectors in various physical measurements, resolving minute forces from single electron charge, spin, and coherent cooper pair tunneling[1], for instance. In a force measurement, the fundamental force sensitivity turns out to be limited by Heisenberg's uncertainty principle, as recognized as quantum standard limit(SQL). In a generic measurement involving photons as the read-out for mechanical motion, SQL is imposed by the back-action from radiation pressure noise. However, one can set up a measurement which avoids this random back-action at the expense of increased uncertainty in the quadrature of harmonic motion orthogonal to the one being investigated[2], or even utilize the quantum back-action to manipulate quantum noise and reach quantum squeezed states[3]. In these experiments studying quantum back-actions, the photon-nanomechanics coupling rate is a key parameter for working in the deep quantum regime where quantum effects dominate the nanomechanical dynamics. As the coupling rate increases, it is expected that one could approach ultra-strong coupling regime, where mechanical states deviate from well-known number states, opening a new paradigm for controlling mechanical quantum states[4]. A quantum dot system embedded in a nanowire is proposed to be a candidate to reach this interesting regime, and our recent progress toward this direction is dissussed. [1] LaHaye et.al., Nature 459, 960-964 (2009). [2] Suh et.al., Science 344, 1262-1265 (2014). [3] Wollman et.al., Science 349, 952-955 (2015). [4] Nation et.al., PRA 93, 022510 (2016).

Keywords:

quantum measurement, nanomechanical system, optomechanical system

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B4.03
2016.10.19 - 2016.10.21

Optomechanics in on-chip optical ultra-high-Q resonators and its applications

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Abstract:

Recently, ultra-high-Q resonatros which has long been considered as a talented optical component for sciecntific experiment has been demonstrated on a silicon chip. The optical and opto-mechanical properites of the developed on-chip UHQ resonators will be provided. Future applications exploiting this on-chip resonators will be discussed.

Keywords:
Ultra-high-Q resonators, silicon photonics, optomechanics, bio/nano sensing

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B4.04
2016.10.19 - 2016.10.21

[한국물리학회상 수상기념 강연] Electro-mechanical Properties of Micro- and Nano- structures for NEMS Application

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Abstract:

In recent years, various nano- and micro-electromechanical systems have been explored and have become a great topic of interest for many researchers. Many of these systems have been seen to show a huge potential for applying to the production of highly integrated and high performance devices. Since the device performances of NEMS and MEMS are strongly governed by the flexural properties of the constituent materials, diverse devices can be designed and manufactured using optimized materials for each application through developing a thorough understanding of their physical properties. To study the dynamic responses of NEMS devices, freely suspended structures were fabricated to assign the electrical and mechanical degrees of freedom by the combination of standard lithography and micro contact transfer technique. In this presentation, we will investigate the mechanical properties of various suspended nano- and micro-scale structures using dynamic and quasi-static flexural measurements. Then, possible NEMS applications of each material will be discussed.

Keywords:

Electro-mechanical Properties of Micro- and Nano- structures forNEMS Application

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B5.01
2016.10.19 – 2016.10.21

Negative Shear Modulus

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Abstract:

There are many studies about effective modulus in the metamaterials. No naturally occurring material exhibits negative modulus, but negative values have been realized using metamaterials. Negative bulk modulus and negative Young's modulus have already been manufactured in many places, however, negative shear modulus has not been realized yet. Here we present realization of negative shear modulus. Our structure includes torsional resonators which provide extra torques on each unit cells and change effective shear modulus of the medium. In the frequency range corresponding to negative shear modulus we observed the shear wave decaying. Applications include damping vehicle vibrations and seismic waves.

Keywords:
Metamaterial, Negative Shear modulus, Evanescent wave, Seismic wave

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B5.02
2016.10.19 - 2016.10.21

Continuously Tunable Effective Modulus using Double Helmholtz Resonators

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Abstract:

Continuously tunable constitutive parameters are important in many applications. Continuous tuning of effective density has been established with metamaterials based on membranes. Here we present a new acoustic metamaterial consisting of double Helmholtz resonators, which allows continuous tuning of effective compressibility ideally from minus infinity to plus infinity: experimentally we were able to tune effective compressibility from −10 to +10 relative to that of air. Our work is relevant to acoustic cloaking.

Keywords:
Acoustic metamaterials, Acoustic cloaking

음향 루네버그 렌즈의 구현에 대한 연구

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Abstract:
자연계에 존재하는 대부분의 물질에서 음파의 속도는 공기 중에서의 속도보다 크다. 따라서 매질에서의 속도에 대한 공기 중에서의 속도의 비로 정의되는 음파에 대한 일반적인 매질의 굴절률은 1보다 작게 된다. 오리피스가 포함된 도파관은 음파의 진행 속도가 느리게 되어 굴절률은 1보다 커지게 된다. 또한 도파관에 대한 오리피스의 크기 비율이 달라짐에 따라 음파의 속도 변화를 줄 수 있으며 따라서 음파에 대한 굴절률의 크기를 1보다 큰 여러 가지 값으로 변화시킬 수 있다. 면 중심 입방 단위 셀의 오리피스 크기를 음파의 진행 방향에 따라 다르게 줌으로써 원하는 형태의 공간적 굴절률 분포를 구현할 수 있다. 음향 루네버그 렌즈는 매질의 굴절률 값이 중심으로부터 떨어진 거리 r에 따라 √[2-(r/a)2)]와 같이 변화하는 구형 렌즈로서 입사되는 음파를 렌즈의 대척 점 위에 집속시킬 수 있으며 수차가 없는 특징을 가지고 있다. 우리는 오리피스 음향 메타물질 단위 셀을 이용한 음향 루네버그 렌즈의 구현에 대해 연구하였다.

Keywords:
acoustic metamaterial, FCOC, Luneburg, lens

Acoustic metasurface for impedance matching between two media

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Abstract:

Air and water exhibit significant impedance mismatch. Conventional antireflection method involving quarterwave coating is not suitable in this case because, first there is no naturally occurring coating material exhibiting required impedance value, and second the coating is too thick to be practical. Here, we present a metasurface placed at the interface with a thickness much smaller than the wavelength. The metasurface is a two dimensional array of unit cells which are consisting of membrane and cavities. We first show analytically that our system can match the impedances of any two acoustic media regardless of their impedance difference. Second we demonstrate, with numerical calculation and experiment, almost total transmission of acoustic wave through the interface between air and water.

Keywords:
Impedance matching, Acoustic metasurface, Total transmission, Antireflection

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B5.05*
2016.10.19 - 2016.10.21

Simple synthesis of high quality In_2S_3 thin films on InAs substrates

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Abstract:

We report a simple and reliable technique to synthesize high-quality In_2S_3 films on InAs substrates by using thermal sulfurization in a hot-wall tube furnace. X-ray diffraction and energy dispersive X-ray spectroscopy data confirmed that the synthesized films were cubic β-In_2S_3 or tetragonal β-In_2S_3, depending on growth conditions. Field emission scanning electron microscopy analysis and Raman spectroscopy showed that the In_2S_3 films are of remarkable crystal quality. Strong photoluminescence was observed at room temperature. Especially, by optimizing the growth conditions, we have grown an extremely high-quality tetragonal β-In_2S_3 thin film firmly remained on the InAs substrate, for the first time.

Keywords:
In_2S_3CVDXRDRamanPhotoluminescence

Spectroscopic investigations of Ho^{3+}-doped gadolinium calcium silica borate glasses for visible and infrared laser applications

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Abstract:

The Ho^{3+}-doped gadolinium calcium silica borate glasses of composition (55-x) B_2O_3- 10 SiO_2 -25 Gd_2O_3 -10 CaO -x Ho_2O_3, where x = 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 mol %, have been prepared by conventional melt quenching technique and are characterized through optical absorption, visible emission spectra and decay time measurements. Judd-Ofelt (JO) intensity parameters (W_λ, λ = 2, 4 and 6) have been derived from the absorption spectrum of 0.5 mol % Ho_2O_3 doped glass and in turn are used to calculate radiative properties for the important luminescent levels of Ho^{3+} ions. The studied glasses show intense green emission at 552 nm and a weak red emission at 664 nm under at 404 nm excitation. The radiative lifetime for the $^5S_2(^5F_4)$ emission level and peak stimulated emission cross-section for the $^5S_2(^5F_4)$ ®$^5I_8$ transition are found to be 252 ms and 0.62 × 10^{-20} cm^2, respectively. The decay curves of the $^5S_2(^5F_4)$ ®$^5I_8$ level exhibit non-exponential nature for all the concentrations. Using the McCumber theory, absorption and emission cross-sections for the $^5I_6$®$^5I_8$ (~ 1.20 mm) and $^5I_7$®$^5I_8$ (~ 2.04mm) transitions for the Ho^{3+} ion have been obtained and gain spectra are also computed as a function of population inversion. The peak stimulated emission cross-section and gain coefficient for Ho^{3+}-doped silica borate glasses have been compared with other reported Ho^{3+} systems. These results indicate that the Ho^{3+} glasses could be useful for the development of visible and infrared lasers.

Keywords:

Ho^{3+} glasses; Optical properties; Judd-Ofelt theory; Decay time; Gain coefficients

Fabrication and luminescent properties of Sr_3SiO_5 phosphors for near-UV based WLEDs

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Abstract:
In recent years, white light-emitting diodes (WLEDs) have been considered as a good solid-state lighting device due to their attractive features such as high efficiency, low power consumption, energy saving, long lifetime, etc. The phosphors play an important role in the fabrication of WLEDs. The best common way to achieve white light is to synthesize single-phase white light-emitting phosphors. In this presentation, rare-earth ions doped Sr_3SiO_5 phosphors were prepared by a sol-gel method. Their structural and morphological properties were analyzed by X-ray diffraction pattern and scanning electron microscopy image. The photoluminescence properties were studied by using a fluorescence spectrometer at room temperature. The temperature-dependent emission spectra were investigated for the co-doped sample. These results show that the phosphors are a good candidate for near-UV based WLEDs.

Keywords:
phosphors, sol-gel, luminescence, WLEDs

Raman scattering studies of tin sulfide (SnS) and tin disulfide (SnS_2) films

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Abstract:

Various materials have been suggested as a solar cell absorber layer having good efficiency and suitable bandgap. Unwanted or secondary phases can be formed in the process of evaporating a thin film, and it is important to know the spatial distribution and the stoichiometry of the secondary phases because it can be change the bandgap and absorbance of a thin film that can deteriorate device properties significantly. By performing Raman scattering spectroscopy with various excitation energy, we can observe the distribution of materials and secondary phases utilizing different penetration depth. In this study, we measured 100nm-thick SnS and SnS_2 samples that were deposited on Mo coated soda lime glass by an e-beam evaporator. For observing the distribution of materials and secondary phases, we measured Raman spectra with four different excitation energies of 457 nm (2.71 eV), 488 nm (2.54 eV), 514.5 nm (2.41 eV), and 632.8 nm (1.96 eV). We also measured transmittance and reflectance for the absorption coefficient and the penetration depth. We report lateral and vertical distribution of different phases by analyzing phonon behavior.

Keywords:

Raman scattering spectroscopy, Solar cell absorber layer thin film, SnS, SnS2, Distribution of different phases

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2016.10.19 - 2016.10.21

Water intercalation under graphene : Electrowetting and Electrocapillary

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Abstract:
We've done an electro-wetting experiment with a water drop on CVD graphene. And we observed a water intercalation phenomenon between graphene and the substrate with exfoliation starting from the circle which the initial water drop was. After removing water on graphene, we got a ring-shape punched graphene on the substrate. We've analyzed the phenomenon with Young-Lippmann's theory and have been looking for reasons why water tears graphene around the rim of a water drop and intercalates underneath graphene. And with this phenomenon, we tried to manipulate graphene in our intention.

Keywords:
Grahpene, Surface tension, Electrowetting, Electrocapillary

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B6.01
2016.10.19 - 2016.10.21

Switching d-wave gap via spin reorientation in electron doped $Sr_3Ir_2O_7$

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Abstract:

Last few years, it was revealed that cuprate phenomenology could be largely reproduced in a doped 5d oxide compound, Sr_2IrO_4. From pseudo-gap at high temperature to d-wave gap at low temperature all key spectroscopic aspects of cuprate has been reproduced in ARPES and STS spectra of surface electron doped Sr_2IrO_4. However, unlike cuprate case where physics do not alter depend on the number of layers in unit cell, it turned out that clearly distinct trivial metallic phase evolves in bilayer compound $Sr_3Ir_2O_7$ when it doped. In this presentation, I will report that such metallic phase can be switched into d-wave nodal metallic phase also in bilayer compound by changing the spin orientation, which generates a low energy spin excitation that will couple with electrons. It strongly and directly implies that the low energy spin excitation is an essential ingredient of d-wave instability observed in doped iridates.

Keywords:
angle resolved photoemission spectroscopy, strongly correlated system, unconventional superconductivity

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 B6.02
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Strain-tuned magnetic anisotropy in the bilayer iridate $Sr_3Ir_2O_7$

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Abstract:
Epitaxial strain due to lattice mismatch between films and substrates is widely used to control structural change and explore new functional properties in complex oxide thin films. Strong coupling between spins, orbitals and lattices are responsible for these features. Here we demonstrate a spin-flop transition in (001) fims of layered $Sr_3Ir_2O_7$ with experimentally accessible compressive strains. Our results call for a contribution of strong c-bond-directional pseudo dipolar interaction to determine correct magnetic anisotropy.

Keywords:
iridate, spin-lattice coupling, strain, magnetic anisotropy

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Electronic structures of [$(SrIrO_3)_m$, $(SrTiO_3)$] (m = 1, 2 and ∞) Superlattices : Optical spectroscopic and density functional calculation studies

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Abstract:

We investigated the electronic structure of [$(SrIrO_3)_m$, $(SrTiO_3)$] (m = 1, 2 and ∞) superlattice (SL) thin films with optical spectroscopy and first-principles calculations. Our optical results confirm existence of the J_{eff} = 1/2 Mott state in the SL samples, similar to the bulk Ruddlesden-Popper series $Sr_{n+1}Ir_nO_{3n+1}$ iridates. However, in the SL samples, we observed redshift of the characteristic optical excitations and an enhancement of the low-energy spectral weight in the SLs, which implies increase of bandwidth for bands near the Fermi surface. The DFT+U calculations suggested that the inserted $SrTiO_3$ layers in SLs gives additional hopping channel, thus increasing the bandwidth of the SLs and reducing effective U. This work demonstrates that heterostructuring of iridium-based systems can modify electronic structures via alteration of the local lattice structure.

Keywords:
SrIrO3/SrTiO3 superlattice, Ruddlesden-Popper series iridates

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Computational characterization of novel sulfonamide inhibitors in complex with carbonic anhydrase IX

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Abstract:
Carbonic anhydrases involved in the rapid interconversion of CO_2 and H_2O into H_2CO_3, are essential for a variety of biological processes. Isoenzyme carbonic anhydrase IX (CAIX) is overexpressed in tumor tissues because of cellular hypoxia that is not exhibited in most normal cells. Therefore, CAIX is considered as a tumor marker and the design of its effective inhibitors is considered to be an urgent target, directly contributing to the cancer treatments. In this study, a set of eleven novel sulfonamide derivatives have been designed and optimized using density functional theory (DFT) with the CAM-B3LYP functional at the 6-31+G(d,p) level of theory. Subsequently, molecular dynamics (MD) simulations were performed in order to characterize the interactions between the designed compounds, CAIX and its binding site. Experimental structure of CAIX (PDB ID: 5FL4) bound with 5-(1-naphthalen-1-yl-1,2,3-triazol-4-yl)thiophene-2-sulfonamide (PDB ID: 9FK) was used as an initial model. Using the developed MD model, 100 ns were rapidly performed for each system. Upon simulation of 9FK in complex with CAIX the system conserved the all the main binding features identified experimentally using X-ray crystallography. Results of the simulated models confirmed superior interactions (in both the hydrophobic and hydrophilic regions of CAIX) of the designed ligands in comparison to the CAIX-9FK system.

Keywords:
carbonic anhydrases, antitumor pharmaceuticals, sulfonamide derivatives

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2016.10.19 - 2016.10.21

A new two-dimensional silicon crystal

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Abstract:

Here we report a new class of freestanding Si nanosheet, which is dynamically stable and shows distinct structural features. Unlike most of the previously reported nanosheets, the new structures possess unique planar outer surfaces with hexagonal symmetry, which are connected by distorted tetrahedrons. We discuss the stability of those nanosheets depending on the arrangement of those tetrahedrons and thickness of the nanosheet.

Keywords:
new Si nanosheet, materials discovery

Generation of the neural network potential of elemental boron from machine learning

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Abstract:
In evolutionary structure search, it is an important step to locate metastable configurations on the potential energy surface. Searching for metastable structures usually involves hundreds or thousands of energy and force calculations within the framework of density functional theory (DFT), in which high numerical accuracy can be kept. In this work, we present how machine learning can reduce the number of intermediate first-principles calculations needed to locate metastable structures on the potential energy surface. Since machine-learning models can learn from and thus mimic atomistic simulations, the metastable structure search can be conducted efficiently in the multilayered feedforward network representation based on the Behler-Parrinello approach. Construction and application of artificial neural network potentials are demonstrated for B systems as an example. We show that the lattice parameters, energies, transition pathway between different phases, and phonon spectra predicted by the neural network potential are well reproduced, compared with the DFT results for several reference phases. We examine the capability of the neural network potential to predict new crystal structures, in combination with the evolutionary search algorithm.

Keywords:
artificial neural network, metastable structures, density functional theory

1234 Automated ab initio calculations for material innovation

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Abstract:
최근 재료분야, 특히 신물질 탐색분야에서 양자계산을 주축으로한 계산과학분야가 많은 주목을 받고 있다. 하지만 양자계산은 높은 정확도를 가지고 있으나 시스템내의 복잡한 물성을 고려해서 믿을만한 신물질을 선별해내기에는 많은 한계가 있다. 본 발표에서는 이런 양자계산의 한계를 짚어보고 이를 극복할 수 있는 방안 중 하나로 자동화계산과 이를 통한 대규모 데이터베이스 구축과 재료정보학 활용에 대해서 논의해보고자 한다.

Keywords:
Automated ab initio calculations for material innovation

Discovery and property optimization of advanced materials using theoretical approaches

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Abstract:

Advanced functional materials are crucial to a wide range of industries and the human life. However, it typically takes at least a decade to incorporate a newly discovered material into applications, and, therefore, an innovation infrastructure for faster materials developments is highly desirable. In this regard, various theoretical tools can be exploited to accelerate the materials development, by either providing the atomistic understanding of a given material or proposing a novel material aimed at a certain purpose; the obtained results are expected to guide the experimental realization of new functional materials, reducing the necessary research resources and trial-and-error. Indeed, we have recently focused on the search of new advanced materials with potential applications in optoelectronics and clean energy, by using evolutionary approaches, such as the adaptive genetic algorithm and conformational space annealing. For example, our global structure searches based on such theoretical approaches have proposed novel structural models of several energy-related materials that their atomic structures are unclear. In this presentation, we briefly review the recent advances in the field of advanced materials developments, and introduce our recent related accomplishments and research status.

Keywords:

Materials design, genetic algorithm, global structure search

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New optical design for AP-XPS at PAL: Status and goal

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Abstract:
In November 2014 collaboration project for constructing the soft x-ray ambient pressure x-ray photoemission spectroscopy (AP-XPS) beamline was launched between KBSI and PAL. Based on the strong user requirement of AP-XPS beamline at synchrotron facility, PAL and KBSI agreed a MOU, in which PAL invests 3.0 billion won for undulator and optical system and KBSI invests 3.0 billion won for endstation for covering the fast emerging fields such as catalysis, environment, materials processing and biology. AP-XPS should be designed to probe electrons from the interface underneath gas layer. Moreover, the photoelectrons produced have the high interaction cross section with the environmental gases. As these nature, AP-XPS inevitably require high flux photons in the range of 200~2000 eV. Unfortunately, in PAL there is no available beamline port which meets the photon requirement for AP-XPS at this moment. Here, we present current status on the way of constructing beamline and optical design dedicated to AP-XPS endstation. Newly designed optics will replace of that of 8A (U6.8) which has been under operational for 20 years. Through this project two beamlines, AP-XPS and SPEM, available middle energy range, leads top edge science by exploring brands new scientific world without pressure gap based on the powerful photon source covering medium energy range.

Keywords:
AP-XPS, 8A beamling at PAL, optical design

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2016.10.19 - 2016.10.21

CO oxidation on Pt(110) with ambient pressure X-ray photoelectron spectroscopy

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Abstract:

In this experiment, we study the CO oxidation on Pt(110) surface under several hundred mTorr pressure conditions with ambient pressure x-ray photoelectron spectroscopy (AP-XPS) and mass spectrometer. To begin with, under O gas pressure and CO gas pressure at 200 mTorr and 40 mTorr, respectively, i.e. the ratio O_2 to CO ~ 5, the chemical states of O 1s and Pt 4f are monitored as temperature is increased. When sample temperature reaches to T ~ 550K. the sudden enhancement of CO oxidation occurs. After reaching reaction temperature, the O_2/CO ratio is varied from 5 to 3.33, 2, and 1.43 without increasing temperatures. Interestingly, even after O_2/CO ratio is decreased, the reaction rate continuously increase while surface oxides formed at O_2/CO ~ 5 also increase.. Our result shows that the Pt surface oxide is catalytically active phase during CO oxidation.

Keywords:
in-situ, Pt(110), CO Oxidation, ambient pressure X-ray Photoelectron Spectroscopy, AP-XPS

Hard X-ray Photoemission Spectroscopy Project at Pohang Light Source

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Abstract:
Recently Pohang Acceleratory Laboratory determined to construct a Hard X-ray Photoemission Spectroscopy (HXPES) experimental station as a compelling scientific program in the existing hard X-ray undulator diffraction-spectroscopy beamline 3A. Resonant X-ray scattering, X-ray standing wave technique, circularly polarized X-ray generation have been the major scientific programs of 3A Materials Physics Beamline. In this talk, we review the concept of beamline extension, characteristics of X-ray source (Revolver Type In-Vacuum X-ray Undulator) and discuss the feasibility of 3A as a HXPES beamline.

Keywords:
Hard X-ray Photoemission Spectroscopy

In-situ study of oxidation states of platinum nanoparticles on a PEFC electrode by near ambient pressure hard X-ray photoelectron spectroscopy

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Abstract:

The platinum nanoparticles (NPs) on carbon supports are generally used in the polymer electrolyte fuel cell (PEFC) as the highest efficiency catalyst. Since their durability is a key factor for their practical usage, many researchers in the catalyst technology have extensively carried out experiments to increase the durability. In the PEFC electrode, the Pt NPs are surrounded by ionomers and carbon supports. Additionally, a large amount of water exists at the working electrode of a PEFC to enhance proton mobility. Therefore, X-ray sources with high large photon energies are required to observe the PEFC electrode under operation because high-energy photoelectrons are needed to pass through the intermediate materials. Namely, the NAP-XPS using hard X-ray (NAP-HAXPES) should be a useful tool for direct observing of the electrode of the PEFC. The in-situ XPS measurements were conducted at the BL36XU beamline in the SPring-8 using the NAP-HAXPES system with a commercial differential-pumping type analyzer (R4000 HiPP-2, VG Scienta). We performed in-situ NAP-HAXPES measurements of the Pt/C cathode of the PEFC. To observe the modification of the electronic states of Pt atoms in the Pt/C cathode catalysts during the operations, the Pt 3d5/2 peaks were recorded at an incidence X-ray beam energy of 7.94 keV (Figure 1). In order to obtain detailed composition, the Pt 3d spectra were decomposed by three components of Pt1, Pt2, and Pt3. Pt1 at 2122.0 eV corresponds to metallic Pt and the Pt3 component at 2125.1 eV originates from the Pt species with a formal valence of +2 as PtO. The Pt2 component at 2123.3 eV contains two contributions from the Pt species of the platinum hydroxide and the oxygen-adsorbed platinum. The characteristic oxidation peak (Pt3) was found when the applied voltage between the electrodes was increased to greater than 1.0 V. In contrast, the peak almost disappears when the applied voltage was decreased to less than 0.8 V. The oxidized state exhibits a distinct hysteresis in the increasing and decreasing bias voltage processes References 1. Oki Sekizawa et al., J. Phys.: Conf. Ser. 430, 012020 (2013). 2. Yasumasa Takagi et al., App. Phys. Lett., 105, 131602 (2014).

Keywords:
in-situ XPS, hard X-ray XPS(HAXPES), the polymer electrolyte fuel cell (PEFC)

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Luminescence properties of InP/InGaP quantum structures grown by a migration-enhanced epitaxy

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Abstract:

The luminescence properties of InP/InGaP quantum structures (QSs) grown on GaAs substrates have been investigated by using photoluminescence (PL) and time-resolved PL (TRPL) measurements. InP/InGaP QSs were grown by a migration-enhanced epitaxy (MEE) method under different growth cycles (2-8) and growth temperatures (440° C-520° C). With increasing the MEE repetition cycles, the PL peak of InP QSs is redshifted from 1.86 to 1.65 eV and the PL decay becomes faster. This decrease of decay time can be explained by the enhanced confinement and the increased wave function overlap among QSs. The PL peak measured at 10 K is shifted to high energy side from 1.68 to 1.80 eV as growth temperature increases from 440 to 520° C, respectively. As the temperature increases from 10 K to 300 K, the bandgap shrinkage of InP QS sample grown at 460° C is much faster than that of bulk InP while the sample grown at 520° C corresponds with the bandgap narrowing of bulk InP. The fast bandgap shrinkage of InP QS samples is attributed to the increased carrier redistribution from small QSs (higher energy states) to large QSs (lower energy states) with increasing temperature. The PL decay times of all samples increase up to ~60-100 K and then shorten rapidly above those temperatures. The increase of PL lifetime is interpreted as a competition of several mechanisms such as thermally induced carrier migration from WL and InGaP barrier, carrier redistribution among the QSs, etc., while the decrease of PL lifetime at high temperature is attributed to the enhanced non-radiative recombination and trapped thermally activated carriers in WL and barriers. The optical properties of InP/InGaP QSs are strongly dependent on the growth parameters such as growth cycles and growth temperature. Therefore, the size/shape and density of InP/InGaP QSs could be adjusted by changing growth cycles and/or growth temperature in order to obtain desired emission wavelength.

Keywords:
InP, Quantum structure, Photoluminescence, Time-resolved photoluminescence

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공간 분해 분석을 이용한 단일 질화갈륨 로드의 마그네슘 도핑 특성 연구

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Abstract:
질화갈륨(GaN)은 직접천이형 화합물 반도체이며, 높은 발광효율 및 열적, 화학적 안정성으로 인하여 발광소자와 태양전지와 같은 광전소자에서 널리 사용되고 있는 물질이다. 특히, 질화갈륨 로드의 경우, 결함밀도 및 strain을 감소시켜 결정품질을 향상시킬 수 있으며, 로드의 무극성 면 위 core/shell 구조의 활성층은 내부전기장에 의한 영향을 최소화시켜 광전소자의 효율을 향상시킬 수 있다.[1] 이와 같은 core/shell 구조를 포함한 질화갈륨 로드를 기반으로 하는 고효율 광전소자를 구현하기 위해서는 고품질의 도핑 층이 요구된다. 특히, 질화갈륨 로드에서의 p-도핑은 3가지의 문제가 있다. 먼저 질화갈륨은 p-도핑을 하는데 있어 물질 자체의 한계를 가진다. 또한, 로드의 3차원 구조체는 평면 시료와 다른 도핑 주입 경로를 형성한다. 마지막으로 단일 로드 내부에서 위치 별 도핑 량의 차이가 발생하게 된다. 이를 극복하기 위해서 많은 연구가 필요한 상황이다. [2] 특히 로드에서 발생하는 공간적 도핑 특성의 차이를 파악하기 위해서는 공간분해 분석이 필요하다. 본 연구에서는 마그네슘으로 p-도핑된 단일 질화갈륨 로드의 위치 별 도핑 특성을 분석하는 연구를 진행하였다. 위치 별 도핑 특성을 확인하기 위해서, 비 파괴적인 광분석 방법인 photoluminescence (PL)를 이용하여 위치 별 발광 특성을 확인하고, 파괴적 성분분석 방법인 time of flight secondary ion mass spectrometry (TOF-SIMS)를 통해 로드의 위치에 따른 도핑 량의 정량적인 변화를 확인하였다. 이 실험으로부터 마그네슘 도핑 량이 질화갈륨 로드의 위치에 따라 차이를 보였고, 이 결과는 질화갈륨 로드의 위치 별 발광과 연관성을 가지는 것을 확인하였다. [1] Y. Dong, B. Tian, T. J. Kempa, and C. M. Lieber, Nano Lett., 9, 2183 (2009). [2] A.Patsha, S. Amirthapandian, R. Pandian, S. Bera, A. Bhattacharya, and S. Dhara, J. Phys. Chem. C, 118, 24165 (2014).

Keywords:
질화갈륨, 로드, 마그네슘 도핑, PL, TOF-SIMS

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상온 단광자 광원을 위한 단일 CdSe/ZnSe 나노와이어의 광특성 분석

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Abstract:

최근 실용 양자통신 구현을 위한 다양한 시도가 이루어지고 있으며, 나노반도체를 기반으로 하는 경우 물성제어와 기능성은 우수하나 단광자 발생 효율을 저온에서 상온으로 올려야 할 필요가 있다. 최근 직경 10 nm 정도의 CdSe/ZnSe 나노막대를 활용할 경우 상온 단광자 발생의 가능성이 제시되었다 [1]. 하지만 상용화를 위해서는 광효율 개선이 필요하다. 이를 위하여 에폭시 기법으로 제작된 CdSe/ZnSe 나노막대에 ZnMgSe를 성장시켜 패시베이션을 하고, 나노막대를 쌍극자 방사를 고려한 두께의 알루미늄 박막 위에 두었다 [2]. 이러한 단일 개선 구조에 대해 입사하는 빔의 세기에 따른 발광, 온도에 따른 발광 및 시간 분해 발광을 통하여 엑시톤과 쌍엑시톤을 상온까지 확인하였다. 또한, 나노와이어의 엑시톤과 쌍엑시톤에 대하여 Hanbury-Brown Twiss 실험을 한 결과 200 K까지 단광자 광원임을 확인할 수 있었다. 참고문헌 [1] S. Bounouar et al. Nano Letters 12, 2977 (2012) [2] T. Cremel et al. Phys. Status Solidi C 11, 1263 (2014)

Keywords:
단광자(Single Photon), 마이크로발광(Micro-photoluminescence), CdSe 양자점

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High voltage generation of NiO/GaN heterojunction piezoelectric generator by suppressed internal carrier screening

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Abstract:

With the extensive use of various wireless sensors and portable electronic devices, energy harvesting from the environment has attracted considerable attention. Piezoelectric generators (PGs) have been proposed for producing electric energy from vibration and mechanical energy sources. Therefore, piezoelectric materials such as lead zirconate titanate (PZT), ZnO and GaN have great potential for sustainable operation of wireless electronic devices. Among the available piezoelectric materials, PZT is the best material to achieve high output voltage due to its outstanding piezoelectric coefficients. However, the low output current and poisonous lead have limited the integration of these materials and human-related applications. Despite of low piezoelectric coefficients, the material properties of GaN such as non-toxicity and good thermal stability have led to the promising candidate for PG. In this work, we fabricated high efficiency GaN PGs with a NiO-GaN p-n junction (pn-PG). The undoped GaN (uGaN) for active element was grown by metal organic chemical vapor deposition (MOCVD) and then NiO layer was formed by RF sputter using NiO target at room temperature. The gas flow conditions during the sputtering were varied to control the electrical properties of NiO. Nickel (Ni)/ gold (Au) and Indium (In) were used as bottom and top electrode material, respectively. Piezoelectric output power was measured by a potentiometer (PARSTAT 4000/Potentiostat/Galvanostat/ELS Analyzer) while straining devices. Four piezoelectric thin film generators as reference and pn-PGs based on NiO-uGaN junction were fabricated. For one device (device A), Ni plays an important role in the enhancement of piezoelectric output power due to the formation of Schottky barrier between metal and uGaN layer. On the other hand, for other devices (device B to D) Ohmic contact were formed between Ni and NiO after the additional annealing step for metallization. P-n junction acts as a reliable Schottky rectifying barrier, leading to the enhancement of piezoelectric output power. In this design, device A shows AC output voltage around 10 mV when cyclic stresses were applied to device. On the other hand, the output voltage of device D was increased by about 750-fold compared to device A. the enhancement was caused by p-n junction structure. P-n junction reduced the free carrier more than Schottky junction, resulting in high degree of carrier screening suppression. In addition, p-n junction prevented the leakage current through the interface, which screens piezoelectric potential, more effectively than Schottky contact in device A.

Keywords:
piezoelectric, NiO, GaN, generator

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Improvement of device performance and stability of homojunction structured tungsten doped IZO thin film transistor

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Abstract:

The device performance and stability of staggered bottom gate structure tungsten-indium-zinc oxide thin film transistors (WIZO-TFTs) were fabricated by a radio frequency (RF) co-sputtering system using the WIZO and indium-tin oxide (ITO) source/drain (S/D) electrode materials on a same WIZO active channel layer. The electrical characteristics of the WIZO film that has been used in the S/D electrode and the active channel layer adjusted through the oxygen partial pressure in the deposition process, respectively. To explain the improvement of the device performance and stability with different WIZO and ITO S/D electrodes, the correlations between the device performance and the physical properties at the interface region between active layer and source/drain electrodes such as contact resistance, interface roughness, interfacial trap density, interfacial energy level alignments were investigated. The WIZO-TFT with WIZO electrodes exhibited the lower contact resistance, lower interfacial trap density, and more flat interface roughness than the WIZO-TFT with ITO electrodes. Furthermore, the electron barrier of the WIZO-TFT with WIZO electrodes is 0.09 eV, which is lower than the value of 0.21 eV obtained for the WIZO-TFT with ITO electrodes. This reduced electron barrier could be attributed to the improvement of device performance and stability, which is related to electron transport.

Keywords:
Homojunction structure, Band alignment, Oxide thin film transistor

Synthesis and emission properties of $BaLa_2WO_7$ phosphors

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Abstract:
Recently, trivalent rare-earth ions activated compounds have attracted much attention for the development of high-efficiency luminescent materials. A series of Eu^{3+}:$BaLa_2WO_7$ (BLWO) and Eu^{3+}/Bi^{3+}:BLWO phosphor samples are prepared by a citrate-based sol-gel method. The phase formation and structural/morphological properties of these phosphors are characterized by powder X-ray diffraction patterns and field-emission scanning electron microscope/transmission electron microscope images, respectively. The photoluminescence properties of these phosphors are studied under near-ultraviolet excitations. All the results indicate that the excellent red light-emitting Eu^{3+}:BLWO and Eu^{3+}/Bi^{3+}:BLWO phosphors could be potentially employed for various applications.

Keywords:
sol-gel method, rare-earth, phosphors,photoluminescence

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GaN 기반 발광다이오드에서 내부전기장 및 전하밀도 감소에 따른 효율 저하 현상 억제

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Abstract:
현재 GaN 기반 발광다이오드에서 중요한 이슈 중 하나는, 복잡한 활성층 구조의 이용 및 3차원 구조체의 적용 없이 기존의 2차원 구조를 갖는 발광 다이오드 형태를 이용하면서, 높은 주입전류 영역에서 효율 저하 현상을 줄이고, 전체적으로 높은 효율을 유지시키는 것이다. 그 중, 활성층의 두께를 증가시키는 방법은 활성층 내부의 전하밀의 감소에 따른, 높은 전류 주입 영역에서 발생하는 비 발광 재결합 과정을 줄여줌에 따라서, 발광 다이오드에서 발생하는 효율저하를 줄여줄 수 있는 방법이기에 현재 많은 연구 그룹에서 사용이 되고 있다. 하지만, 증가된 활성층 두께에 따른, 내부전기장의 증가 및 결함, 그리고 추가적인 스트레인의 형성으로 인해, 효율 저하를 일으키는 다른 문제를 발생시킨다 [1]. 본 연구에서, 기존의 2차원 구조를 갖는 발광 다이오드에서, 전체 활성층의 두께 및 양자 우물 하나의 두께를 일정하게 유지시키면서, 양자 장벽의 두께의 감소에 따른 활성층의 수를 증가시키는 구조를 이용하였고, 이를 통해, 효율 저하 현상의 감소 및 전체적인 효율 증가 특성이 동시에 발생됨을 관찰하였다 [2]. 발광소자 내부의 material quality의 저하 현상 없이, 양자 장벽의 두께가 감소하고, 양자 우물 수가 증가함에 따라, 활성층 내의 내부전기장 및 전하밀도가 동시에 줄어드는 것을 확인하였다. 또한, 활성층 내의 이러한 현상으로부터, 높은 주입 전류 영역과 관련된 비 발광 재결합 과정이 줄어들게 되어, 전체적인 효율의 증가 및 효율 저하 현상이 감소한다는 사실도 확인하였다. 앞으로 이러한 구조는, 다양한 파장영역에서 고효율의 발광 소자를 제작하는데 응용이 될 것이다. [1] Applied Physics Letter 91, 181113 (2007) [2] Scientific report (on review)

Keywords:
발광다이오드, 효율저하, 내부전기장, 전하밀도

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Performance of Cr-doped ZnTe based intermediate band solar cells

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Abstract:

ZnTe based solar cells have a possibility of high efficiency with formation of an intermediated energy band structure by impurity doping. A pulsed (10 Hz) Nd:YAG laser operating at a wavelength of 266 nm was used to produce a plasma plume from an ablated a ZnTe:Cr target, whose density of laser energy was 10 J/cm^2. The base pressure of the chamber was kept at a pressure of approximately 1x10^{-6} Torr. ZnTe:Cr and i-ZnTe thin films with thickness of 100 nm were grown on p-Si substrate, respectively, and then AlZnO thin films with thickness of 150 nm were grown on these layers at oxygen partial pressure of 3 mTorr. Growth temperature of all the films was set to 250 ^{o}C. For ohmic back contact to p-Si, Ni/Au with thickness of 30/100 nm were deposited on back side of p-Si by using thermal evaporation. Finally, grid patterns of Ti/Au were deposited on front of the solar cells by using thermal evaporation. From the fabricated solar cell, dark current was measured by using Keithley 2600, and the solar cell parameters were measured under Air Mass 1.5 Global solar simulator with an irradiation intensity of 100 mW cm^{-2}. Photoelectric conversion efficiency, open circuit voltage, short circuit current, and fill factor of the ZnTe:Cr based intermediate band solar cell were 5.87 %, 0.45V, 21 mA, and 0.56, respectively.

Keywords:

Intermediate band solar cell, ZnTe

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Optical and Electrical Properties of Amorphous InGaZnO Thin Film Transistors by RF Magnetron Sputtering

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Abstract:
Amorphous metal oxides such as amorphous indium gallium zinc oxide (a-IGZO) have become mainstream materials for large-area and flexible electronics because their long-range structural disorder enhances the uniformity of the electrical properties and mechanical flexibility compared with crystalline metal oxides. In addition, amorphous metal oxide semiconductor-based thin-film transistors (TFTs) have attracted considerable attention as an emerging technology to replace amorphous and polycrystalline Si TFTs due to high optical transparency, amorphous microstructure, high electron mobility, low off-current level, and low processing temperatures. In this study, a 80-nm-thick a-IGZO films were deposited onto a p^{++}-type Si wafer (resistivity of 〈0.005 Ωcm) coated with a SiO_2 film (280 nm) using RF magnetron sputtering. Next, source/drain (S/D) electrodes were formed through thermal evaporation of Al (80 nm). The structural properties of thin films were analyzed by XRD measurement and X-ray photoelectron spectroscopy (XPS). Their optical absorption was measured in the wavelength range of 200－800 nm using an ultraviolet－visible (UV－Vis) spectrophotometer. The electrical properties of TFTs were investigated by using current-voltage (I-V). The field-effect mobility of the a-IGZO channel was improved from ~0.02 to ~9 $cm^2/V\times s$ by thermal treatment.

Keywords:
a-IGZO, TFT, RFmagnetron sputter,Amorphous oxide semiconductor

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Studying Dielectric Properties by Graphene Field-Effect Transistor

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Abstract:

For the investigation of intrinsic two-dimensional electronic system, graphene in the configuration of field-effect transistor had been intensively studied in many aspects. The ambipolar feature in its transistor operation as a function of gate bias and the unique quantum Hall transport characteristics had been reproduced robustly in many studies irrespective of specific device conditions. From these results, we can imagine that the detailed variation of graphene's electrical transport can contain the information about dielectrics contacting the conduction channel of graphene transistor. The first example is the graphene device fabricated on a defective oxide dielectric. During the gate-bias sweep, the combination of charge-trap memory behavior with quantized channel conductance of the two-terminal quantum Hall phenomena appeared at low temperature under magnetic fields. [1] Secondly, the graphene device was fabricated on the ferroelectric single-crystal (PMN-PT) substrate. During the gate-voltage sweep, the complicated interplay between the charge trap phenomena (at the h-BN / ferroelectric-substrate interface) and the ferroelectric switching (under the graphene/h-BNchannel region as well as the contact electrode region) was observed in this system. [2] The other report concerning the graphene device on ultra-high-k thin-film dielectric ($SrTiO_3$) substrate also demonstrates the advantage of graphene's universal quantum Hall conductance behavior characterizing the contacting dielectric material. [3] 1. H. Kang, Y. Yun, J. Park, J. Kim, T. K. Truong, J.-G. Kim, N. Park, H. Yun, S. W. Lee, Y. H. Lee and D. Suh, Nanotechnology (2015) 2. N. Park, H. Kang, J. Park, Y. Lee, Y. Yun, J.-H. Lee, S.-G. Lee, Y. H. Lee, and D. Suh, ACS Nano (2015) 3. J. Park, H. Kang, K. T. Kang, Y. Yun, Y. H. Lee, W. S. Choi, and D. Suh, Nano Letters (2016)

Keywords:
Graphene, Field-Effect Transistor, Ferroelectrics, Quantum Hall, Functional Oxides, Ultrahigh-k

Mesoscopic research with electronic interferometers

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Abstract:
Electronic interferometry has played a significant role in investigating some of the most fundamental and subtle issues of quantum physics, such as decoherence, entanglement and complementarity etc. Moreover, they are regarded as the most promising platform for probing anyonic quasi-particles in the fractional quantum Hall effect regime. Anyons are exotic excitations to obey fractional exchange statistics, which is different from that of fermions and bosons. In this talk, I will briefly review the basics of electronic interferometry in the quantum Hall regime and then discuss recent research progress towards probing anyonic statistics.

Keywords:
Electronic interferometry, Fractional quantum Hall effect, Anyons

Quantum dots coupled to impedance matching circuits

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Abstract:

Coupling InAs nanowire and carbon nanotube devices to microwave circuits offers a significant increase in bandwidth and signal-to-noise ratio. These facilitate fast non-invasive readouts important for quantum optics, shot noise and correlation measurements. Here, we successfully couple InAs nanowires and carbon nanotube (CNT) double quantum dots to impedance matching circuits. The devices show a tunable bipolar double dot behavior, reaching the few-electron/hole regime. The resonance response reflected by the matching circuit is a sensitive probe of the charge state of the device, allowing a determination of the absolute charge number. The resonance response at the interdot charge transitions enables quantitative parameter extraction. Presented results open the path for novel studies of microwave photons interacting with electrons in carbon nanotubes. Acknowledgements : Research at DGIST and Basel is supported by the DGIST start-up fund (2016040006), DGIST R&D program (16-NB-04), the NCCR-Nano, NCCR-QIST, ERC project QUEST, and FP7 project SE2ND.

Keywords:
Quantum dot, high frequency measurements, impedance matching, Carbon nanotube, InAs

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Relative entropy from a charged particle

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Abstract:
We consider the relative entropy in a dual geometry produced by a charged particle. In the linear order, we show that the first law should be modified. This modification is naturally expected from the charged Reyni entropy. The 2nd order of the relative entropy is positive. We study on how this nonnegativity can be related to the weak gravity conjecture.

Keywords:
Relative Entropy,Entanglement Entorpy

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De Sitter Entropy and Area Law with Topological Soliton

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Abstract:

Global topological solitons of the hedgehog ansatz are added to de Sitter space- time in arbitrary dimensions larger than three, and thermodynamic law is checked at the cosmological horizon without additional horizon. All geometric and thermodynamic quan- tities are varied in the presence of this interacting matter distribution including pressure, however the area law is satisfied in exact form.

Keywords:
de Sitter spacetime, entropy, area law, global monopole

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Area law of black hole entropy with topological hair

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Abstract:
Global topological solitons of the hedgehog ansatz are added to Schwarzschild black hole in arbitrary dimensions larger than three, and thermodynamic law is checked at the horizon without additional horizons. All geometric and thermodynamic quantities are varied in the presence of this interacting matter distribution inluding pressure, however the area law is satisfied in exact form.

Keywords:
entropy, black holes, area law, topological soliton, non-BPS

Exact Holography of the Mass-deformed M2-brane Theory

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Abstract:

After the Kaluza-Klein reduction on S^7 in 11-dimensional supergravity, we construct 4-dimensional gravity theory which encodes the information of asymptotic limit for the Lin-Lunin-Maldacena (LLM) geometry. Applying the mapping dictionary of gauge/gravity duality, we show exact agreement between vevs of chiral primary operators in the mass-deformed ABJM theory and the asymptotic expansions in the reduced 4-dimensional gravity theory. This quantitative agreement is extended to all possible LLM solutions with any gauge group (N 〉 1) and Chern-Simons levels. Our results provide a highly nontrivial test of gauge/gravity duality away from the conformal fixed point.

Keywords:
Kaluza-Klein reduction, Lin-Lunin-Maldacena (LLM) geometry, gauge/gravity duality, vevs of chiral primary operators,mass-deformed ABJM theory

Exact Holography of the Mass-deformed M2-brane Theory for Finite N

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Abstract:
Applying the mapping dictionary of gauge/gravity duality, we show exact agreement between vevs of chiral primary operators (CPOs) in the mass-deformed ABJM theory and the asymptotic expansions in the reduced 4-dimensional gravity theory. We obtain quantitative agreement between the vevs of CPOs with conformal dimension 1 in field theory side and corresponding asymptotic coefficients in gravity side. This is the first nontrivial agreement in gauge/gravity duality for finite N and discuss possible future directions.

Keywords:
mass-deformed ABJM theory, gauge-gravity duality, LLM geometry

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Holography of Free Adjoint Models

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Abstract:
AdS duals of various free adjoint-model CFTs have been studied. After analysing the field contents for the first few Regge trajectories and the underlying higher spin symmetry, we calculate the one-loop free energy of the AdS theories and match it to the corresponding CFT quantity.

Keywords:
AdS/CFT, higher spin, tensionless string

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Perturbative study of the holographic entanglement entropy in external electric field

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Abstract:
We study the holographic entanglement entropy in an external electric field.

Keywords:
Holography, Entanglement, anti-de Sitter spacetime

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Analysis of optical conductivity for strongly correlated system with magnetization from holography

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Abstract:
We study the optical conductivity in a holographic model starting from the 3+1 dimensional Einstein-Maxwell-Axion action with Chern-Simons interaction. In this model, the time reversal symmetry is broken to consider magnetically ordered system. We analyse the changes of pole positions in the optical conductivity by varying the interaction strength and magnetic fields to find the origin of appearance of peaks in optical conductivities.

Keywords:
Holography, Strongly correlated system, Magnetization, Transport Coefficients

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Negative magnetoresistance in stronly interacting ferromagnetic material from holography

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Abstract:
We study DC transport coefficients of stronly interacting ferromagnetic material by using gauge/gravity duality. We find gravity dual of the strongly interacting system with finite magnetization. We calculate DC transport coefficients from black hole horizon data. By inverting electric conductivity matrix, we obtain the longitudinal and transverse resistivity and find that the system shows negative magnetoresistance which is closely related to the time reversal symmetry breaking. We also study the external parameter(temperature, density, etc.) dependence of the thermoelectric power and Nerst signal of the system.

Keywords:
gauge/gravity duality, strongly correlated system, negative magnetoresistance. ferromagnetism

The COSINE detector

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Abstract:
COSINE is a dark matter experiment using ultra-low background NaI(Tl) crystals led by the Center for Underground Physics at IBS and Yale University. The goal of the experiment is to reproduce the controversial DAMA/LIBRA's annual modulation signature in the same type of crystals. The construction of the detector at the Yangyang underground laboratory has been completed and the collaboration is ready to start a first-phase commissioning. In this talk, the installation of the main shielding and the NaI(Tl) crystal units, and the status of the experiment will be reviewed.

Keywords:
dark matter, NaI(Tl)

Dry run data of the COSINE experiment

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Abstract:
The COSINE experiment is joint collaboration between the KIMS and DM-ICE NaI(Tl) experiments to prove or refute DAMA/LIBRA's annual modulation result with same NaI(Tl) crystals. We already installed 106 kg of the NaI(Tl) crystals and started dry run since Aug. 2016. Stability of system as well as background understanding have been performed with one-month long dry run experiment. In this presentation, I will discuss about our understanding with dry run data of the COSINE experiment.

Keywords:
COSINE, Darkmatter, NaI(Tl)

A study on muon selection criteria in the COSINE dark matter Experiment

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Abstract:
COSINE is a collaboration experiment between the KIMS-NaI (Korean Invisible Mass Search with NaI crystals) and the DM-Ice which has a goal to reproduce the annual modulation signature reported by the DAMA/LIBRA using the same target material of NaI(Tl) crystals. In low background dark matter experiments, the cosmic-rays muon can be a serious background source to the seasonal modulation of events which can mimic annual modulation signature in the crystal signal. To tag muon-induced signal, COSINE has installed muon veto detectors composed by 37 pannels of 3 cm plastic scintillators surrounding outmost part of a shielding structure. Starting of dry run of the COSINE-100 experiment since Aug 2016, we accumulate data of the muon veto detector. In this presentation, we will describe muon selection criteria of the plastic scintillator for the muon veto as well as muon flux calculation.

Keywords:
COSINE experiment, dark matter, muon selection criteria, muon detector

A DAQ and trigger system for the COSINE experiment

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Abstract:

The COSINE is a collaboration experiment between the KIMS and the DM-ICE to prove or refute the DAMA/LIBRA's annual modulation result with the same NaI(Tl) crystals. A total of 106 kg of NaI(Tl) crystals was installed in a new shield structure at the Yangyang underground laboratory and a dry run has started in the summer of 2016. We have developed a DAQ (Data Acquisition) system which is made of two types of FADC modules, one for the NaI(Tl) crystals and the other for plastic scintillator muon counters, and a TCB (Trigger Control Board) module with negligible dead time. Additionally, we have developed several trigger options to reduce noise triggers from photo sensors and to lower the energy threshold of the crystal detectors. In this talk, we will present details of the DAQ and trigger system in the COSINE experiment.

Keywords:
COSINE, Dark Matter, DAQ

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Pulse discrimination power (PSD) measurement of NaI(Tl) crystal.

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Abstract:

In direct detection of WIMP dark matter particles, scintillation crystals such as NaI(Tl) are commonly used as targets/detectors. In these crystals, nuclear recoil events and beta/gamma-induced events can be discriminated based on their differences in scintillation characteristics. By using a so-called pulse shape discrimination (PSD) analysis, discrimination between WIMP-induced recoils and the background beta-gamma events can be possible. The PSD power of the NaI(Tl) crystal was characterized using quality factors and measured from 1 keVnr to 12 keVnr. To measure the quality factor, the responses of a NaI(Tl) crystal to nuclear recoils are measured and compared the result with the response to electron recoils. Nuclear recoils are produced by 2.43 MeV mono-energetic neutrons from D-D fusion reactions in a neutron generator and electron recoils are produced by Compton scattering of 662 keV gamma-rays from a 137Cs source. The target NaI(Tl) crystal (2cm x 2 cm x 1.5 cm) was made from the same Alpha Spectra-grown ingot as a large crystal used for KIMS-NaI experiment. Neutron-induced events were selected by the time coincidence of signals in BC501a liquid scintillator neutron detectors and the NaI crystal.

Keywords:

Dark Matter, WIMP,KIMS-NaI, NaI(Tl), Pulse shape discrimination power

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AMoRE-Pilot status and analysis

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Abstract:

The Advanced Mo-based Rare process Experiment (AMoRE) aims to search for neutrinoless double beta decay of ^{100}Mo using low-temperature detectors consisting of Mo-based scintillating crystals read out via metallic magnetic calorimeters. Simultaneous measurements of heat and light signals are performed at mK temperatures that are reached using a dilution refrigerator. The AMoRE-Pilot experiment, using five ^{100}Mo-enriched, ^{48}Ca-depleted $^{40}Ca^{100}MoO_4$ crystals with a total mass of about 1.5 kg, has been running in the 700-m-deep Yangyang underground Laboratory as the first stage of the AMoRE project. The current status of the AMoRE-Pilot run, as well as the analysis of recent data, will be presented.

Keywords:

Neutrinoless double beta decay, underground experiment, low-temperature measurement, low-background measurement

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Status of the AMoRE Background Simulation

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Abstract:

The AMoRE(Advanced Mo based Rare process Experiment) is an experiment to search for neutrino-less double beta decay of ^{100}Mo with $^{40}Ca^{100}MoO_4$ crystals. Since the neutrino-less double beta decay is a rare process, the AMoRE requires an extremely low background condition. To understand the condition, simulations of the AMoRE background have been performed by Geant4 simulation package. In the simulation, radioactive background sources such as ^{238}U, ^{232}Th, ^{235}U, and ^{40}K, were generated in CMO crystals and surrounding materials such as shields and the rocks. From the results of the simulations, the expected background rates based on radioactivity measurements of materials were estimated. The status of the AMoRE Pilot and AMoRE phase-1 background simulations will be presented.

Keywords:

Simulation, GEANT4, neutrino-less double beta decay

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2016.10.19 - 2016.10.21

$CaMoO_4$ crystal study of radioactive contamination in new setup for the AMoRE-I experiment

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Abstract:
The AMoRE (Advanced Molybdenum based Rare process Experiment) is a search for neutrino-less double beta decay of ^{100}Mo. We developed special calcium molybdate scintillation crystals with Molybdenum enriched in ^{100}Mo and Calcium depleted in ^{48}Ca especially for this experiment. We are growing 5 kgs of $^{40}Ca^{100}MoO_4$ crystals in collaboration with a company in Russia for the first phase of the experiment (AMoRE-I), which will operate in the Yang Yang underground laboratory (Y2L) in Korea. This experiment requires extremely low levels of radioactive contamination in the $CaMoO_4$ crystals, especially for contaminants in the Uranium and Thorium decay chains. We measured radioactive contamination of the first two production crystals, SE1 and SE2 in an existing underground 4π-veto detector at Y2L, and a third, SE3, in new version of the set up that we recently established at the lab. We report measurements of the activities of Polonium isotopes and other alphas in U/Th decay chain in the SE1, SE2 and SE3 crystals.

Keywords:
neutrino-less double beta decay, $CaMoO_4$, radioactive contamination.

Status of the AMoRE DAQ system

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Abstract:
The data acquisition (DAQ) system has developed for Advanced Mo-based Rare Process Experiment (AMoRE), an experimental search for neutrinoless double beta decay of 100Mo. The DAQ electronics consists of a trigger & clock board for synchronising modules, a 500 MHz flash analog-digital conversion module for crystal measurements, and a 64 MHz analog-digital converters for counters in the cosmic-ray muon veto system. The DAQ software is developed to run in a LINUX operating system to record complete events or individual signals. The system has been operating with the muon veto system for a few months and testing with crystal measurements is planned to start soon. The status of AMoRE DAQ system will be presented.

Keywords:
Data acquisition, High energy experiment

Neutron Removal from Deformed Projectiles

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Abstract:

We present the longitudinal momentum distributions of one-neutron removal reactions from deformed projectiles. In the Eikonal approximation of the Glauber model, the neutron removal from 31Ne is analyzed with the quadrupole deformation parameter and the effective binding energy of the valence neutron.

Keywords:
Neutron removal

Elastic $\alpha-{}^{12}C$ scattering at low energies in cluster effective field theory

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Abstract:

The elastic $\alpha-{}^{12}C$ scattering at low energies is studied employing an effective field theory in which the α and ${}^{12}C$ states are treated as elementary-like fields. We discuss scales of the theory in the stellar energy region where the ${}^{12}C(\alpha,\gamma){}^{16}O$ process occurs, and then obtain an expression of the elastic scattering amplitudes in terms of effective-range parameters. Using experimental data of the phase shifts for l = 0, 1, 2 channels at low energies, for which the resonance regions are avoided, we fix values of the parameters and find that the phase shifts at the low energies are well reproduced by using three effectiverange parameters for each channel. Furthermore, we discuss problems and uncertainties of the present approach when the amplitudes are extrapolated to the stellar energy region.

Keywords:
Elastic $\alpha-{}^{12}C$ scattering, phase shift, cluster effective field theory

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2016.10.19 - 2016.10.21

New heavy-ion transport code: Daejeon Boltzmann-Uehling-Uhlenbeck (DJBUU) Comparison of DJBUU and RBUU under controlled condition.

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Abstract:
국내에 건설 중인 중이온가속기 라온(RAON)에서는 다양한 종류의 중이온 충돌 실험이 진행될 예정이다. 수송 모델을 바탕으로 한 시뮬레이션 (Transport simulation)은 중이온 충돌 실험으로 부터 얻어지는 다양한 물리적 정보들을 예측하는데 중요한 도구가 된다. 라온에서 수행 예정인 실험에 적용될 수 있는 Daejeon Boltzmann-Uehling-Uhlenbeck (DJBUU) 코드 개발이 현재 진행되고 있다. 이번 발표에서는 개발 중인 DJBUU를 소개하고, 안정적으로 수치모사를 할 수 있는 BUU 타입의 코드 중 Relativistic-Boltzmann-Uehling-Uhlenbeck (RBUU) 코드의 결과와 새롭게 만들어진 DJBUU의 결과를 비교 분석하고자 한다. 본 연구에서는, 새로 개발된 DJBUU 코드에 다양한 이론 모델을 적용함으로써, 중이온 충돌 수치 모사를 통한 고밀도 물질 연구에 기여할 것으로 기대된다.

Keywords:
Transport model, Dense asymmetric matter,Rare Isotope, Phase Transition

Thermal neutron cross-section and resonance integral of the $^{185}Re(n,g)^{186}Re$ and $^{187}Re(n,g)^{188}Re$ reactions

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Abstract:

The measurements of neutron cross-sections directly involves fundamental information for the study of neutron interactions with nuclei. They also give great importance for the safety design of nuclear reactors and for the evaluation of the neutron flux density and energy spectrum around a reactor. This work reports results about thermal neutron capture cross-section and resonance integral of the $^{185}Re(n,g)^{186}Re$ and $^{187}Re(n,g)^{188}Re$ reaction using pulsed neutrons. Thermal neutron capture cross-section and resonance integral of the $^{185}Re(n,g)^{186}Re$ and $^{187}Re(n,g)^{188}Re$ reactions have been measured relative to that of the $^{197}Au(n,g)^{198}Au$ reaction by activation method. The induced activities in the activated foils were measured by a g-ray spectrometer based on a calibrated high purity germanium (HPGe) detector. The measured results are compared with literature values and Talys code.

Keywords:

Thermal neutron capture cross section; Resonance integral; Activation method; $^{185}Re(n,g)^{186}Re$ and $^{187}Re(n,g)^{188}Re$; $^{197}Au(n,g)^{198}Au$, HPGe detector.

Measurement of activation cross-sections for neutron induced reactions in ^{nat}Er

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Abstract:

The flux weighted average neutron induced cross-sections of $^{nat}Er(n,xn)^{161,171}Er$ and $^{nat}Er(n,pxn)^{167,166}Ho$ have been measured with average neutron energy range of 1.22 to 25.93 MeV via activation technique. The neutron beam is produced by proton of 30 and 40 MeV energy hitting with a 2 mm beryllium (^9Be) target from 50 MC cyclotron at the Korean Institute of Radiological and Medical Sciences (KIRAMS), Korea.The activated foils were measured with off-line gamma spectrometric system consisting with high purity germanium detector and 4K multichannel analyzer. The measured experimental values of cross-sections were compared with literature values and calculated values by theoretical model TALYS 1.8 and Empire 3.2.2 Malta along with TENDL-2015 libraries. The measured and calculated cross sections were found in good agreement.

Keywords:
1.22-25.93 MeV Neutron; beryllium (^9Be); Neutron induced cross sections; $^{nat}Er(n, xn)$ and $^{170}Er(n, g)$ reactions; Off-line γ-ray spectrometric technique; cyclotron.

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Calculation of total fusion cross section for $^{11}Li+^{208}Pb$ system

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Abstract:
We calculate the total fusion cross sections for $^{6}He+^{209}Bi$, $^{6}Li+^{209}Bi$, $^{10}Be+^{209}Bi$ and $^{9}Be+^{208}Pb$ systems using coupled channel method and compare with the experimental total fusion cross section data. In order to calculate the total fusion cross sections, we consider the globally determined Wood-Saxon potential using Akyuz-Winther potential type and the coupling of the ground state and low-lying excited states the projectile nuclei. Also, we compare the total fusion cross section obtained from coupled channel method calculations and ones obtained from Wong's formula which is based on one-dimensional barrier penetration model. From the same manner, we estimate the total fusion cross section for $^{11}Li+^{208}Pb$ system and compare with the experimental data.

Keywords:
Fusion, ^{11}Li, Coupled-channel method

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Possibilities of production of neutron-rich Md isotopes in multi-nucleon transfer reactions

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Abstract:
The possibilities of production of yet unknown neutron-rich isotopes of Md are explored in several multi-nucleon transfer reactions with actinide targets and stable and radioactive beams. The projectile-target combinations and bombarding energies to produce new neutron-rich isotopes of Md are suggested for future experiments.

Keywords:
Neutron-rich, Md isotopes, Multi-nucleon transfer reactions

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Photo-production cross-sections and yields of $^{100}Mo(g,n)$ ^{99}Mo->^{99m}Tc and $^{59}Co(g,xn)^{58-55}Co$ with bremsstrahlung energy 55-65 MeV

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Abstract:

The average photo-neutron cross-sections and yields of $^{100}Mo(g,n)^{99}Mo$®^{99m}Tc and $^{59}Co(g,xn; x=1-4)^{58-55}Co$ reactions have been measured with the end-point bremsstrahlung energies 55-, 60-, and 65-MeV from 100 MeV electron accelerator at Pohang Accelerator Laboratory (PAL). High-purity (99%) metallic foils of ^{nat}Mo and ^{59}Co of thickness 0.05 mm were irradiated with bremsstrahlung beam generated from electron hitting a thin tungsten target (0.1 mm). The induced activities in the irradiated foils were measured by high-resolution off-line g-ray spectrometric system consisting of a high-purity germanium detector and a 4K multichannel analyzer. The bremsstrahlung spectrums were simulated with Geant4 simulation code. Hence, the measured experimental values of cross-sections and yields were compared with the experimental values found in the literature and calculated values by theoretical model code TALYS 1.6 and Empire 3.2.2 Malta 2014 which shows good in agreement. It is observed that the average cross-section increases with bremsstrahlung energy up to photo-absorption region i.e. Gaint Dipole Resonance (GDR) and become decreases with increasing energies due to new reaction channel opens-up above GDR. The details of the photo-neutron cross sections of $^{59}Co(g,xn; x=1-4)^{58-55}Co$ and $^{100}Mo(g,n)^{99}Mo$®^{99m}Tc and produced yields of medically important isotope ^{99}Mo®^{99m}Tc in comparison with $^{235}U(n,f)^{99}Mo$ and $^{98}Mo(n,g)^{99}Mo$ are presented.

Keywords:
Photo-neutron cross sections, Bremsstrahlung end point energy 55-, 60-, and 65-MeV, Geant4, TALYS 1.6, Empire 3.2.2 Malta

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Uncertainty and finite-size effect in the partition function zero of a Wang-Landau-sampled density of states

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Abstract:
The zeros of partition function often provide an alternative yet systematic way to understand phase transitions without directly measuring a relevant order parameter. Here we investigate how numerical errors in an approximate Wang-Landau density of state affect the evaluation of the partition function zero in complex temperature plane. We introduce two simple systems of the two-dimensional Ising model and the six-state clock model to exemplify the success and failure in the application of the Wang-Landau sampling to the finite-size-scaling analysis of the leading zero. By numerically estimating the fluctuations of the resulting partition function, we argue that the behavior of specific heat at phase transition implies the essential finite-size effects that the Wang-Landau approach may encounter in the partition function zero analysis.

Keywords:
Monte Carlo method, finite-size-scaling analysis,partition function zero, phase transition

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2016.10.19 - 2016.10.21

행렬곱상태를 이용한 양자 XXZ모형의 상전이 연구

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Abstract:
행렬곱상태을 이용하여 1차원에서 양자 XXZ모형의 상전이에 대해서 연구하였다. 시간진화블럭축약법을 이용하여, 양자 XXZ모형의 기저상태의 에너지와 스핀 상관계수를 구하였다. Ising항의 크기에 따라 양자 XXZ모형은 반자성체, XY 상태, 강자성체로의 상전이를 보여주며, 이때 에너지, 스핀, 스핀 상관계수의 행동이 변하는 것을 스핀 S=1/2, 1, 3/2, 2에 대해서 분명하게 볼 수 있었다. 이를 할다인(Haldane) 가설에 따라 해석해 보고자 하였고, 스핀과 격자 크기가 변화함에 따른 행동도 관측하였다.

Keywords:
양자상전이, 텐서네트워크상태, 양자XXZ모형

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2016.10.19 - 2016.10.21

Critical behavior of k-core percolation

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Abstract:
k-Core percolation has served as a paradigmatic model of discontinuous percolation for a long time. Recently it was revealed that the order parameter of k-core percolation of random networks also exhibits a critical behavior. Thus k-core percolation exhibits a hybrid phase transition. Whereas the critical behaviors of the ordinary percolation are well understood, those of hybrid percolation transitions have not been clearly understood yet. Here, we investigate the critical behavior of k-core percolation of Erdős-Rényi networks. It is found that the fluctuations of the order parameter and the mean avalanche size diverge in different ways. Thus, we classify the critical exponents into two types: the one associated with the order parameter and the other with finite avalanches. We find numerically that the conventional scaling relations including the hyperscaling relations hold for the former; however, the hyperscaling relations do not for the latter. Finally we discuss some universal feature occurring in the hybrid percolation transitions by comparing the critical behavior of k-core percolation with that of the cascade failure model on multiplex networks.

Keywords:
percolation, critical phenomena, complex network

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2016.10.19 - 2016.10.21

Universal mechanism for hybrid percolation transitions

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Abstract:

Hybrid percolation transitions (HPTs) induced by cascading processes have been observed in diverse complex systems such as k-core percolation, breakdown on interdependent networks and cooperative epidemic spreading models. Much effort has been devoted to describe the properties of HPTs of individual systems. Yet the fundamental question about the possible universal mechanism underlying those HPTs has not been investigated at a microscopic level. Here, we find that the discontinuity in the order parameter in such HPTs results from two steps: a durable critical branching (CB) and an explosive, supercritical (SC) process. In a random network of N nodes at the transition the CB process persists for $O(N^{1/3})$ time and the remaining nodes become vulnerable. Those vulnerable nodes are activated then in the short SC process. This crossover mechanism and scaling behavior are universal for different HPT systems.

Keywords:
hybrid phase transition, branching process

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Hybrid phase transition in a two-step contagion model with multiple infectious seeds

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Abstract:

A hybrid phase transition (HPT) that exhibits properties of continuous and discontinuous phase transitions at the same transition point has been observed in diverse complex systems. Previous studies of the HPTs on complex networks mainly focused on whether the order parameter is continuous or discontinuous. However, more careful and fundamental questions on the critical behaviors of the HPT such as how the divergences of the susceptibility and of the correlation size are affected by the discontinuity of the order parameter have been addressed. Here, we consider a generalized epidemic model that is known to exhibit a discontinuous transition. We study two cases: when there is initially one infectious node and when the density of initial infectious seeds is finite. Performing extensive numerical simulations and using finite-size scaling analysis, we examine critical behaviors for each case. Particularly, we find that when there is one infectious node and under a certain condition, the order parameter can exhibit a discontinuous jump but does not exhibit any critical behavior before or after the jump. However, critical behavior appears in the form of a power-law behavior of the outbreak size distribution. The mean outbreak size, corresponding to the susceptibility, diverge following the conventional percolation behavior. On the other hand, when there are multiple initial infectious nodes, the order parameter increases continuously and shows a critical behavior with the exponent of $\beta_m = 1/2$, and at a transition point, it jumps suddenly. The fluctuation of the order parameter also diverges at a transition point. We conclude that while the mixed-order phase transition occurs in single infectious seed case, the HPT occurs in multiple infectious seed case. We will discuss various critical properties for the HPT of the latter case.

Keywords:
hybrid phase transition, epidemic process

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C1.06
2016.10.19 - 2016.10.21

Percolation transitions and their universality classes in multiplex lattices

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Abstract:

We study the percolation transitions of the multiplex viability model [B. Min and K.-I. Goh, Phys. Rev. E 89, 040802(R) (2014)] on two-layer square lattices. This model is a generalized percolation model on multiplex systems comprised of two distinct processes establishing the viability, the cascade of activations (CA) and the cascade of deactivations (CD), depending upon which different transition points and thereby hysteresis are observed. To address the universality issue of this model, here we perform extensive Monte Carlo simulations and show that in two-layer square lattices the two processes not only have different percolation transition points but also exhibit different critical behaviors with distinct sets of critical exponents. For CA, the transition is found to be in the same universality class as the ordinary percolation (OP) in 2D. On the other hand, for CD, the transition belongs to different universality class from OP but shows critical behaviors consistent with those of 2D mutual percolation model. To achieve a self-contained and self-consistent scaling picture of the transitions we introduce a novel definition of the cluster that properly addresses the critical properties. The obtained results are verified for consistency through scaling relations such as $d\nu = 2\beta + \gamma$.

Keywords:
multiplex networks

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2016.10.19 - 2016.10.21

Fractal dimension in a hybrid percolation transition

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Abstract:

It is well known that for the ordinary percolation, both an infinite cluster and finite clusters are fractal with a same fractal dimension at a transition point. This is a feature of second-order phase transition. Here we show that when a percolation model undergoes a hybrid phase transition, exhibiting features of both first-order and second-order transitions at a same transition point, fractal dimension can be obtained only from finite clusters; however, the fractal dimension of an infinite cluster is equal to the spatial dimension in which the system is embedded. On the other hand, the perimeters of finite and the infinite clusters are fractal with a same fractal dimension.

Keywords:
fractal dimension, hybrid percolation transition

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C2.01
2016.10.19 - 2016.10.21

Ultrafast excited-state dynamics of low-bandgap polymers and polymer:fullerene bulk heterojunctions

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Abstract:
유기폴리머 물질은 용액공정을 기반으로 하는 프린팅과 롤투롤 (roll-to-roll) 프로세싱과 같은 저비용의 방법으로 광전자 변환소자로의 적용이 가능하다는 장점으로 인해 각광을 받게 되었다. 하지만 유기폴리머 태양전지는 광흡수시 생성되는 엑시톤 (exciton)의 이동도가 낮아 광-전 변환효율이 실리콘 태양전지 대비 현저히 낮은 단점이 있었다. 이러한 문제점을 극복하기 위해 새로운 기능성 폴리머의 합성, 벌크 헤테로정션 블렌드 (bulk heterojunction blend), 유기용매의 변화 등 여러 가지의 물질합성 기법들이 도입되어 유기폴리 태양전지의 성능은 향상 되었으나 그 근원이 되는 들뜬상태 (excited state)에서의 운반자 동역학 (carrier dyanmics)에 대한 정보는 여전히 부족한 상황이다. 따라서 본 연구에서는 펨토초 시간분해 분광기술을 이용하여 여러 종류의 낮은 밴드갭 폴리머와 벌크 헤테로정션 블렌드 필름들에 대한 광전자이동 양상을 연구하였다.

Keywords:
Ultrafast transient absorption, excited-state dynamics, organic polymers

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Opitcal trap dielectric particles by Bessel beam generators in water based DNA solution

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Abstract:
Optical trap of Bessel beam generators has delicate tweezers for control the dielectric particles to avoid the damage in solution. Bessel beam has focused beam profile for long distance than Gaussian beam has. This optical tweezer can operate blood vessel to handle desired objects to send proper destination. To imitate environment of human body, I mix biomaterial which is DNA and pure water. This paper sets up in DNA with polystyrene bead. The goal is to show optical trap of the bead in interaction biomaterial, DNA, with Bessel laser.

Keywords:
optical trap, Bessel beam profile, DNA

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2016.10.19 - 2016.10.21

Characteristics of surface waves between general bi-isotropic media

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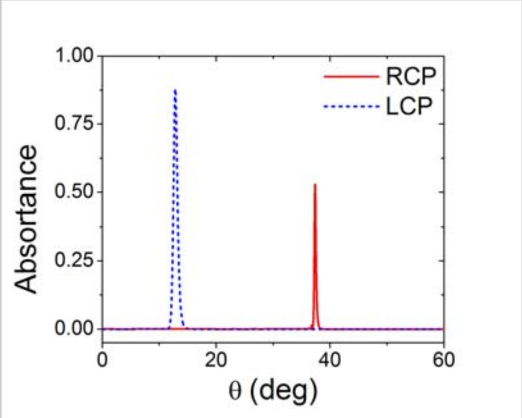
Abstract:



We study theoretically the characteristics of surface waves excited at the interface between two general bi-isotropic media, which include isotropic chiral media and Tellegen media as special cases. We derive a generalized dispersion relation for surface waves, using which we calculate the effective index and the propagation length numerically. We also calculate the absorptance, the cross-polarized reflectance and the spatial distribution of the electromagnetic fields for linearly- and circularly-polarized waves incident on various kinds of bilayer systems consisting of two bi-isotropic layers, using the invariant imbedding method. The results obtained using the invariant imbedding method agree with those obtained from the analytical dispersion relation perfectly. In the figure, we plot the absorptance as a function of the incident angle when right-circularly-polarized (RCP) and left-circularly-polarized (LCP) waves are incident from an isotropic medium with $\varepsilon=\mu=10$ onto a bilayer system made of two different chiral media, which have $\varepsilon=\mu=2$ and the chirality index $\gamma=4$ and $\varepsilon=\mu=-2$ and $\gamma=-4$ respectively. We observe that surfaces waves are excited at different angles depending on the helicity of the incident wave. When linearly-polarized waves are incident, both of these surface waves are excited for one experimental configuration. Other peculiar behaviors of surface waves are also discussed.

Keywords:
Surface wave, Bi-isotropic medium, Chiral medium

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2016.10.19 – 2016.10.21

Mega-dielectric material based on mesoscopic space-filling curves

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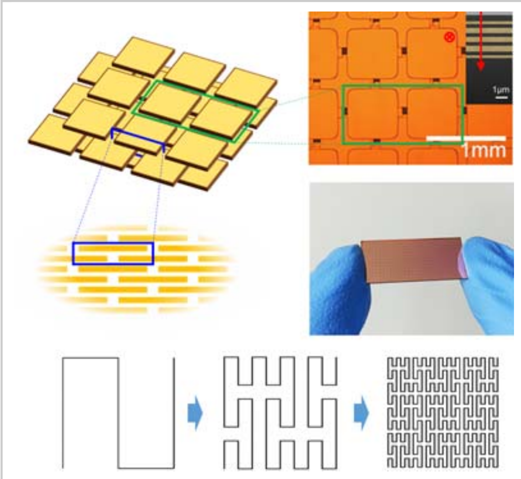

Abstract:

Since the invention of optical lens, the study of optics has evolved around the refractive index, the fundamental property of all optical materials. The range of the refractive index of naturally occurring materials is very limited due to their small transition dipole moments. Recently, artificial unit cell structures with larger dipole moments have been reported, but the resulting effective medium usually suffers from strong dispersion due to the additional electromagnetic resonance or from limited degree of enhancements. Here we report experimentally verified refractive index over 1,800 in microwave frequencies. We also show for the first time that the macroscopic electric displacement field can be orders of magnitude larger than its mesoscopic value. We exploited both the enhanced local dipole moment and the space-filling geometry to achieve this gigantic enhancement. Due to the quasi-static nature of the enhancement principle, the enhanced value is nearly constant over decades of frequencies. The index of 1,800 may realize 1,800 times finer imaging resolution, 1,800 times slower propagation speed, and 3,000,000 times higher absorption limit and spontaneous emission rate.

Keywords:

refractive index, dielectric constant, space-filling-curve,metamaterial

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2016.10.19 - 2016.10.21

Design and fabrication of a W-band quasi-optical mode generator

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Abstract:
We present the design of a dual mode quasi-optical mode generator capable of generating $TE_{6,2}$ and $TE_{10,1}$ rotating modes at 94.5 and 98.6 GHz frequency respectively. It consists of a perforated metallic cavity with a tapered inner rod to suppress the spurious modes. This system is excited by a Gaussian beam focused onto the caustic of the straight middle section of the cavity through the 1 mm diameter holes. The generation of the modes is quite sensitive to the inner rod design. The metallic cavity and tapered inner rod is fabricated using 3D printing technique as shown in Fig. 1. Measurement of the generated waveguide mode is carried out by scanning the electric field after excitation of the mode generator through a W-band Gaussian beam source. Measurement results confirms the generation of rotating $TE_{6,2}$ and $TE_{10,1}$ modes at their respective frequencies.

Keywords:
quasi-optical mode generatorRotating higher-order modes

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2016.10.19 - 2016.10.21

Selectively tunable anisotropic Optical Stark effect of excitons in ReS_2

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Abstract:

ReS_2 is a member of a recently emerged family of group VII 2D TMDs. Unlike molybdenum (Mo) and tungsten (W) dichalcogenides, group VI TMDs, which have hexagonal crystal structure, ReS_2 exhibits reduced in-plane crystal symmetry with a distorted 1T structure. Due to this unique symmetry, Re atoms form chains aligned along the b-axis, leading to anisotropic linearly polarized excitons. Here, we control the optical Stark effect of the two direct exciton states in bilayer ReS_2 (by polarization selective optical pump-probe spectroscopy. Based on the linearly polarized characteristic of excitons in ReS_2, we gradually tune the Stark shift of the two energetically nondegenerate states by manipulating the polarization of the linearly polarized pump pulse. We measure the pump-induced change in the transmission of probe light (differential transmission) as a function of pump-probe time delay in pump-probe experiments (Fig. a). Figure b illustrates that the expected two exciton states (X1 and X2) manipulation by tuning pump polarization: the optical Stark shift predominantly occurs at X1 (X2) if polarization match with the spatial direction of X1 (X2). Thus, it is predicted that the optical Stark shift at two exciton states can be selectively controlled by tuning light polarization.

Keywords:

Optical Stark effect, ReS_2, anisotropy, exciton, selectivity

Berry phase analysis of Polarization Independent Spatial Light Modulators based on commercial LCDs

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Abstract:
본 연구에서는 상업용 LCD를 이용하여 입사 빛의 편광 상태를 유지하며, 초기 편광 상태와 무관하게 위상을 조절할 수 있는 공간 광 변조기와 그와 유사한 구조로 입사 빛의 편광 상태를 유지하나 편광에 종속적으로 위상 조절 범위가 다른 공간 광 변조기를 제작하였다. 두 경우 모두 동역학적 위상에 의한 위상 조절 범위는 동일하나 후자의 경우는 기하학적 위상을 통하여 편광에 따라 다른 위상 조절 범위를 갖게 된다. 이 공간 광 변조기의 편광, 위상, 회절, 간섭 등 광 변조 특성을 분석하였으며, 간섭성을 갖는 빛을 사용하는 LCD에서 기하학적 위상이 갖는 의미를 분석하였다.

Keywords:
Berry phase,Polarization independent phase only spatial light modulator,Spatial Light modulator, SLM, commercial LCD

Synthesis and electrochemical properties of transition metal based nanostructures on conductive textile substrates for supercapacitor applications

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Abstract:

Recently, there has been a growing interest on the development of wearable and miniature electronic devices because of their remarkable application potentials. To power-up these devices, fabrication of compatible flexible and sustainable energy sources such as energy storage and conversion systems has been highly required and is attracting significant research attention. Accordingly, numerous efforts have been focused to design the lightweight, flexible and textile-based energy storage devices for wearable electronics. Among many energy storage devices, supercapacitors have attracted increasing attention due to high power density, long lifespan, low cost and eco-friendly nature compared to other energy storage devices. For these textile-based supercapacitors, it is still a significant challenge to utilze the low-cost textile electrodes and well-designed nanomaterials with green synthesis methods. To address this challenge, we investigated the cost-effective textile-based conductive electrodes which are composed of metallic layers on polyester fibers and synthesized the versatile transition metal (Ni, Mn, Cu, etc.) based nanostructures on conductive electrodes by a simple electrochemical method at low temperature. The as-grown nanostructures on conductive electrodes were utilized as a flexible and binder-free electrode and their electrochemical performance was evaluated for supercapacitors.

Keywords:
conductive textile, supercapacitors, electrochemical performance

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C3.02
2016.10.19 - 2016.10.21

Advanced energy storage system : lithium ion capaciors

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Abstract:
Recently, considerable attention has been devoted to the lithium-ion capacitor (LIC) as a promising energy-storage device with high-power and high-energy density. The feature of higher energy density than electric double layer capacitor (EDLC) makes the LIC suitable for use in energy-storage applications with renewable energy sources. The most challenging issue in the development of a self-sustaining LIC is pre-lithiation of the negative electrode without using lithium metal prior to cell operation. The concept of adding a transition metal oxide as an alternative lithium source in the positive electrode has been proposed to resolve this matter. While the proposed concept was successfully implemented, the achievable capacitance of advanced LIC is still limited in terms of meeting the requirements for commercial use. In pursuit of further improvement of energy density, we report a new additive and discuss the possibility and limitations of it from an electrochemical and structural perspective.

Keywords:
Advanced energy storage system : lithium ion capaciors

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C3.03
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Nanostructured Metal Oxide Electrodes for Rechargeable Metal-Air Batteries

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Abstract:
Rechargeable metal-air batteries are expected to have energy densities several times higher than those of state-of-the-art lithium-ion batteries. If successfully developed, therefore, they could enable long-range electric vehicles and large-scale large stationary energy storage systems. In general, a metal-air battery consists of a metal anode (e.g., Li and Zn), a liquid ion-conducting electrolyte, and a porous cathode (oxygen electrode), and it operates via electrochemical reactions involving oxygen supplied from the ambient air on the cathode, i.e., the oxygen reduction reaction (ORR) during discharge and the oxygen evolution reaction (OER) during charge. Unfortunately, most metal-air batteries suffer from sluggish ORR-OER kinetics and thus exhibit low round-trip efficiency for discharge-charge cycling as well as poor power capability. This talk briefly introduces the technical challenges facing development of metal-air batteries with specific attention to electrochemistry and cathode materials, and presents promising strategies to designing nanostructured metal oxide-based cathodes that could improve the oxygen reaction kinetics and mitigate the interactions between the electrode and electrolyte.

Keywords:
Nanostructured Metal Oxide Electrodes for Rechargeable Metal-Air Batteries

All solid state battery using $Li_{10}GeP_2S_{12}$ as solid electrolyte

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Abstract:
Over recent year, the range of lithium ion battery application has been extended to large scaled uses such as electric vehicle. This has driven demand for lithium ion battery system that can offer higher energy density, higher current drain, and greater safety. All solid state battery using solid electrolyte has been expected as next generation battery system due to its high energy density, high power, and safety. All solid state battery is consist of solid state of cathode, electrolyte, and anode, where solid electrolyte is key material in order to successful launch of all solid state battery. Recently, sulfide based super ionic Li^+ conductor $Li_{10}GeP_2S_{12}$ (LGPS) reported by Prof. Kanno group, which shows ionic conductivity of 12 $mScm^{-1}$ that is comparable to liquid organic electrolytes[1]. The discovery of LGPS lead to the commercial possibility of all solid state battery. Another issue of development of all solid state battery is reducing interfacial reaction between cathode (or anode) and electrolyte. Whole battery reactions are occurred in solid state Li^+ migration in ASB, therefore solid/solid interfacial reaction should be understood. In this study, ASB was composed using LGPS as solid electrolyte and $LiCO_2$, $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$, and $Li_7Ti_5O_{12}$ as electrode material. Material compatibility and interfacial resistance between electrode and LGPS was investigated using bulk-type cell. More detail results will be discussed at the meeting. References [1] N. Kamaya, K. Homma, Y. Tamakawa, M. Hirayama, R. Kanno, Nat. Mat. 10, 682-686 (2011)

Keywords:
All solid state battery using $Li_{10}GeP_2S_{12}$ as solid electrolyte

Epitaxial oxide films for energy applications

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Abstract:

The transition metal oxides have a wide spectrum of physical and chemical functionalities, useful for many potential applications in energy technologies. However, the underlying physical mechanisms have been still unclear whether performance is intrinsic to materials themselves or attributed to extrinsic defects. Here, we report epitaxial stabilization of single crystalline oxides for energy applications and investigate their intrinsic functionalities. First, our epitaxial VO_2(B) and TiO_2(B) films offer excellent long-term stability with extremely high capacity for Li ion battery electrode. Second, we design and create unique cell geometry of micrometer-thick epitaxial nanocomposite films which contain yttria-stabilized ZrO_2 (YSZ) nanocolumns. The ion conductivity of these nanocolumns is enhanced by over two orders of magnitude compared to plain YSZ films, showing the strong practical potential of these nanostructured films for use in much lower operation temperature ionic devices. Our successful epitaxy of oxides will open the door to study their fundamental properties for potential energy applications and understand their intrinsic physics.

Keywords:

Epitaxial film, Battery, Solid oxide fuel cell

[한국물리학회상 수상기념 강연] Functional high-yield molecular electronic devices

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Abstract:
Molecular devices that utilize molecules as electronic device components are fascinating [1], however molecular monolayer devices are not practical because a typical vertically structured molecular junction has a very low device yield. In this talk, I will explain a few methods to overcome this low yield problem; specifically (1) a method by introducing an intermediated protective layer between the molecular layer and the top electrode [2], and (2) a method for high-yield molecular junctions with a direct metal transfer technique [3]. I will further explain our recent demonstration of molecular electronic devices with high yield structure and with some device functionalities such as rectifying or photoswitching [4]. References [1]. Chem. Rev. 116, 4318 (2016)-review, Adv. Mater. 23, 1583 (2011)-review, Nature 462, 1039 (2009). [2]. Akkerman et al. Nature 441, 69 (2006); Wang et al. Adv. Mater. 23, 755 (2011). [3]. Jeong et al. Nanotechnology 26, 025601 (2015); Jeong et al. Appl. Phys. Lett. 106, 063110 (2015). [4]. Jeong et al. Adv. Funct. Mater. 24, 2472 (2014); Kim et al. Adv. Mater. 26, 3968 (2014); Kim et al. Adv. Funct. Mater. 25, 5918 (2015).

Keywords:
molecular electronics

Polymeric surface modification for efficient single-junction and tandem organic solar cells

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Abstract:

In this study, we discuss how polymer-based surface modifiers containing simple aliphatic amine groups substantially and universally decrease the work function of conductors' surface including metals, transparent conducting oxides, conducting polymers, and graphene. The work function reduction is induced from physisorption of the neutral polymer, which turns the modified conductors into efficient electron-collecting or- injecting electrodes. These polymer surface modifiers are processed in air from solution, providing an appealing alternative to chemically reactive low-work function metals. With this modification, many different types of efficient single- and tandem solar cells, including fully-polymeric solar cells, have been demonstrated.

Keywords:
organic solar cell, polymer surface modification, charge recombination layer, tandem

Solution-processed vanadium oxide hole injection layer to improve quantum-dot light emitting diodes

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Abstract:

Quantum-dot light emitting diodes (QLEDs) were fabricated using a solution-processable vanadium oxide (V_2O_5) hole injection layer (HIL), to improve the performance and stability of QLEDs. Generally, poly (3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) is a conventional HIL for QLEDs. However, the acidic and hygroscopic nature of PEDOS:PSS affect to decrease the device performance and stability. Therefore, We have synthesized V_2O_5 solution and used as a HIL for QLEDs, due to its effectively injected the hole into the emissive layer, non-acidic and non-hygroscopic properties. Moreover, V_2O_5 can be synthesized and coating on the flexible substrate using a low annealing temperature. QLEDs with a V_2O_5 HIL exhibited much higher luminance and longer life-time than the device with a PEDOT:PSS HIL under ambient conditions. The origin of the effective hole injection of device was the existence of gap state at the valence band region of solution processed V_2O_5 layer, that was confirmed by the photoelectron spectroscopy. The result would provide that V_2O_5 is a great potential alternative to organic PEDOT:PSS for high-performance and stable QLEDs.

Keywords:
Quantum-dot LED, Vanadium oxide, Inorganic hole injection layer

Noise characteristics of organic nanocomposite resistive memory devices

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Abstract:

Recently, organic material-based nanocomposites have attracted significant attention due to their advantages in the fabrication of low-cost, low-temperature, and solution-processed electronics (such as thin-film transistors, memory devices, solar cells, and wearable sensing components) on large-area flexible platforms. Among these organic electronics, high performance organic resistive memory devices with appropriate architectural designs have been widely studied in the past decade. The organic nanocomposite resistive memory devices generally show unipolar-type memory characteristics, i.e., the on/off states can be set and reset at the same voltage polarity. In addition, their current-voltage characteristics often show a multi-storage functionality, such as the intermediate resistive states (IRSs), which are typically attributed to a negative differential resistance (NDR) behavior. The switching mechanism of the organic nanocomposite memory devices is still under debate, and few studies have focused on and elaborated the NDR and it derivative IRSs. Especially, the strongly disordered and inhomogeneous structures have hindered the comprehensive understanding of NDR and the IRSs. We present our studies on the noise characteristics of PI:PCBM and PS:PCBM composite for the organic memory material [1,2]. The current fluctuations were investigated over a bias range that covers IRSs and NDR in organic nanocomposite unipolar resistive memory devices. The scaling behavior between the relative power spectral density and resistance was observed, indicating a percolation behavior. Considering a linear rate equation of the charge trapping-detrapping at deep trap levels, the percolation behavior and NDR could be understood by the modulation of the conductive phase fraction with an external bias. In other words, the multi-level switching of the organic resistive memory devices is attributed to the current pathway reduction and fluctuation in NDR. This study will be useful for the development and tuning of multi-bit storable organic nanocomposite memory device systems.

Keywords:
organic electronics, organic resistive memory, noise analysis, percolation

Investigation of a new approach for high-yield molecular tunneling junctions with direct metal transfer method

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Abstract:

Molecular electronic junctions aim to utilize individual molecules or molecular layers as an active channel for electronic device components. To investigate the charge transport mechanism and characteristics through molecular junctions, a variety of approaches to construct molecular junctions such as mechanically controllable break junction technique, scanning probe microscope-based technique, and solid state device-based methods have been demonstrated [1]. Specifically, the solid state device-based method, due to its excellent stability and reliability, has gained extensive attention as a general testbed for the practical application of molecular junctions. However, one of the major obstacles that one can encounter while forming the molecular junctions in this way is generation of filamentary path of top metal since usually direct evaporation of metal electrode is done for the top electrode. This phenomenon results in a low device yield of molecular junctions, which makes them inappropriate to be investigated the characteristics. In this presentation, we propose a new approach for high-yield molecular junctions with direct metal transfer (DMT) method [2]. In particular, we could fabricate reliable and stable pure metal-molecular-metal junction with improved yield (~70%) much better than conventional direct evaporation of top metal electrodes (~1% yield). This new approach can be one of a most probable ways to achieve a reliable platform for the precise characterization and practical application of molecular electronic junctions. Also with this method, we measured inelastic electron tunneling spectroscopy (IETS) characteristics of metal-molecule-metal junctions made with alkanethiolate molecules [3]. The measured IETS spectra could be assigned to molecular vibration modes which are determined by the chemical structure of the molecules. We also observed discrepancies and device-to-device variations in the IETS spectra such as negative values or dips and peaks that cannot be assigned to any possible vibrational modes of the alkanethiolate molecules. These are possibly originated from defects in the molecular junctions and insulating introduced from the fabrication process and the device architecture for solid-state device-based molecular junctions formed by the DMT method. References [1] H. Song et al., Adv. Mater. 23, 1583 (2011). [2] H. Jeong et al., Nanotechnology, 26, 025601 (2015). [3] H. Jeong et al., Appl. Phys. Lett. 106, 063110 (2015).

Keywords:
molecular electronics, direct metal transfer, inelastic electron tunneling spectroscopy

Hole Transport Enhancement Mechanism of CuSCN in Organic Devices

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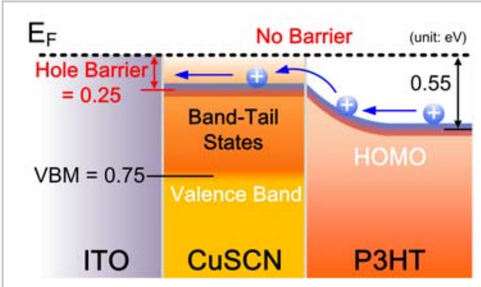

Abstract:

Copper thiocyanate (CuSCN) has been introduced as a promising hole transport layer due to its physical properties, such as a high transparency and high hole mobility (0.01-0.1 cm^2 V^{-1} s^{-1}).[1] Recently, CuSCN has shown the improved device performance superior to poly(3,4-ethylene dioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) interlayer in bulk heterojunction OPVs[2], perovskite photovoltaics[3] and organic light-emitting diodes[4] due to its good electron blocking ability and chemical stability. Despite such successful device applications its hole transport enhancement mechanism in organic devices has not been understood yet. Because the device performance is highly dependent on the hole transport barrier (HTB) between electrode and organic material, the energy level alignment at the interfaces of organic material/CuSCN/electrode is key to understand the enhanced hole transport with the CuSCN interlayer. In this regard the ultraviolet photoelectron spectroscopy (UPS) measurements were carried out on a CuSCN film/indium tin oxide (ITO). The UPS spectra of CuSCN show the high work function (5.40 eV) and the band-tail states near valence band maximum of CuSCN. It is observed at the 0.25 eV below the Fermi level and acts as hole transport states. The band-tail states explain the good hole transport between CuSCN and ITO. To determine the energy level alignment of organic material/CuSCN, we chose the poly (3-hexylthiophene-2,5-dinyl) (P3HT) as a prototype organic donor material. In situ stepwise vacuum electrospray deposition–UPS measurements sequence were conducted to investigate the interfacial electronic structure of P3HT/CuSCN. At the interface of P3HT/CuSCN, the P3HT HOMO shifts upward to meet the energetic equilibrium and then the P3HT HOMO contacts the band-tail states of CuSCN directly. It indicates the holes in P3HT can transport into CuSCN without energy barrier. The remaining HTB from P3HT to ITO is 0.25 eV, which is the barrier between ITO and CuSCN. This small HTB was confirmed by the current density–voltage (J–V) measurement on the hole-dominated devices of Al/P3HT/CuSCN/ITO. As a results, the band-tail states of CuSCN have a crucial role in hole transport enhancement in organic devices. Reference [1] P. Pattanasattayavong, N. Yaacobi-Gross, K. Zhao, G.O.N. Ndjawa, J. Li, F. Yan, B.C. O'Regan, A. Amassian, and T.D. Anthopoulos, Adv. Mater. 25, 1504 (2013). [2] N. Yaacobi-Gross, N.D. Treat, P. Pattanasattayavong, H. Faber, A.K. Perumal, N. Stingelin, D.D.C. Bradley, P.N. Stavrinou, M. Heeney, and T.D. Anthopoulos, Adv. Energy Mater. 5, 1401529 (2015). [3] P. Qin, S. Tanaka, S. Ito, N. Tetreault, K. Manabe, H. Nishino, M.K. Nazeeruddin, and M.G.A. Tzel, Nat. Commun. 5, 3834 (2014). [4] A. Perumal, H. Faber, N. Yaacobi-Gross, P. Pattanasattayavong, C. Burgess, S. Jha, M. a. McLachlan, P.N. Stavrinou, T.D. Anthopoulos, and D.D.C. Bradley, Adv. Mater. 27, 93 (2015).

Keywords:
CuSCN, tail states, photoelectron spectroscopy, energy level alignment, organic photovoltaics, hole transport layer

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2016.10.19 - 2016.10.21

Control the hysteresis of ferroelectric properties of PVDF-TrFE depending on the photoactive crosslinker and its application from non-volatile memory to logic device

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Abstract:

Ferroelectric polymers, such as polyvinylidene fluoride (PVDF) and its copolymer poly (vinylidene fluoride-trifluoroethylene), have attracted due to its good piezoelectricity, ferroelectric responses and higher dielectric constant than other polymer. Field effect transistors (FET) employing ferroelectric thin film as gate insulators enabled non-volatile memory application. Addition of photoactive crosslinker (bis-perfluorobenzoazide : Bis-FB-N3) to link the polymer chains covalently via nitrene-based N-H insertion reactions, which not only makes photo-pattern of dielectric film possible with solvent resistance, but also affected the non-volatile memory properties of ferroelectric polymer. As the contents of Bis-FB-N3 increased in ferroelectric dielectric, hysteresis windows of transistor memory were decreased. In this work, we could simply control the hysteresis of PVDF-TrFE by adding the Bis-FB-N3 photocrosslinker. Resulting devices showed common transistor properties without hysteresis as a low gate voltage sweep. In contrast to low gate bias, memory windows were increased with higher gate bias and non-volatile memory operations were confirmed. Utilizing these properties, we fabricated PMOS inverter logic device using two transistors which have same dimensions and different threshold voltages by non-volatile hysteresis. These hysteresis were investigated by Capacitance-Voltage (C-V) and Polarization-Voltage(P-V) measurement. X-ray photoelectron spectroscopy (XPS) confirmed their chemical state, and X-Ray Diffraction (XRD) and Atomic Force Microscopy (AFM) verified their phase and surface morphology of photocrosslinked PVDF-TrFE ferroelectric layer, respectively.

Keywords:
PVDF-TrFE, Phenylazide, ferroelectric memory, organic transistor, PMOS inverter

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C5.01
2016.10.19 - 2016.10.21

Possibility of topological bulk composites and thermoelectricity

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Abstract:

Topological insulators are insulating or semiconducting materials in bulk with robust surface metallic state. The surface metallic state is topologically protected, originating from the time reversal and Z_2 invariances due to strong spin-orbit coupling. It was found that many Bi-based materials, such as $Bi_{1-x}Sb_x$, Bi_2Se_3, Bi_2Te_3, and so on, exhibit topological insulating behavior because the Bi-ion is the heaviest stable element without radioactivity, implying the possibility of strong spin-orbit coupling. On the other hand, the most good thermoelectric materials $(Bi,Sb)_2(Te,Se)_3$ based system are believed to have topologically protected state. Here we propose that the topological interface at grain boundaries of two different topological materials can decouple the trade-off relationship between electrical conductivity and Seebeck coefficient channels. In order to have the topological interface effect in grain boundary, we should control the direction of spin-momentum locking. We have been explored the topological composite materials of $Ag_2Te/Bi_{0.5}Sb_{1.5}Te_3$ as well as Fermi level tuning of $Bi_{2-x}Sb_xSe_2Te$ crystals as an attempt to manifest topologically protected grain boundary state.

Keywords:
thermoelectric, topological, composites

KPS 한국물리학회 The Korean Physical Society

Control of surface morphology of stacking faulted silicon nanowires and their coherent phonon transport characteristics

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Abstract:

In my talk, I will first present an experimental observation of coherent phonon transport characteristics in silicon nanowires (SiNWs) synthesized by a one-step surface reconstruction growth mechanism. As-grown SiNWs taper down along the growth direction alongside a decrease in both roughness and stacking faults density. Furthermore, by systematically measuring the temperature-dependent thermal conductivity using a conventional thermal bridge method, we found that the measured thermal conductivity values of surface-reconstructed (SR)-SiNWs (13 – 20 W/m×K) at room temperature are markedly lower than that predicted from the conventional diffuse phonon transport model for given NW diameters. We also observed that the thermal conductivities of SR-SiNWs exhibit an unexpected power law of ~T^{α} () in the temperature range of 25 – 60 K, which cannot be explained by the typical Debye ~ T^3 behavior. Interestingly, our experimental results are consistent with a frequency-dependent model, which can be induced by coherence in the diffuse reflection and back scattering of phonons at the rough surface and stacking faults on SR-SiNWs, resulting in the suppressed thermal conductivity. Therefore, the demonstrated rational synthesis model and measurement technique promise great potential for improving the performance of a wide-range of one-dimensional NWs-based thermoelectric devices. Finally, I will also discuss the measurement techniques for extracting the thermal properties such as both in-plane and out-of-plane thermal conductivity and Seebeck coefficients of other 1D and 2D nano-materials including Sb_2Te_3, porous Bi, and BiTe etc. at the end of the presentation. In this topic, a theoretical model calculation using Callaway model will be included.

Keywords:

Control of surface morphology of stacking faulted silicon nanowires and their coherent phonon transport characteristics

Computational design of high-performance thermoelectric materials

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Abstract:

As the world's demand for energy rapidly increases while fossil fuel supplies decrease, it is becoming more important to develop new, inexpensive materials that can supply sustainable and clean energy to meet the needs of the future. One of promising approaches in this direction relies on thermoelectric (TE) materials, which convert temperature gradient directly into electricity. While traditional TE materials such as Bi_2Te_3 have witnessed applications over decades, they contain expensive, rare, heavy and sometimes harmful elements. It is thus crucial to search for novel and abundant materials and/or structures with a view towards high-efficiency, cost-effective energy conversion applications. Notably, recent advances in semiconductor nanostructures have provided a new strategy along this direction. In this talk, I will describe how state-of-the-art computational approaches can play an important role in designing high-performance TE materials using crystalline Si and II-VI semiconductors, by providing both fundamental understanding on the conversion properties of these materials and guidance for their experimental synthesis. Since it is critical to understand the thermal and electronic properties of a material in order to develop efficient TE devices, emphasis will be given to how our understanding of these properties can be advanced through computational approaches

Keywords:

Thermoelectric, figure of merit

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C5.04
2016.10.19 - 2016.10.21

The achievement of high ZT in n-type SnSe single crystal

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Abstract:

SnSe is a semiconductor with an indirect band gap energy of E_g =0.829 eV at 300 K with orthorhombic Pnma phase, while it shows direct band gap of E_g = 0.464 eV with Cmcm structure phase at high temperature. It exhibits two dimensional (2D) layered structure with strong Sn-Se bonding along b-c plane and weaker bonding along a axis direction, resulting in a strong anisotropic transport properties. Recently, Zhao et al. reported that high thermoelectric power factor and low thermal conductivity at high temperature make SnSe as a very good p-type thermoelectric material; ZT values along b and c axes are up to 2.6 and 2.3 at 923 K, respectively. They attributed the remarkably high ZT value along the b axis to the intrinsically low lattice thermal conductivity in SnSe. More recently, two first-principles calculations predicted good thermoelectric performances in both n- and p-type SnSe's and better n-type thermoelectric properties than p-type SnSe and J. Yang et al. predicted ZT~3.1 in n- type SnSe. Here we report that n-type SnSe single crystals were successfully synthesized by doping for the first time and also n-type carrier concentration can be controlled by doping content. In this talk we will discuss on dopant type and thermoelectric properties of n-type SnSe single crystals in detail.

Keywords:

The achievement of high ZT in n-type SnSe single crystal

KPS 한국물리학회 The Korean Physical Society

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C6.01
2016.10.19 - 2016.10.21

What we have learned from the study on copper-oxide high-temperature superconductors?

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Abstract:
30 years have passed since the discovery of copper-oxide high-temperature (high-Tc) superconductors. Scientists around the world have devoted their efforts to discover / develop higher-Tc superconductors, to understand their mechanisms, and to improve their performances towards applications. Thanks to these efforts, our understanding of high-Tc superconductors has tremendously advanced. It is also true, however, that several important issues are still unsettled and under hot debate. In this talk, I will review the progress of the research on the high-Tc superconductors which I have witnessed for the last 30 years.

Keywords:
high-temperature superconductors

Density Waves of HTSC in Atomic Scale

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Abstract:

Pseudo-Gap (PG) phase of the cuprates is believed to hold a key to the understanding of the mechanism of high Tc superconductivity. Recently, discoveries of CDW phase in PG phase have been reported on cuprate superconductors, but its detailed origin is still not fully understood. We studied PG phase of BSCCO 2212 using variable temperature STM and observed density modulations similar to the reported CDW's wave vectors. Unlike the previously reported CDW's, however, we find these density modulations disperse in particle - hole asymmetric manner and their correlation length is not a conventional one. On the other hand, we succeeded in realizing Scanning Josephson Tunneling Microscopy and discovered wave like features in Cooper pair density by directly probing Josephson current. In this presentation, we will discuss a new length scale in PG phase - phase coherence length of these density modulations in real space and their possible origin as well as their relation to the superconductivity by comparing these PG density waves to the recently discovered PDW (Pair Density Wave).

Keywords:

Density Waves of HTSC in Atomic Scale

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C6.03
2016.10.19 - 2016.10.21

Enhanced superconductivity in surface-electron-doped iron pnictide.

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Abstract:

Recent discovery of a surprisingly enhanced superconductivity in monolayer FeSe on $SrTiO_3$ highlights the tendency in iron chalcogenides that superconductivity favors heavy electron doping. It could be regarded as a possible approach to build up the higher transition temperature superconductor, however, such tendency has been observed only in the iron chalcogenide. In iron pnictide, contrastingly, superconductivity disappears in heavy electron doping. It possess a important question whether heavy electron doping is really proper way to enhance the superconductivity. In this presentation, I will demonstrate that in fact such tendency in chalcogenide could be followed by iron pnictide also. Trough surface electron doping applied to optimally doped $Ba(Fe,Co)_2As_2$, we observed enhancement of superconductivity up to 42 K from 23 K of original value. Our results indicate that with pure charge doping, superconductivity in iron pnictide could be further enhanced, so that the stronger superconductivity in higher doping level is the universal tendency of entire iron based superconductor familiess.

Keywords:
iron based superconductor, angle resolved photoemission spectroscopy

Electronic Structure of PdTe2 investigated by Angle-Resolved Photoemission Spectroscopy

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Abstract:
We report the electronic structure of PdTe2 as an intriguing example of topologically non-trivial system. Our ARPES measurements and first principle calculations reveal that PdTe2 with the CdI2-type structure has two different kinds of Dirac points in one system. One is a Dirac point in the surface states of a PdTe2 (001) surface due to nontrivial Z2 topology, and the other is a new kind of Dirac point that implies the existence of so-called type-II Dirac fermions as a counterpart of type-II Weyl fermions.

Keywords:
PdTe2Dirac fermionWeyl fermionARPES

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C7.02
2016.10.19 - 2016.10.21

Ultrafast Polaron Dynamics in Layered and Perovskite Manganites: 2D and 3D Polarons

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Abstract:

We have studied the subpicosecond quasiparticle dynamics of the perovskite manganite La0.7Ca0.3MnO3 and the layered manganite La1.4Sr1.6Mn2O7 using ultrafast optical spectroscopy at 1.5 eV. For T ≥ TC, relaxation proceeds on the time scale of several hundred femtoseconds corresponding to the redressing time of a photoexcited electron to its polaronic ground state. The temperature and dimensionality dependence of this polaron redressing time provides insight into the relationship between polaronic motion and spin dynamics on a subpicosecond time scale. We also observe a crossover to more conventional electron-phonon relaxation in the ferromagnetic metallic phase.

Keywords:
Polaron, Ultrafast dynamics

Giant exchange bias effect in $YCo_{0.25}Mn_{0.75}O_3$

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Abstract:

Previous studied exchange bias (EB) phenomena in Y_2CoMnO_6 would originate from interfacial exchange coupling between Mn^{4+}– O^{2-}–Mn^{4+}, Co^{2+}– O^{2-}–Co^{2+} antiferromagnetic (AFM) ordering induced by only antisite defect without spin glass behavior and Co^{2+}– O^{2-}–Mn^{4+} ferromagnetic (FM) ordering. On the other hands, we investigated EB effect by enhanced Mn ion ratio in Y_2CoMnO_6 in order to change of ratio between Co and Mn ions, successfully made $YCo_{0.25}Mn_{0.75}O_3$ compound. We confirmed that the weekly ferromagnetic behavior is found below 38 K, giant exchange bias field, H_{EB} ~13 kOe, was observed at 2 K upon measuring field of 15 kOe with applied FC in 40 kOe. The observed exchange bias effect reveals the strong dependence on cooling magnetic fields, measuring fields, and temperature. We suggest that the giant effect would originate from the interfacial pinning of exchange couplings between not only FM and AFM clusters but also FM and spin-glass by Mn^{3+}– O^{2-}–Mn^{3+} AFM ordering generated due to additional Mn ions.

Keywords:
exchange bias, spin glass

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Film thickness variation mediated strain-state crossover in epitaxial VO_2 films

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Abstract:

In this presentation, we present the correlation between the interfacial strain and the metal-insulator-transition of VO_2 films. The (020) oriented VO_2 films were grown on Al_2O_3(0001) by RF magneton sputtering at various deposition time to obtain different strain state. As deposition time increased, an unusual out-of-plane compressive strain (~ −0.0129 %) was observed. Since, out-of-plane tensile strain is required to minimize the interfacial lattice-mismatch between VO_2 and Al_2O_3, this unusual strain can be originated from the different growth mode depending on the film thickness. From the local structure analysis, we found that a V-V bond length was more sensitive to the strain-state than that of an apical and equatorial V-O bond length. Furthermore, metal-insulator transition (MIT) temperature shifted to higher temperature with decreasing the out-of-plane tensile strain. These variations of MIT temperature might be related to the change of V-V bond length, which could change electronic orbital occupancies. This work is supported in part by NRF Korea (NRF-2015R1D1A1A01058672) and Korea Basic Science Institute Research Grant (E36800). One of us (J. W. Kim) was supported by the GPF program (2015H1A2A1034200) of NRF.

Keywords:

VO2; Strain; Metal-insulator transition; Local structure

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Calculating branching ratio and spin-orbit coupling from first-principles: A formalism and its application to iridates

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Abstract:

We developed a simple technique to calculate spin-orbit coupling, , and branching ratio and implemented it into our DFT code, `OpenMX' [1]. This method is for first-principles electronic structure calculation and straightforward for any of standard formulations and codes. We applied this technique to several different large spin-orbit coupling iridates. The calculated and branching ratio of a prototype Mott insulator, Sr_2IrO_4, are in good agreement with recent experimental data over the wide range of Rh-doping. Three different double perovskite iridates (namely, Sr_2MgIrO_6, Sr_2ScIrO_6, and Sr_2TiIrO_6) are also well described. This technique can serve as a promising tool for studying large spin-orbit coupling. [1] http://www.openmx-square.org/ [2] J.-H. Sim, H. Yoon, S. H. Park, and M. J. Han, arXiv:1608.06388 (2016)

Keywords:
first-principles,spin-orbitcoupling, branching ratio

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Scanning tunneling microscopy / spectroscopy study on excitonic insulating phase in Ta_2NiSe_5 single crystals

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Abstract:

The excitonic insulator (EI) was first proposed theoretically in 1967[1], but only few materials have been suggested to be EIs[2-5]. Also, the experimental evidences of the EI state has been mostly indirect such as transport measurements or renormalization of band dispersions. We carried out Scanning tunneling microscopy / spectroscopy (STM/S) experiments at 78 K and room temperature and theoretical calculations to investigate the electronic structure Ta_2NiSe_5, which was recently suggested to be an EI. Our STM/S results show metal-insulator phase transition, showing clearly an energy gap of 550 meV at 78 K. Furthermore, the band characters of the valance and conduction band are inverted at low temperature, which indicates a strong hybridization of Ta and Ni bands. This strong hybridization is one of important evidences of the EI state. The theoretical calculations with two-band and three-band exciton models also show the exciton formation opens the energy gap with band inversions, supporting our experimental results. These results indicate that the EI mechanism in Ta_2NiSe_5 is close to the Bardeen-Copper-Schrieffer (BCS) condensation of copper pairs. [1] D. Jerome, Phys. Rev. 158, 462 (1967) [2] J. Neuenschwander, Phys. Rev. B 41, 12693 (1990) [3] P. Wachter, Phys. Rev. B 51, 5542 (1995) [4] Th. Pillo, Phys. Rev. B 61, 16213 (2000) [5] Y. Wakisaka, Phys. Rev. Lett. 103, 026402 (2009)

Keywords:
Excitonic Insulator, Metal-Insulator transtion, Scanning Tunneling Micriscopy / Spectroscopy, Layered materials,Ta_2NiSe_5

Critical behavior in quasi-one-dimensional organic conductors as investigated by a cubic anvil cell up to 8.5 GPa

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Abstract:

Adjusting electron-electron interaction in correlated metals often leads to intriguing phase transitions such as a metal-insulator transition or a superconducting transition. One prototypical metal-insulator transition, called Mott transition, occurs via competition between on-site Coulomb repulsion (U) and inter-site electron hopping, and can be modelled by the Hubbard model. In this model, different phases can be formed with variation of the parameter U/W, where W refers to the kinetic energy of electrons. In a 3D material like Cr-doped V_2O_3 and 2D organic metals, critical behaviors have been found at the suspected critical end point tuned by the hydrostatic pressure controlled by helium gas. The former was found to follow the mean-field behavior while the latter was found to belong to unconventional universality class. Here, we have investigated electrical conductivity of quasi-one-dimensional organic conductors (S,S)-DM-MeDH-TTP AsF_6 and (S,S)-DM-MeDH-TTP PF_6 under hydrostatic pressure up to 8.5 GPa as tuned by a cubic anvil pressure cell. We found the critical end points in the both material system, and could extract the critical exponents, d, b and g, satisfying the scaling relationship. The obtained critical exponents were found to show again unconventional values that are distinct from the exponents known in the 3D or 2D correlated metals. This may indicate that the quasi-one-dimensional organic conductors could belong to a new universality class at the critical end points. This work was supported by CRI program (2010-0018300).

Keywords:

Quasi-one-dimensional, organic conductor, criticality, quantum criticalily

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Temperature and Doping Evolutions of the Electronic Response of $Sr_3(Ir_{1-x}Ru_x)_2O_7$

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Abstract:
Since the discovery of the effective total angular momentum $J_{eff}=1/2$ Mott state, Ruddlesden-Popper series iridates $Sr_{n+1}Ir_nO_{3n+1}$ have been attracting a great deal of attention. We investigated the electronic response of $Sr_3(Ir_{1-x}Ru_x)_2O_7$ single crystals (x=0, 0.22, 0.39) as a function of temperature by using infrared spectroscopy. The optical response of $Sr_3Ir_2O_7$ and $Sr_3(Ir_{0.78}Ru_{0.22})_2O_7$ showed strong temperature dependence. We found that as the temperature decreases the optical gaps of the two compounds opened near their respective antiferromagnetic ordering temperatures. We will discuss the temperature evolutions in terms of Lifshitz-type metal-insulator transition. We also found that Ru doping led to an abrupt insulator-metal transition between x=0.22 and x=0.39. Concurrently, drastic changes of the Ir/Ru-O stretching mode and the in-plane Ir/Ru-O-Ir/Ru bending mode were observed. We will discuss the effects of structural changes on the doping-induced insulator-metal transition.

Keywords:
$Sr_3(Ir_{1-x}Ru_x)_2O_7$, Lifshitz-type metal-insulator transition, structural phase transition, and infrared spectroscopy.

Single-cell single-molecule co-IP applied to EGFR signaling assay

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Abstract:
We have developed Single-cell single-molecule co-IP applied to EGFR signaling assay. In this assay, the single molecule techniques are applied to a spatially localized proteins from single cells. Each cell was captured to 150 high density cell capturing design. We were focused on Epithermal Growth Factor Receptor(EGFR), a major target for cancer cell therapy. Fisrtly, bait proteins were attached onto the surface, cells were lysated, in-situ. Then, activity EGFR from the single cancer cells was measured. EGFR expression level of the cell is also measured using Sim-Pull Assay. We believe that this assay confers a platform to study membrane proteins in single cell level.

Keywords:
Single Cell, Co-IP, EGFR, PC9

Part by part folding of DNA origami by single-molecule force annealing using magnetic tweezer

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Abstract:
Since its first introduction in 2006, DNA origami based nanostructures have evolved to produce more complex objects in terms of its shapes and functions. Despite of attempts to develop alternative assembly protocols for DNA origami, its folding still mainly depends on thermal annealing which limits structural and functional diversity. Here we demonstrate consecutive folding of DNA origami structures in just one single stranded scaffold DNA by recently developed single molecule force annealing method. Using magnetic tweezers, we stretch a single scaffold DNA with mechanical tension and afterwards inject staple strands to induce efficient hybridization between scaffold and staple strands. When the force is slowly decreased to zero, which is force annealing, folding of DNA nanostructure is efficiently completed through strand displacement reaction governed by force guiding. After repeating this mechanical folding process for the rest part of scaffold strand, part by part mechanical folding process is finished within 10min for each part. Consecutive part by part folding of DNA origami structure suggests a scheme towards biotechnology such as new topology of DNA nanostructures or protein drug delivery system.

Keywords:
DNA origami, Mechanical folding, Part-by-part assembly, Nanotechnology

Enhanced diffusivity of motor protein in nonequilibrium steady state

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Abstract:
By analyzing single molecule motility data of kinesin-1 at varying ATP concentrations and mechanical loads, we found, the motor diffusion coefficient D is tightly coupled with the motor velocity V violating Einstein relation. Especially, when the increase of V is augmented by ATP concentration, D is expressed in the form of a third order polynomial of V . We also quantify the heat generation in terms of V and D highlighting the difference between passive and active diffusion.

Keywords:
kinesin, active diffusion, nonequilibrium, steady state

Understanding PI3K in Cancer at the Single-Molecule Level

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Abstract:
PI3K-Akt signaling pathway controls cell growth, proliferation, and motility, and is frequently deregulated in many types of cancer. PI3K is a lipid kinase that converts PIP_2 into PIP_3 on membrane, which then recruits downstream signaling proteins such as Akt. Traditionally, the activity of PI3K has been probed indirectly by the phosphorylation of Akt. Here, we developed a technique that directly measures the activity of PI3K by single-molecule fluorescence. In this method, surface-tethered PI3K phosphorylates PIP_2 on nearby vesicles, fluorescently-tagged Akt is introduced, and its binding to vesicles is imaged to quantify PI3K activity. After validating the method with fluorescent protein-tagged PI3K, we extend this assay to endogenous PI3K from breast cancer cells to understand the response of cancer cells to PI3K inhibitors. We hope this assay could be useful in screening for PI3K inhibitors or guide selection of cancer patients for PI3K-targeted therapy.

Keywords:
PI3K, cancer,single molecule, fluorescence

Structures and Physical Properties of Ionic Liquid Mixtures

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Abstract:

Ionic liquids are the materials existing at liquid phase below 100 ° C even though the materials consist of only cations and anions. They are called "designer solvent" as the physical properties of the materials can be tuned by changing their constituent ions. Recently, ionic liquid mixtures have gained attention as a way of maximizing the advantage of ionic liquids because the material properties can be changed continuously in the mixture with the composition change. The excess molar volume, a difference between molar volume of the mixtures and a linear interpolation between the volumes of pure components, is widely investigated as one of the key physical properties for the ionic liquid mixtures. The excess molar volumes have been found to be significantly different for some mixtures, but the origin of this difference is not well understood yet. The different microstructures of the mixtures, which can range from a simple mixture of two different consisting ionic liquids to a different structure from those of pure materials, have been suggested as the origin of the difference. The structures of different ionic liquid mixtures are studied by IR spectroscopy to confirm this suggestion, as a peak in the IR spectrum for the moiety participating in the hydrogen bonding (vC(2)-H) changes sensitively with the change of the anion in the ionic liquid. The absorbance of vC(2)-H changes proportional to the composition for the mixtures consisting of monoatomic anions. The absorbance however, changes nonlinearly for the mixtures of which one of the anion had multiple interaction sites. This experimental results indicate that the constituent ions determine the structure and the physical properties of the mixtures.

Keywords:
ionic liquids, IR spectroscopy, liquid mixtures

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Multi-Color Single Particle Tracking of Membrane Protein in Living Cell Using DNA-PAINT

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Abstract:
Recently, super-resolution techniques using photoactivatable fluorescent particle enabled imaging individual molecules distributed closer than classical diffraction limit. Furthermore, tracking each localized particle provides information on dynamics of single molecule, acquiring heterogeneity of motions based on their complex environment in living cell. However, his method to track high density of single particle in living cell, named sptPALM, uses photo-activation which not only limit excitation and emission channel for fluorophore but also is unsuitable for controlling density of fluorescent particles when used for multi-color tracking. Here DNA-PAINT which uses binding and detaching of DNA oligonucleotides to control density of single particle trajectories is adapted to simultaneously track different targets. The DNA strands binds specifically to its complementary strand that enables regulation of each particle density by simply adjusting each concentration of imaging strands in the media. With ErbB family as a model system, the individual dynamics information of the family member is gained by single particle tracking DNA-PAINT simultaneously.

Keywords:
super-resolution imaging, single particle tracking, DNA-PAINT

Force spectroscopy of single SUVs

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Abstract:
Mechanical deformation of lipid membranes plays a crucial role in cell functioning. While mesoscopic membrane deformations are relatively well studied, mechanics of a confined membrane compartment that is directly involved in the cellular membrane remodeling process has not been fully investigated yet. To this end, we pulled substrateimmobilized single small unilamellar vesicles (SUVs) of 120-140 nm by using magnetic tweezers. Modulating substrate to SUVs surface interactions and piconewton scale point force to the SUVs, we directly observed local discontinuities associated with two states transition by means of force vs. extension curves. Theoretical modeling of the SUVs and energy landscape analysis of the measurements together suggest that interplay between membrane bending and stretching is responsible for the two states transition. The result provides a biophysical insight on cellular membrane remodeling processes in nanoscale. Furthermore, we expect that presented theoretical and experimental frameworks can be directly utilized to investigate membrane-protein interactions in various cellular functioning

Keywords:
Lipid membrane,Force spectroscopy

Effect of counterions on interfacial dipoles in NPEs

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Abstract:
We report solution-processed organic solar cells consisting of poly (3-hexylthiophene) (P3HT), a Non conjugated polyelectrolyte (NPE) and [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM), wherein the effect NPE layer thickness on device properties was investigated. The current-voltage characteristics under illumination and dark as well as photoluminescence were characterized using various concentrations (0.2, 0.1, 0.05, 0.01, 0.005 and 0.001wt%) of to deposit the NPE interlayer between the electrode transport layer (ETL) and Active layers. The results of device performance show exhibited efficiencies by using a little quantity of $PEIH^{+}X^{-}$(Bim_4^-, Br^-, I^-). Novel organic solar cells with various counter ions (Bim_4^-, Br^-, I^-) exhibited the efficiencies of 4.36%(Bim_4^-), 3.15%(Br^-), 1.93%(I^-).

Keywords:
Non conjugated polyelectrolyte (NPE),organic solar cell,

Functional HER2 dimer pull down enables direct observation of the early stage of cellular signaling and gives more reduced information for drug efficacy

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Abstract:
HER family receptors are promising drug targets for cancer treatment. They are known to be activated by forming homo- or heterodimer within same family members. By forming dimer, they activate their kinase domains, and phosphorylate their tyrosine tails. However, it is still mysterious whether or how they produce signal diversity afterwards. Because most of the studies were done with their purified domains, new results with full length proteins are necessary. Here we introduce a new concept of kinase assay based on single molecule co-IP with full length endogenous proteins, without purification. As a model system, we used HER2 and HER3, which are members of HER family. Using Single molecule co-IP technique, we observed kinase activity of ligand induced HER2 and HER3 heterodimer and ligand free HER2 complex, which is strongly regarded as HER2 homodimer. By introducing their downstream protein, we observed how their phosphorylation result affect the interaction between them and their downstream proteins. Moreover, HER2&HER3 heterodimer showed intrinsic Lapatinib resistance while HER2 homodimer showed effectively inhibited kinase activity.

Keywords:
HER2, HER3, heterodimer, homodimer, kinase assay, Lapatinib, Afatinib

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Back-gated MoS_2 photodetector with enlarged response by zinc oxide quantum dots

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Abstract:

Transition metal dichalcogenides (TMDs) have been attracting attention because of their applications in optoelectronics and photo-detection. One of the widely used TMDs semiconductors is molybdenum disulfide (MoS_2), which has tremendous applications because of its tunable bandgap and large quantum luminescence efficiency. Here we report high photo responsivity (~ 1913 AW^{-1} at V_{bg} = 30 V) in the MoS_2 photodetector. For a further development to enhance light absorption and gain, we made heterostructures of MoS_2 with thin layer of ZnO quantum dots (ZnO-QDs). We observed that photo responsivity is increased dramatically equal to 2267 AW^{-1} at V_{bg} = 30 V. The high response in MoS_2/ZnO-QDs heterostructures is attributed to effective charge transfer and absorption of light, resulting in production of electron-hole pairs with decay time reduction.

Keywords:

Quantum dots, MoS_2, Photodetector, Transition metal dichalcogenides

Layer dependent and photon-assisted tunneling effect in vertical Au/WS_2/Au devices

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Abstract:

We have fabricated Au/WS_2/Au vertical tunnel junction devices, for which we investigated layer dependent and photon-assisted tunneling effect at various temperature from 25 to 300 K. The tunneling current and threshold voltage depends on the thickness of WS_2 film. Small tunneling current and high threshold voltage were observed for thick WS_2 layer device, whereas large tunneling current and low threshold voltage were observed for thin WS_2 layer device. The tunneling current decreased as temperature is lowered due to suppression of thermally assisted tunneling. The symmetric behavior of current-voltage curves supports the existence of back-to-back Schottky barriers. In addition, the photon-assisted tunneling effect was investigated under deep UV light. The tunneling current was enhanced under deep UV light and the threshold voltage becomes low because of the photon assisted tunneling over the Schottky barriers. The device structure in this experiment can provide an efficient way to investigate the characteristics of vertical current through transition metal dichalcogenides materials.

Keywords:
Transistion metal dichalcogenides, Vertical tunneling, WS_2

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Effect of remote interfacial phonon on the resistivity of graphene

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Abstract:

In this presentation, we introduce our results on the temperature (T) dependence of electrical resistance in graphene, measured between 10 and 400 K. Graphene samples were prepared on various substrates; SiO_2, h-BN and HfO_2. The resistivity of graphene shows a linear T-dependence at low T and becomes superlinear above ~100 K for graphene prepared on HfO_2 substrate. The transition temperature strongly depends on the substrates. We find ~150 and ~200 K for graphene on SiO_2 and on h-BN, respectively. Surface optical phonon energies of HfO_2, SiO2 and h-BN are 21, 59 and 101 meV, and our results can be explained by the remote interfacial phonon scattering by the surface optical phonons of the substrates.

Keywords:
graphene, remote interfacial phonon, temperature

Low Frequency Raman Peaks of Scrolled Graphene

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Abstract:
We discuss Raman spectra of scrolled graphene structure. We scrolled monolayer graphene by applying a droplet of isopropyl alcohol (IPA) solution (IPA/water~1:3) to the exfoliated graphene on substrate. In Raman spectroscopy, we have observed peculiar low-frequency Raman peaks below 120 cm^{-1}. The low-frequency Raman properties of the scrolled graphene are clearly distinguished from the radial breathing mode (RBM) of carbon nanotubes, but similar to the layer breathing mode and the shear mode in twisted multi-layer graphene. From the similarities of Raman spectra between the scrolled graphene and the twisted multi-layer graphene, we argue that in such specific locations layers in the scrolled graphene encounter specific twisted angle between layers and result in the peculiar low frequency Raman peaks.

Keywords:
graphene, scrolled graphene, carbon nanoscroll, CNS, Raman spectroscopy, Layer breathing mode, LBM, shear mode, C mode, R peak, low-frequency peaks.ribbon-like structure, ribbon-like scrolled graphene. mono-layer graphene

Gigahertz Generation and Detection of a Single-Electron Gaussian Wave Packet

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Abstract:

A quantum-dot pump is an on-demand single-electron source. It has the unique property of emitting hot electrons of ~ 100 meV above Fermi energy one by one. In order to utilize it for a fermion version of optics and related quantum processing, it is crucial to realize a quantum-dot pump emitting a prescribed electron wave packet of a useful form. We propose how to generate an electron in a Gaussian state, using a quantum-dot pump with GHz operation and realistic parameters. With the help of a strong magnetic field, the electron occupies a coherent state in the pump, insensitive to details of non-adiabatic evolution. When the Landauer-Buttiker traversal time of the pump barrier is much shorter than the passage time of the coherent state, the coherent state is emitted into a Gaussian wave packet. The Gaussian packet can be identified by using a dynamical potential barrier, with resolution reaching the Heisenberg minimal uncertainty hbar/2.

Keywords:

Quantum dots, Mesoscopics, Tunneling & traversal time

Noise at quantum point contacts between fractional quantum hall edge states

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Abstract:
We propose a device, consisting of three fractional quantum hall edges connected by two QPCs, to study transport properties of anyonic edge excitations. The device is in the non-equilibrium situation where bias voltage is applied to one of the edges while the others are grounded. We find that nontrivial excess shot noise is produced in the fluctuations of electrical currents. We attribute the excess quantum noise to the fractional exchange statistics of the anyons.

Keywords:
Fractional quantum hall edge, noise

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Scopus 등재로 바라본 새물리 현황 및 발전 전략

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Abstract:
새물리(New Physics: Sae Mulli)는 2015년 8월 Scopus에 등재 확정되면서 2015년 1월 논문부터 Scopus에 등재하였다. 이는 2010년 기존 새물리의 명칭을 New Physics: Sae Mulli 로 변경하여 국,영문 혼용지로 변화하고, 2013년 말 저널홈페이지 및 온라인투고시스템을 구축하면서 기존 국내 독자층 뿐만 아니라 해외의 독자층까지 포용하려는 목적의 성과물이라고 볼 수 있다. 이러한 노력의 성과를 객관적으로 파악하기 위해 2014년 이후 투고된 논문의 통계를 토대로 현재를 살펴보고 타학회지의 사례를 중심으로 새물리(New Physics: Sae Mulli)가 앞으로 나아가야 하는 방향에 대해 제언하고자 한다.

Keywords:
Scopus 등재로 바라본 새물리 현황 및 발전 전략

JKPS & Springer Nature

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Abstract:
The Journal of the Korean Physical Society (JKPS) is the flagship journal of the KPS and has been co-published with Springer since 2012, forming an integral part of Springer's growing portfolio in Korea. The journal covers all fields of physics spanning from statistical physics and condensed matter physics to particle physics, across 2 volumes and 24 issues per year, with almost 700 papers published in 2015. I will discuss the current position of JKPS within the physics publishing landscape, and strategies for development of the journal to better serve the international physics community and the KPS membership. I will also mention some of the most relevant developments associated with the formation of Springer Nature, created in 2015 through the merger of Nature Publishing Group, Palgrave Macmillan, Macmillan Education and Springer Science+Business Media.

Keywords:
JKPS, Springer Nature, Publishing

Ethics in Publishing: Authors, Reviewer and Editors

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Abstract:

Springer Nature is a member of the Committee on Publication Ethics (COPE) and subscribes to its principles on how to deal with acts of misconduct. We work with our journal editors to ensure that we adhere to the principles of COPE, committing to investigate allegations of misconduct and to ensure the integrity of research. We expect authors to refrain from misrepresenting research results which could damage the trust in the journal, the professionalism of scientific authorship, and ultimately the entire scientific endeavor. I will describe the practical guidance we offer to Journal Editors and our Society Publishing Partners to help manage the repercussions potentially arising from publishing work which may be in breach of the codes of conduct.

Keywords:
Publication Ethics, COPE

The role of journal editors to make better Journal

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Abstract:

In this presentation insight will be given on how journal editors can improve the impact of their journals. How do you identify high-impact content and what can you do in order to attract articles that are expected to receive many citations? And once you published them, what can you do to promote them?

Keywords:
Editors, Scientific Journals, Citation

Improving South Korea's position in the worldwide Physics Community by capturing high impact content

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Abstract:
This presentation session will have a closer look at the position of South Korean Physics research within the worldwide Physics community. By analyzing citation data, deep information about the research fields, institutions and individuals with the highest impact can be extracted. Which fields are driving South Korea's position and in which journals do the most successful South Korean researchers publish? These are questions that will be addressed throughout this talk.

Keywords:
Physics Community, South Korea, Scientific Journals.

Overview of Hyper-Kamiokande

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Abstract:
Hyper-Kamiokande is a straightforward extension of successful water Cherenkov detector experiment Super-Kamiokande and will provide major new capabilities to make new discoveries in particle and astroparticle physics thanks to an order of magnitude increase in detector mass and improvements in photon-detection system along with the envisioned J-PARC Megawatt-class neutrino beam. The international proto-collaboration is developing the project in its international framework with the cooperation of ICRR-UTokyo and IPNS-KEK. The principal project milestones include: project approval in 2017, construction start in 2018, and start of data taking in 2026.

Keywords:
neutrino

J-PARC neutrino beam

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Abstract:
Intense neutrino beam is produced for long baseline neutrino experiments using high inetnsity proton accelerators in Japan Proton Accelerator Research Complex (J-PARC). The beam form Main Ring (MR) at 30GeV is used for the neutrino beam production. The beamline has been operational since 2009. The original design beam power of MR is 750kW and now stable operation at 425kW is achieved. Upgrade of MR is scheduled in 2018 to achieve the desing intensity. Futher upgrade of the MR beam power upto 1.3MW is planned for the future extention of T2K and Hyper-Kamiokande. In my talk, design, achievements, and future plan will be described in detail.

Keywords:
neutrino

Hyper-Kamiokande & near detectors and physics potentials

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Abstract:
Hyper-Kamiokande (HK) is a ring-imaging water Cherenkov detector and consists of two cylindrical tanks (each with a diameter of 74m and height of 60 m) with the second tank commencing operation later than the first tank. Two tanks in total will provide the fiducial volume which is about 20 times larger than that of Super-Kamiokande (SK). The HK candidate site, located 8km south of SK and 295km away from J-PARC, is in the Tochibora mine near Kamioka town in Gifu Prefecture, Japan. The neutrino flux and cross-section models can be constrained by data collected at near detectors, situated close enough to the neutrino production point so that oscillation effects are negligible. Their data addresses important uncertainties in the neutrino flux or cross-section modeling. With an order of magnitude larger mass than SK, HK will significantly extend the science reach in a wide range of field by detecting neutrinos from various sources, such as accelerator, atmosphere of Earth, the Sun, and supernova. Especially, using the neutrino beam from an upgraded J-PARC accelerator, HK will be able to measure with the highest precision the leptonic CP violation. HK will also have an excellent discovery potential for the proton decay. In this talk, the physics potential with the baseline design of HK will be presented.

Keywords:
neutrino

Two-particle correlation via Bremsstrahlung

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Abstract:

Ridge is the well-known structure in two-particle angular correlations at high-energy heavy-ion collisions. This structure is physically understood through elliptic and higher-order flows at nucleus-nucleus collisions. Recently, it also appears in small systems, such as proton-proton collisions. However, Ridge structure in small system is hard to explain via hydrodynamics, since we do not expect the medium such as the Quark-Gluon plasma is produced in small systems. Thus, we try to describe this phenomena through kinematic interaction between jets and medium partons. In high-energy heavy-ion collisions, the energetic particles called jets lose their energy while passing through the medium. While this energy-loss process, photons/gluons are emitted from interaction between jets and medium partons. In this study, We concentrate on energy loss via photon radiations, as known as Bremsstrahlung. In previous studies(C. Y. Wong, Physical Review C 85, 064909 (2012).) two symmetric double scattering process between jet particle and medium parton interfere constructively such that medium partons are aligned along incoming jet particles to produce the peaks and the Ridge altogether. In our study, we calculate the cross section for two symmetric diagrams of photon emission and medium parton scattering. We expect these two amplitudes from symmetric Bremsstrahlung process to give constructive interference leading to the collective motion of Ridge structure. We check the angular correlation for emitted photon and final jet, and that for medium parton and final jet. We fix that the incident jet energy is 10 GeV, final jet energy is 9 GeV and incident angles of jet particles are θ p = 10 ∘ and Φ p = 0 ∘ . We find that the collective motion appears in both correlations. In the correlation between final jet and emitted photon, peaks align to initial jet particles and photons are emitted mostly in forward direction. In the correlation between final jet and final medium parton, Ridge structures come out and the peak of the medium momentum is perpendicular to the incoming jet particle which is resulted from the 4-momemtum conservation between incoming jet particle, photon, and medium parton. In these calculations, we assume that initial medium partons follow the Maxwell-Boltzmann. We check that the Fermi-Dirac distribution do not change the result significantly. Further works including the effects from boost and flows are needed and then the effects from multiple scatterings, too. Our formalism can be extended for the Gluon Bremsstrahlung with the addition of color degree of freedom.

Keywords:
Bremsstrahlung, constructive interference

J/Ψ production in pp and pPb collisions from CMS

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Abstract:

The charmonia are important probes to study the properties of the de-confined medium, the so called quark-gluon plasma (QGP), produced by ultra-relativisitc heavy-ion collisions. On the other hand, the prompt and non-prompt J/Ψ productions in asymmetric proton-nucleus collisions enable us to investigate the so-called "cold nuclear matter effects (CNM)", which provide new information to examine quantitatively the genuine hot-medium effects in nuclear collisions. This presentation reports the prompt and non-prompt J/Ψ productions from CMS, using 34.6 /nb of pPb recorded in 2013, and 28.5 /pb of pp recorded in 2015 at the same beam energy of 5.02 TeV. The differential production cross sections are analyzed in 2 〈 P_T〈 30 GeV/c. The center-of-mass (CM) rapidity coverage is somewhat different as −2.87 〈 y_{CM}〈 1.93 for pPb and −2.4 〈 y_{CM} 〈 2.4 for pp. The nuclear modification factor, R_{pPb}, is presented by comparing the J/Ψ yields in pPb and those in pp. Also the ratio of the forward (p-going direction) and backward (Pb-going direction) yields in pPb is analyzed in several ranges of P_T, rapidity, and the event-activity variable to investigate the CNM.

Keywords:
CMS pPb J/psi

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C15.03*
2016.10.19 - 2016.10.21

B plus nuclear modification factor in PbPb at 5.02 TeV with CMS

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Abstract:

Heavy quarks are promising probes to investigate the detailed properties of hot and dense medium generated by heavy-ion collisions at collider energies. Since heavy quarks are sensitive to the transport properties of the medium, the energy-loss pattern of them is expected to be different from that of light quarks in a strongly-interacting matter. For example, the dead cone effect predicts low energy loss of heavy quarks in the hot and dense medium. The B plus mesons are reconstructed via J/Psi + K. This analysis is done based on the PbPb data 350.68 ub-1 at 5TeV collected by CMS in 2015.

Keywords:

B meson, nuclear modification factor

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2016.10.19 - 2016.10.21

Chip characterisation test for pALPIDE-3 & HIC assembly at ALICE

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Abstract:
ALICE 실험은 중이온 충돌로부터 생성될 것으로 예상되는 쿼크 글루온 플라즈마를 연구하는데 목적이 있다. 현재 ALICE에서는 쿼크 글루온 플라즈마 연구에 이용되는 입자들을 낮은 p_T 영역에서 보다 정밀히 측정하고, 입자 궤적의 위치분해능 향상을 위해 내부궤적장치 업그레이드를 진행하고 있다. 본 연구에서는 업그레이드 된 내부궤적장치에 사용될 칩 프로토타입 중 최종 버전인 pALPIDE-3의 특성을 다양한 테스트를 통해 파악하였다. 칩반응이 변하지 않는 범위에서 소비전력을 최소화 할 수 있는 조건을 알아보기 위해 아날로그 인가 전압 변화에 따른 칩반응 변화를 확인하였고, 칩 내부회로에 노이즈 신호를 인가하였을 때의 칩반응 변화를 확인하였다. 아날로그 인가 전압 변화에서는 1.6V에서 2.2V까지 0.2V 단위로 변화시켰을때 threshold, cluster multiplicity가 어떻게 달라지는지 확인하였고, DAC 값을 조정함으로써 아날로그 인가 전압이 변하더라고 같은 칩반응을 보이는 칩 조건을 확인하였다. 배경신호에 대한 칩반응을 살펴보기위해서는 외부에서 인가하는 신호의 주파수와 진폭에 따른 칩반응 변화를 확인하였다. 모든 프로토타입에 대한 칩 특성 테스트를 완료했고, 현재 최종 버전인 ALPIDE 칩을 생산중이다. 올해 말부터 한국 ALICE 그룹에서는 6만개의 ALPIDE 칩 qualification 테스트를 진행할 예정이며 전체 모듈 20% 정도의 HIC(Hybrid Integrated Circuit) 어셈블리를 진행할 예정이다. 본 발표에서는 HIC 어셈블리 방법 및 과정에 대해서도 소개할 예정이다.

Keywords:
ALICE ITS Upgrade

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C15.05*
2016.10.19 - 2016.10.21

Measurement of bottomonia states in pp and PbPb collisions.

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Abstract:

Bottomonia states are one of the cleanest probe to search the characteristics of the quark-gluon plasma (QGP) since they are produced on the early stage through hard scattering. The ratio of the excited states Y(nS) respect to the ground state Y(1S) in both pp and PbPb collisions are combined to form the double ratio, which is an equivalent to the ratio of R_{AA}'s. This observable can provide the information of the amount of suppression in the QGP of each state which is supposed to have different binding energies. This quantity has now been studied as a function of event centrality and Y(nS) kinematics using recently collected data. In this talk, the CMS collaboration presents the results on bottomonium production in pp and PbPb collisions.

Keywords:
Quarkonium, Upsilon, Bottomonia, LHC, CMS

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 C15.06*
2016.10.19 - 2016.10.21

Isolated photon-Jet Correlations in pp and PbPb collisions at 5.02 TeV with CMS

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Abstract:
Electromagnetic probes such as photons do not participate in the strong interaction, and thus provide a clean measurement of the initial state in nuclear collisions. Correlations of photons balancing with jets in PbPb collisions constitute the golden channel to study parton energy loss in strongly interacting matter, since the photon not only determines the initial transverse momentum of the balancing parton, but also preferentially selects quark jets. We will present new results from pp, pPb, and PbPb collisions at 5.02 TeV collision energy, including the high statistics data collected with the CMS detector in the 2015 LHC run. The results include detailed studies of azimuthal and momentum correlations of isolated photons and associated jets, as well as jet I_AA, as a function of photon p_T and collision centrality.

Keywords:
CMS, Isolated photon, jet, PbPb

KPS 한국물리학회 The Korean Physical Society

Characterization of ALICE Pixel Detector using accelerator beams in Korea and Mass Chip Test Project in Pusan for ALICE-ITS upgrade

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Abstract:
A new ITS (Inner Tracking System) of ALICE (A Large Ion Collider Experiment) detector is currently being developed for enhanced vertexing and tracking capabilities and faster data taking with increasing beam luminosity at LHC in 2020. The PNU team has been participating several part of the project including the pixel chip chracteristic measurement and will perform a mass test of a half of total 60k silicon chips and HIC (Hybrid Integrated Circuit) assembly with Inha University in the upcoming years. The test results of pixel chip characterization using accelerator beams in Korea and the overview of the mass chip test project will be presented.

Keywords:
LHC, ALICE, PNU, ITS-Upgrade

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D1.01
2016.10.19 - 2016.10.21

Quantifying the heat dissipation from a molecular motor's transport properties in non-equilibrium steady states

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Abstract:

Theoretical analysis, which maps on unicyclic Markov processes the single molecule time trajectories of an active molecular motor, allows us to evaluate the amount of heat dissipated from the motor and to elucidate its dependence on the mean velocity and diffusivity. Unlike passive Brownian particles in equilibrium, the velocity and diffusion constant of molecular motors, powered by non-conservative forces, are closely inter-related to each other. In particular, our study makes it clear that the increase of diffusivity with the heat production is a natural outcome of systems in non-equilibrium steady states, which is reminiscent of the recent experimental premise that the diffusion of an exothermic enzyme is enhanced by the heat released from its own catalytic turnover. Compared with freely diffusing exothermic enzymes, one-dimensionally ratcheted kinesin-1 is highly more efficient in converting conformational change into a locally directed motion, thus displaying a significantly higher enhancement in diffusivity with its turnover rate. The heat dissipation, velocity, and diffusivity quantified from our analysis also allow us to evaluate the energetic cost for determining the position of a transport motor with a given precision. We find that compared to myosin-V or dynein, less thermodynamic cost is needed to extract information of position for kinesin-1.

Keywords:
kinesin,enhanced diffusion, active particle, effective diffusion constant,thermodynamic uncertainty relation

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D1.02
2016.10.19 - 2016.10.21

Tau- & Taxol-mediated Microtubule Architectures

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Abstract:

Microtubules (MTs) are protein nanotubes comprised of straight protofilaments (PFs), head to tail assemblies of $\alpha\beta$-tubulin heterodimers. MTs are involved in intracellular trafficking, cell division and maintain cell shape. Tau, an intrinsically disordered protein (IDP) expressed in neuronal axons, binds to microtubules and regulates their dynamics. Tau dysfunction is linked to neurodegeneration but the molecular mechanism of Tau-induced microtubule bundling remains unknown. Taxol, a cancer chemotherapeutic agent is known to suppress the MT dynamics. In this talk, we describe our recent findings on taxol & tau's regulatory roles on the interactions between tubulins as well as between MTs, by using synchrotron small angle x-ray scattering (SAXS) and transmission electron micrograph (TEM).

Keywords:
Microtubule,Tau, Taxol, SAXS, TEM

Tinnitus as a neural net property

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Abstract:

Tinnitus is a persistent noise that people hear without an external source. Although many people suffer from tinnitus, reliable treatment and the fundamental cause of tinnitus have not yet been revealed. In this research, we simulate hearing in a computer with a model of the basilar membrane and an artificial neural network (ANN). In the simulation, we find that the ANN sometimes falsely recognizes noise as a signal. This is similar to a symptom of tinnitus. As a result, tinnitus occurs as an intrinsic property of the neural net.

Keywords:
Tinnitus, Machine learning

Pattern recognition of complex sounds with background noise

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Abstract:

In the pure-tone detection of hearing, an appropriate noise level may improve pure-tone detection. To investigate the hearing mechanism in noisy environments, we perform hearing tests of Korean syllables with various levels of white noise. We found that the recognition rate of some syllables has non-monotonic dependence on the background noise level. When we performed similar tests with a machine-learning speech recognition system, we found the a similar hearing enhancement when the system was insufficiently trained. These findings imply that the phenomenon comes from the central nervous system.

Keywords:
Pattern recognition ,complex sound,machinelearning

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D1.05*
2016.10.19 - 2016.10.21

Multiphasic Fusion in Auditory Inner Hair Cell Synapses

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Abstract:
In a cochlea, almost 90 percent of the auditory afferent neurons are distributed on inner hair cells, where there is a special structure called the ribbon synapse. It is widely believed that reliable and fast synaptic transmissions are possible due to the ribbon synapse. Recently, an interesting phenomenon has been found in excitatory postsynaptic currents (EPSCs) of the ribbon synapse--multiphasic EPSCs. In this phenomenon, EPSC rises and falls in a non-monotonic manner. We investigate whether multiphasic EPSCs are caused by compound exocytosis which is a recent popular hypothesis. We model the structure of the compound vesicles and simulate the dynamics of the glutamate in the vesicles using a random-walk model. In contrast to the above hypothesis, our simulation shows that the compound vesicles do not lead to multiphasic EPSCs. This is because there are no sufficient time intervals between each EPSC.

Keywords:
Ribbon Synapse, Hearing, Multiphasic EPSC

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D1.06*
2016.10.19 - 2016.10.21

Auditory Transduction using Artificial Basilar Membrane with Its Machine Learning System

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Abstract:

In cochlea, the basilar membrane performs spectral analysis by possessing various peak positions for various signal tones. The frequency resolution of the membrane itself, however, is not great due to mechanical damping of the membrane. This problem can be overcome through pattern recognition of the neural processing in auditory systems. Here, we introduce our efforts to design and fabricate an artificial membrane with a neural network that shows high frequency resolution and simple speech recognition.

Keywords:
Basilar membrane, Pattern Recogniton, Hearing

Terahertz nanophotonics based on metallic nanogaps

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Abstract:

This presentation will be given in the field of terahertz (THz) spectroscopy based on nanogap antennas in a thin metal film for a convergence of optics and electronics. Our first approach is to explore optics at nanometer scale for milli-meter wavelengths, in THz region, leading to unprecedented electric field enhancement when the incident long-wavelength light impinges into 1 nm-wide gaps. Atomic layer lithography overcame a technological challenge by combining photolithography and atomic layer deposition (ALD) to create 1-nm-wide vertical gaps that form centimeter-scale loops. This combination of the THz nanotechnology and the wafer-scale nanogap production would enable new and potentially revolutionary experiments at the nanometer regime with high throughput and reproducibility, which will have an immediate and significant impact for 2D material plasmonics, thin film sensing, fingerprinting of chemical/biological molecules, and high-temperature superconductor applications in THz region.

Keywords:
terahertz spectroscopy, nanogap, atomic layer lithography

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D2.02
2016.10.19 - 2016.10.21

Proposing all-optical petahertz device

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Abstract:
Considering the optical-field-induced current in dielectrics driven by a single strong few-cycle laser pulse, we propose an asymmetric conducting of the current by forming a heterojunction made of two distinct dielectrics with a low hole mass and low electron mass, respectively. This introduces the novel concept of a petahertz diode to rectify the current in the petahertz domain. Furthermore, extending to a model of the double-pulse excitation, we find that, in an all-optical way of the double-pulse quantum interference, a simple integrated processing of switching, amplification, and rectification based on the same heterojunction would be enabled, materializing prototypes of the petahertz logic gates or logic gate processors.

Keywords:
optical-field-induced current,dielectric, petahertz device

Characterization of ultrashort mid-IR pulse by phase-sensitive surface nonlinear optical spectroscopy

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Abstract:

Tunable ultrashort mid-IR pulse (l: 2~10 mm) has been intensively utilized for nonlinear optical and time-resolved spectroscopies. In this study, we investigated a phase- and an amplitude of ultrashort, broadband, mid-IR pulse generated from optical parametric amplification (OPA) and difference frequency generation (DFG). We constructed nonlinear optical interferometer consisting of two reference surfaces (quartz and GaAs) generating surface sum-frequency signal from the combination of incident ultrashort mid-IR (~ 3 mm) and the 800 nm narrow band NIR pulses. In the optimized condition for which the maximum of the seed OPA input to the DFG stage is matched with the gain maximum of the DFG crystal, the spectrum showed a smooth envelop with a uniform fringe pattern from the interference. When the DFG crystal is detuned from the phase-matching condition, on the other hand, we found relatively broader band of the mid-IR pulse having two peaks in the spectrum. A node between the above two peaks in the middle of the interferogram is accompanied by a jump in the spectral phase.

Keywords:
Nonlinear optics, Interference

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 D2.04*
2016.10.19 – 2016.10.21

Displacement measurement using an optoelectronic oscillator with an intra-loop Michelson interferometer

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Abstract:

We report on precise measurement of small displacement using an optoelectronic oscillator (OEO) with an intra-loop Michelson interferometer. In comparison with homodyne or heterodyne detection, where displacement shows up as either a power change or a phase shift, respectively, in the OEO detection displacement produces a shift in oscillation frequency. Because frequency is usually the easiest quantity to measure, OEO detection method provides unique advantages. Our apparatus is similar to that of heterodyne detection: a special modulator produces a sideband which is polarized orthogonal to the carrier. A polarizing beam splitter sends the two beams to orthogonal arms of a Michelson interferometer. Unlike the heterodyne detection, however, because the interferometer is a part of an OEO loop, the phase shift induced by mirror displacement results in a shift in oscillation frequency. In order to avoid nonlinear response of the OEO to a displacement, the OEO is phase locked to a stable oscillator and the correction signal is measured to extract displacement. We operate our apparatus in both heterodyne and OEO detection scheme to compare performances. Operating frequency is 80 MHz with a free spectral range of 1.8 MHz. The device is placed on an active vibration isolation stage, and housed in a vacuum chamber. Standard deviations in both schemes are similar and they are largely limited by environmental perturbation in spite of our isolation efforts. With 10 ms measurement time, standard deviation from both measurements is smaller than 20 pm.

Keywords:
OEO, Optoelectronic oscillator, Michelson inteferometer, Heterodyne detection, Displacement measurement

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2016.10.19 - 2016.10.21

Transmission characteristic of terahertz waves modulated by film thickness of nano-resonators

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Abstract:
Nano-resonators with desired resonance frequency and high field enhancement are highly demanded in many applications including high harmonic generation, molecular sensing, and non-linear optics. For such purposes various parameters of the nano-resonators including gap width, loop length and period have been optimized, while the effect of metal thickness on the performance of the resonators remained elusive. Here, we theoretically and experimentally investigate resonance frequencies and field enhancements in sub-10 nm-wide nano-resonators with different metal thicknesses. Scope of this study encompasses thicknesses as small as 10 nm, accessing by far the thinnest terahertz nano-resonators reported in the literature. Thinner resonators incorporate blue-shifted resonance frequencies and higher field enhancements, which is attributed to gap plasmon enhanced gap-air coupling. Modal-expansion analysis quantitatively supports the experimental results.

Keywords:
Nano-resonators, Terahertz, Modal-expansion, Thin film

Microwave and Millimeter-wave Funneling through Nanogaps

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Abstract:

We demonstrate microwave and millimeter-wave funneling through metallic gaps of nanometer-scale width, corresponding to $\lambda/10,000,000$. We fabricate a nanogap sample with an extreme aspect ratio: sub-10 nm wide rectangular rings with a perimeter of 6.5 mm. Considering the peak transmittance value of 45% and the small coverage ratio of transparent area in the nanogap surface, we can infer a giant intensity enhancement factor of up to 25 million inside the nanogaps. We also measure terahertz transmittance and observe a convergence to the microwave range. Our work represents the highest field enhancement recorded for the microwave regime, made possible by wafer-scale-length nanogaps matching the wavelengths, with future applications in centimeter wave nonlinearities and enhanced detection sensitivities.

Keywords:

light confinement, microwave, terahertz spectroscopy, nanogap, atomic layer lithography

THz Spectral Filling by Complementary Tandem Configuration

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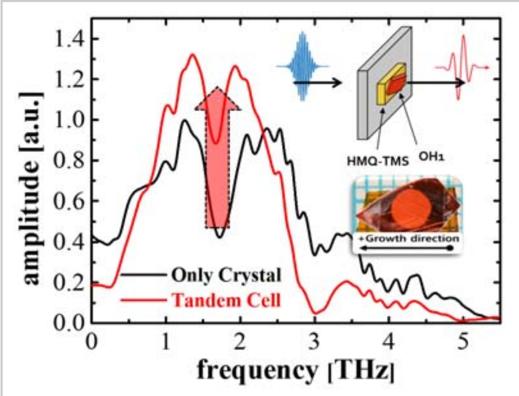

Abstract:

Recently, nonlinear optical organic crystals have been proposed as promising materials for generating and detecting broadband THz waves delivering high electric fields. Because they possess much larger optical nonlinearities, excellent optical-to-THz energy conversion efficiency at room temperature than those of inorganic crystals, controllability of phase matching condition, and simple technique in crystal growth. But, it is hard to possess the various excellent properties in a single crystal concinnously. Also there is a various emission gap caused by the strong absorption of phonon modes related to the intrinsic constituent consisting of the crystal molecules. It is hard to suppress the influence of phonon mode without change of intrinsic material properties, which is previously possible only with change of chemical structure. So this intrinsic problem should be solved in collaboration with another field. In this paper, the spectral gap was efficiently overcome in in nonlinear organic crystal by using a tandem configuration widely used in semiconductor industry for the first time. Tandem cell exhibits THz spectral shaping and enhance optical-to-THz conversion efficiency compared to single THz sources. Furthermore, the conversion efficiency and spectrum can be further improved by complementary multi-junction for suppression of various phonon absorption as well as a proper phase matching conditions.

Keywords:
Terahertz wave, Nonlinear organic crystal, Tandem configuration

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MBE growth of III-V based nano structures for the application to low-power consumption III-V CMOS on Si for Post-Si Era

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Abstract:
In KIST, 5(+3) MBE systems are installed for the study of low dimensional structures. With the MBEs, we are in the middle of studying; As/P/Sb-based materials with new properties, High speed 3-5 2DEGs/2DHG for physics (mesoscopic physics, Topo. Insul. etc), high speed, and low power consumption electronics, Digital-alloyed 2D structures for QCL, QWIP, LD, PDs, Catalyst free/Au-assisted GaAs/ InAs / InP /InSb nano-rod 1D structures for SPS or Nano TR etc., Various kind of semi-conductor QDs grown by SK, MEE, and Droplet methods. With these MBE systems, the researchers in KIST published more than 300 SCI articles include Science (2009) and Nature (2013), more than ~10 Nature sisters/ PRL/Nano letters. Scientists have pioneered the first stages of Si electronics, and now a new frontier in semiconductor electronics is arising. We will introduce contemporary issues associated with breaking new ground in the post-Si-era for semiconductors and discuss the research activities in the recently launched Post-Silicon Semiconductor Institute at KIST. In this presentation, Iwill show MBE systems & activities with them in KIST and discuss probable co-works.

Keywords:
MBE growth of III-V based nano structures for the application to low-power consumption III-V CMOS on Si for Post-Si Era

Growth control of In(Ga)As/GaAs quantum dots and their application in optoelectronic devices

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Abstract:
Strain-induced self-assembled In(Ga)As/GaAs quantum-dot materials have attracted much attention since 1990s, due to their unique properties compared with quantum-well and bulk materials, and their promising capabilities in novel quantum device applications. Great efforts have been devoted to the growth technique and structure optimization of the quantum dots since then, in order to develop high-performance optoelectronic devices. In this talk, I will review the research works on MBE growth of In(Ga)As/GaAs quantum-dot materials in our laboratory, focusing on the growth control in this highly mismatched material system in order to have size-uniform, density-controllable and wavelength-selectable quantum dots, and on strain management in large-size, multi-layer QD materials so as to release the accumulated strains and achieve defect-free QD materials for device application. Then I will introduce our work on some of the QD-based optoelectronic devices, including high power, long-lifetime quantum-dot lasers, 1.3mm quantum-dot lasers on GaAs substrates, and quantum-dot photo-detectors.

Keywords:
quantum-dot , optoelectronic devices

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Growth of Group III-Nitride Semiconductor Nanostructures and Their Photonic Applications

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Abstract:
Although considerable effort has been devoted for developing high-efficiency and high-power light emitting devices, there still exist serious problems such as large density of dislocations, poor material quality of high-In-content InGaN (i.e., green gap), strong built-in internal electric field along the c-axis growth direction, efficiency droop in high carrier injection, etc. Low-dimensional semiconductor nanostructures such as quantum dots and nanorods have attracted a lot of attention due to their rich and unique optical properties. In this talk, we present various types of group III-nitride semiconductor nanostructures and their versatile photonic and quantum photonic applications. GaN-based pyramidal, annular, columnar, and tapered structures were successfully fabricated by means of metal-organic chemical vapor deposition and/or chemical etching techniques. These GaN nanostructures were used as new templates, on which InGaN/GaN quantum wells structures were grown for demonstrating broad-band multi-color visible light emission, intriguing unidirectional photonic diode behavior, and ultrafast and high efficiency single photon generation. An overview and comparison of the characteristics of the above nanostructures will be given.

Keywords:
Growth of Group III-Nitride Semiconductor Nanostructures and Their Photonic Applications

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Interfacial orbital alignment of C_{60}/DTDCTB/PEDOT:PSS/ITO for organic photovoltaics

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Abstract:
A small molecule having a narrow-band gap and push-pull structure has been received great attention for its ability to absorb light at long wavelengths, leading to organic photovoltaics (OPVs) with high power conversion efficiencies (PCE). Among them, ditolylaminothienyl-benzothiadiazole-dicyanovinylene (DTDCTB), which consists of donor-acceptor-acceptor (D-A-A) configuration, was reported as showing the high PCEs when combined with fullerene acceptors. To adapt it in various OPVs, understanding the electronic structure of DTDCTB is necessary. However, a detailed electronic structure of DTDCTB itself and orbital line-ups at the DTDCTB/C_{60} interface have not been reported yet although it determines the device performance decisively. In this study, we investigated the interfacial orbital line-ups at the DTDCTB/C_{60}/ poly (3,4-ethylenedioxythiophene):poly(styrenesulfonate)/ITO interfaces using in situ ultraviolet photoelectron spectroscopy and inverse photoelectron spectroscopy. The photovoltaic gap, which is defined as the energy difference between the HOMO level of a DTDCTB donor and the LUMO level of a C_{60} acceptor, was evaluated 1.30 eV. This is known to be the theoretical maximum value of the open-circuit voltage in OPVs. Furthermore, a low hole extraction barrier of 0.42 eV was evaluated with large band bending of 0.65 eV in the DTDCTB layer. These favorable electronic structures of DTDCTB contribute to the high PCE in OPVs.

Keywords:
UPS, IPES, interfacial orbital line-up, DTDCTB, C_{60}

Gate dependent non-local spin resistance and symmetry of spin-orbit scattering in an Au-patched graphene

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Abstract:

The primary research in spintronics is the creation, manipulation, and detection of a spin current in addition to a charge current to extend the capability of current electronic devices. Particularly, spintronic applications of a graphene have received growing attention in recent years due to the perceived long spin coherent time. Engineering the electron dispersion of a graphene to be spin dependent is a key strategy to realize fully functional spin logic devices. The spin Hall effect arising from a spin orbit coupling can be adapted to electrically generate or detect a spin current in the spin logic device without a ferromagnet. Recently, spin Hall effect in chemically and physically decorated graphenes has been experimentally observed by nonlocal measurement. However, the nonlocal signals in graphene hall bar devices exploiting spin Hall effect have been under controversy. In this study, we introduced an ultra-thin Au-patch on a graphene surface to enhance the spin-orbit coupling, and employed an H-bar type device to probe the nonlocal spin signal induced by spin Hall effect. The geometry of the studied H-bar devices has channels of 1 mm width and 4 mm length. An ultra-thin Au patch (1 nm) was deposited by a thermal evaporation. The observed non-local signals in the studied devices displayed strong gate-dependent fluctuations. And in-plane field dependent spin precession signature can be observed at particular gate voltage. At that point, spin hall angle and spin relaxation length of the Au-patch graphene device were g ~ 8.8 % and λ_s ~ 2.2 mm at 2 K, respectively. Spin relaxation rates were proportional to square of temperature with increasing temperature, indicating an Elliott-Yafet spin relaxation mechanism.

Keywords:
graphene, spin current, spin hall effect, nonlocal measurement, Elliot-Yafet mechanism

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Plasmon Activating Effective Optical Waveguide of Hybrid Crystals Based on Organic and Nanoscale metals

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Abstract:

We demonstrate the enhancement of the photoluminescence (PL) and optical waveguide performance of functional organic crystals (OCs) through incorporated with nanoscale metals. We observed nanoscale laser confocal microscope (LCM) PL characteristics of the OCs drastically varied with silver nanoparticles (NPs). In optical waveguiding experiments, the propagation characteristics of optical signals along the single OC were dependent on the existence of the silver NPs. For the hybridized with silver NPs, the waveguiding PL signals of OC had relatively higher output, indicating the strong optical energy transfer. Additionally, the waveguiding characteristics such as decay constant along the OC considerably decrease the optical loss in hybrid OCs. It is remarked that the effective surface plasmon resonance (SPR) coupling between organic crystal and nanoscale silver NPs can be significantly activating luminescence propagate without optical loss.

Keywords:

plasmon, optical waveguide, organic crystal

실크 기판 위에 구현된 멜라닌 광스위칭 채널

조민식[1], 민예림[1], 민경택[1], 김성환[*2]
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Abstract:
멜라닌은 피부와 머리카락에 존재하는 색소 물질로, 반도체 특성과 광스위칭 특성을 지녀 유기 전자소자의 능동 구성 물질로 많은 관심을 받아왔다. 본 연구에서는 생체 친화 고분자인 실크 단백질 기판 위 멜라닌 나노입자로 구현된 선형 채널을 형성하여, 이들의 광스위칭 현상을 관측하였다. 일정 전압을 걸어준 상태에서 소자를 레이저 빛에 노출시켰을 때 전류의 크기가 증가하는 것을 확인하였다. 이 연구는 향후 바이오 전자소자의 응용 범위를 넓혀 생체 조직 위에서 안정적으로 동작하는 기능성 소자 제작의 가능성을 보여준다.

Keywords:
바이오 전자소자, 멜라닌, 실크 단백질

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2016.10.19 - 2016.10.21

Study of carrier mechanism of ITO/PI/TIPS-Pentacene/Au diode by using electrical and optical measurements

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Abstract:

The carrier mechanism in actual organic devices is not so simple, owing to the dielectric nature of active organic semiconductor layers, the complexity of the interfaces, trapping effect by stress biasing, and others. By coupling the conventional current-voltage, capacitance-voltage, capacitance-frequency measurements and charge modulation spectroscopy (CMS) optical measurement system, we studied the hysteresis behavior and the temperature dependence of indium tin-oxide/polyimide/6,13-Bis(triisopropylsilylethynyl)-pentacene (TIPS-Pentacene)/Au diode to understand the effect of trapping caused by injected carriers in terms of the carrier mechanism. The coupled electrical and optical measurements were shown to be helpful to clarify carrier injection that followed by carrier trapping, in terms of hysteresis behavior. By making use well of the CMS measurements, we observed energy states of carriers in TIPS-Pentacene double-layer diode. Finally, the carrier mechanism in organic semiconductor devices was discussed by analyzing the diode as a Maxwell-Wagner effect element, on the basis of dielectric physics.

Keywords:
TIPS-Pentacene, Hysteresis behavior, Maxwell-Wagner effect model, Trapping mechanism.

Mobility and Bias Stability of Organic Field-Effect Transistors with Self-Assembled Monolayer Treatment

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Abstract:

We investigated the relationship between the mobility and bias stability of organic field-effect transistors (OFETs) regarding a self-assembled monolayer (SAM) treatment. For this systematic study, four types of silazane-based SAMs with different alkyl chain lengths in the range of 1 to 8 were employed. The direct proportional relationship between the mobility and SAM alkyl chain length was observed. The mobility was increased from 0.29 cm^2/Vs without SAM to 0.46 cm^2/Vs, 0.61 cm^2/Vs, 0.65 cm^2/Vs, and 0.84 cm^2/Vs after the SAM-treatment with an alkyl chain length of 1, 3, 4, and 8, respectively. On the other hand, inverse proportional relationship was observed between the bias stability and SAM alkyl chain length. Under the gate bias stress for 2 hours, the bias-stress-induced threshold voltage shift of the OFET was decreased from 12.19 V without SAM to 5.69 V with a short SAM-treatment (alkyl chain length of 1), and 7.14 V with a long SAM-treatment (alkyl chain length of 8). To overcome this tradeoff relationship between the mobility and bias stability of OFETs regarding a SAM-treatment, we employed a two-step SAM-treatment; Sequential treatment of long SAM and short SAM. As a result, both the high mobility and good bias stability were achieved. With two-step SAM-treatment, the OFET showed high mobility as a long SAM-treated OFET and good bias stability as a short SAM-treated OFET.

Keywords:
Organicfield-effect transistors, Self-assembled monolayer, Bias stability

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2016.10.19 - 2016.10.21

All-protein-based single mode distributed feedback laser

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Abstract:
Distributed feedback (DFB) lasers are attractive in many applications such as bio/chemical sensors due to lower thresholds and single mode lasing with narrow resonance. Conventionally organic dyes are used as a gain material in DFB lasers, however the exogenous addition of dye material degrades the biocompatibility of lasers. Here we experimentally demonstrated a all-protein-based DFB laser using green fluorescent protein (GFP) as a gain doped in the silk protein matrix. The silk/GFP solution was coated on a quartz grating to yield the DFB laser. The fabricated laser exhibited single mode lasing at the wavelength of 522 nm and the lasing threshold at 1.5 μJ.

Keywords:
Silk fibroin, protein laser, DFB laser

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Band engineering and nanostructuring in the vicinity of breakdown of topological crystalline insulator in Pb-based multiple elements doped compounds

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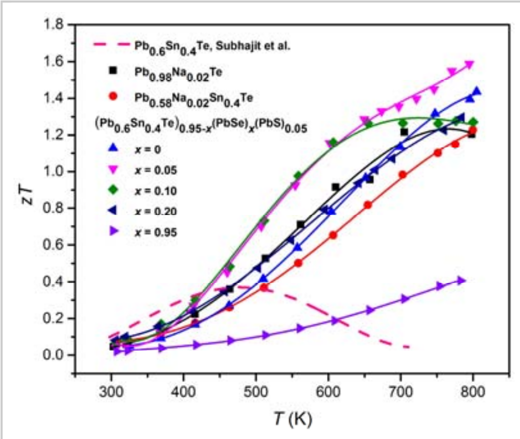
Abstract:



It was reported that the Na doping in topological crystalline insulator $Pb_{0.6}Sn_{0.4}Te$ breaks the crystal symmetry and opens up a bulk electronic band gap, which suppresses the bipolar conduction, resulting in an increase of zT = 1 at 856 K [1]. In the present work, we further improve the thermoelectric performance by introducing band engineering and nano-precipitation, which have been a promising enhancement in zT values for PbTe-PbSe, PbTe-PbS binary systems [2, 3]. Here, we demonstrate thermoelectric properties of multiple elements doped system of 1% Na-doped $(Pb_{0.6}Sn_{0.4}Te)_{0.95-x}(PbSe)_x(PbS)_{0.05}$ (x = 0, 0.05, 0.10, 0.20, and 0.95). Comparing with $Pb_{0.98}Na_{0.02}Te$ and $Pb_{0.58}Sn_{0.4}Na_{0.02}Te$, the compounds are aimed to the simultaneous emergence of band engineering and nano-precipitation by PbSe doping and PbS precipitation, respectively. The optimized zT value (1.59 at 800 K) has been found for x = 0.05 compound, which is about 33% and 59% higher than those of $Pb_{0.98}Na_{0.02}Te$ and $Pb_{0.58}Sn_{0.4}Na_{0.02}Te$ compounds, respectively. Furthermore, we display significantly enhanced engineering figure of merit (zT_{eng}), engineering power factor (PF_{eng}), thermoelectric efficiency (η), and output power density (P_d). In addition, the Sn-doping can decrease of the use of Pb which has been regarded as environmentally unlikely elements. The result paves a way for potential application in thermoelectric material. Reference [1] S. Roychowdhury, U. S. Shenoy, U. V. Waghmare, and K. Biswas, Angew. Chem. Int. Ed. 54, 15241 (2015) [2] Y. Pei, X. Shie, A. LaLonde, H. Wang, L. Chen, and G. J. Snyder, Nature. 473, 66 (2011) [3] S. N. Girard, J. He, X. Zhou, D. Shoemaker, C. M. Jaworski, C. Uher, V. P. Dravid, J. P. Heremans and M. G. Kanatzidis, J. Am. Chem. Soc. 133, 16588 (2011)

Keywords:
Topological crystalline insulator,band engineering,nano-precipitation

Theoretical and experimental study: Enhancement of Thermoelectric performance in SnTe through the negative correlation effect between thermos-power and carrier density with Ag doping.

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Abstract:
p-type SnTe has a potential to be a good thermoelectric (TE) material for power generation device by optimization of carrier density. However, it is very difficult to control carrier density in SnTe by some dopant doping. In the previous reports, the carrier density is increased for either type of dopant doping and although the carrier density increase, the TE performance is enhanced. Therefore, we want to confirm the reason of carrier density increasing and enhancement of Seebeck coefficient with dopant. We theoretically confirm that the Sn vacancy and Ag complex defect can be increased by Ag substitution in Sn site. The enhancement of carrier density is caused by increased Sn vacancy with Ag doping and Seebeck coefficient is increased by increased ionized scattering. Thereby, the enhanced impurity scattering with Ag doping lead to electrical conductivity decreasing due to exponential decay of electrical mobility. As a result, the electrical conductivity and carrier density are separately reacted by Ag doping and then this phenomenon represented negative correlation between power factor and thermal conductivity. Therefore, the TE performance is enhanced, which behavior do not be concerned the dopant cation. This research suggests that the possibility of lattice and defect control will be important than carrier concentration in SnTe system and hole dopant also can be critical candidates for enhancement of SnTe TE performance.

Keywords:
Thermoelectric, Sn vacancy, power factor, SnTe

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2016.10.19 - 2016.10.21

Barrier blocking by nanoinclusion enhancement thermoelectric efficiency of low doped n- type $(PbTe_{0.84-x}Cl_x)$ - $(PbSe)_{0.07}$ - $(PbS)_{0.07}$

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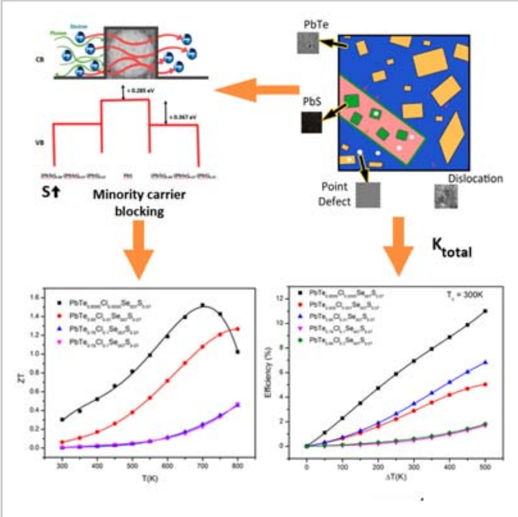
Abstract:

The efficiency of thermoelectric material is limited by the material thermoelectric figure of merit (ZT). Recently, many work have been done to improve ZT by nanostructured and band structure. However, nanostructured cannot reduce lattice thermal below amorphous limit. Here, we explored enhancing power factor of n type $PbTe_{0.84-x}Cl_x$-$PbSe_{0.07}$-$PbS_{0.07}$ (x = 0.0005) by small doping carrier through an energy barrier. Suck small doping results in an increasing ZT in n type of $PbTe_{0.84-x}Cl_x$-$PbSe_{0.07}$-$PbS_{0.07}$ to 1.58 at 750 K, which is the state-of-the-art value for n-type PbTe based materials.



Keywords:
nanoinclusion,nanoinclusion,figure of merit (ZT)

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2016.10.19 - 2016.10.21

Thickness-Dependent Lattice Thermal Conductivity of MoS_2 and Effect of Point Defects

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Abstract:
Thermal conductivity plays an important role in the efficiency of thermoelectric figure of merits (ZT). The ZT is expressed as $ZT=(S^2\sigma)T/(k_e+k_l)$, where σ is electrical conductivity, S is Seebeck coefficient, and k_l and k_e are thermal conductivities contributed by phonons and electrons, respectively. Reducing the thermal conductivities and enhancing the power factor ($S^2\sigma$) can improve the thermoelectric efficiency. In order to improve thermoelectric efficiency, it is essential to evaluate accurately the fundamental thermal conductivities. Determining the intrinsic lattice thermal conductivities of atomically thin layer materials is not trivial and its thickness-dependence is still controversial. In the cases of graphene and some h-BN samples, experimental and theoretical studies have shown the tendency of increasing thermal conductivity as decreasing the layer thickness [1-2], but for other h-BN samples and MoS_2, experiments have shown the tendency of decreasing thermal conductivity as decreasing the lather thickness [3]. In this study, we investigate the thickness-dependence of the lattice thermal conductivities of MoS_2, and show that it increases as the number of layer decreases. We suggest that the decreasing behavior of the thermal conductivities, measured in experiments, is due to extrinsic effects, such as increased density of S vacancies, which can be formed during the fabrication of thin layers. The S vacancies are found to reduce remarkably the lattice thermal conductivity in MoS_2. [1] S. Ghosh et al., Nat. Mat. 9, 555 (2010). [2] Insun Jo et al., Nano Lett. 13, 550 (2013). [3] L. Lindsay et al., Phys. Rev. B 84, 155421 (2011).

Keywords:
Thermal conductivity, MoS_2, Layer materials

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2016.10.19 - 2016.10.21

The structural and transport properties of Sb_2Te_3 thin films grown on GaSb/Si(111) by molecular beam epitaxy

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Abstract:

Sb_2Te_3 is well-known thermoelectric (TE) material for room temperature applications. Sb_2Te_3 is a layered narrow-gap semiconductor with a band gap of about 0.3 eV. The material has rhombohedral unit cell with lattice constants a = 4.264 Å and c = 30.458 Å. Up to now, the growth high quality Sb_2Te_3 thin films still is required. In this work, we grown Sb_2Te_3 thin films on Si (111) using GaSb buffer layer by Molecular Beam Epitaxy (MBE), growth temperature from 175 °C ÷ 300 °C. The Reflection High Energy Electron Diffraction (RHEED) and X-ray diffraction results indicated that films were epitaxial grown on GaSb/Si(111). The reflection high energy electron diffraction (RHEED) and X-ray diffraction (XRD), Physical Property Measurement System (PPMS), Raman spectroscopy, Atomic Force Microscope (AFM) were used to analysis the structural, transport, of these films. The structural detail and transport properties will be discussed.

Keywords:

Thermoelectric, Layered semiconductor, epitaxy

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Genes for unconventional high temperature superconductors

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Abstract:

Both curates and iron-based superconductors were discovered accidentally. Lacking of successful predictions on new high Tc materials is one of major obstacles to reach a consensus on high Tc mechanism. Here we explain that necessary electronic environment for unconventional high Tc superconductivity. The necessary condition explains the rareness of unconventional high Tc superconductivity and can serve as guiding rules to search for new high Tc materials. We predict that the third family of unconventional high Tc superconductors exist in the compounds which carry two dimensional hexagonal lattices formed by cation-anion trigonal bipyramidal complexes with a d^7 filling configuration on cation ions. Their superconducting states are predicted to be dominated by a d+id pairing symmetry and their maximum Tc should be higher than those of iron-based superconductors. Verifying these predictions can convincingly establish high Tc superconducting mechanism and pave a way to design new high Tc superconductors.

Keywords:
Genes for unconventional high temperature superconductors

How to determine the pairing interaction of cuprate superconductors

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Abstract:
After all thirty years of intense research into high Tc cuprate superconductivity, the pairing mechanism ever remains elusive. One may wonder why - why the high Tc problem is so difficult. This talk is my half hour answer to that question. It was established for cuprates as well that superconductivity is also from pairing, but of the d-wave symmetry. Leading ideas for high Tc pairing mechanism consistent with the d-wave symmetry are the resonating valence bond, the loop current order, and the antiferromagnetic spin fluctuations scenarios. The root of the high Tc conundrum lies in the requirement that the superconductivity must be understood together with the pseudogap and anomalous normal states in their totality. Perhaps one of the best ways to differentiate among the proposals is to determine the frequency and momentum dependence of the self-energy from experiments and compare it with the proposed ideas. This procedure may be implemented by using the ultra high resolution laser angle resolved photoemission spectroscopy (ARPES). The extracted self-energy from Korea-China-US collaboration from ARPES analysis of Bi2212 cuprates will be presented and discussed from this perspective. # Supported by Samsung Science & Technology Foundation SSTF-BA1502-06. * J. M. Bok, J. J. Bae, H.-Y. Choi, C. M. Varma, W. Zhang, J. He, Y. Zhang, L. Yu, and X. J. Zhou, "Quantitative determination of pairing interactions for high-temperature superconductivity in cuprates", Science Advances 2, e1501329 (2016). * Seung Hwan Hong, Jin Mo Bok, Wentao Zhang, Junfeng He, X. J. Zhou, C. M. Varma, and Han-Yong Choi, "Sharp low energy feature in single-particle spectra due to forward scattering in d-wave cuprate superconductors", Physical Review Letters 113, 057001 (2014).

Keywords:
cuprates, superconductivity, pairing, self-energy, ARPES

Pairing Mechanism of the FeSe-monolayer and related Systems

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Abstract:

Since the discovery of the Fe-based superconductors 8 years ago, still the pairing mechanism of this new class of superconducting material is under debate. More recently, the discovery of the FeSe/SrTiO3 monolayer system (Tc~60-100K) and other heavily electron-doped iron selenide (HEDIS) compounds such as $A_xFe_{2-y}Se_2$ (A=K, Rb,Cs, Tl, etc.) (Tc~ 30-40K), $(Li_{1-x}Fe_xOH)FeSe$ (Tc~40K) , and pressurized bulk FeSe (Tc~37K) are posing a serious challenge to our understanding of the Iron-based superconductors (IBS). In this talk, I will propose a unified pairing mechanism for all these compounds with introducing a new concept: dynamical tuning of pairing cutoff energy. Utilizing this new concept, the above mentioned systems -- all commonly have the hole Fermi surface missing -- tune the pairing cutoff to the incipient band energy ε_b and form the s^{++}-wave gap state only with the electron pockets. In this way, the system can achieve the maximum T_c latent in the systems and becomes robust to the impurity scattering.

Keywords:
Fe-based superconductors, Pairing mechanism, FeSe-monolayer system

Holography of Dirac fluid with two currents in Graphene

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Abstract:
Recent experiments have uncovered evidence of the strongly coupled nature of the graphene: the Wiedemann-Franz law is violated by up to a factor of 20 near the charge neutral point. We describe this strongly-coupled plasma by a holographic model in which there are two distinct conserved U(1) currents. We find that our two current model has a significantly improved match to the experimental data than the models with only one current. We discuss the possible origins of the two currents.

Keywords:
Transports, Non-Fermi Liquid, Graphene, BlackHole

Anomaly Manifestation of Lieb-Schultz-Mattis Theorem and Topological Phases

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Abstract:

Relying only on microscopic information, Lieb-Schultz-Mattis theorem constrains the possible low-energy spectrum of long-distance theory emergent from lattice. The theorem dictates that the emergent state cannot be a trivial insulator if the filling per unit cell is not integral and if translation symmetry and particle number conservation are strictly imposed. By investigating symmetric gapless states which are forced to be critical by the theorem, we show that the theorem, the absence of a trivial insulator phase at non-integral filling, manifests itself as quantum anomaly at low-energy limit. We further show that the anomaly of the gapless states emergent from lattice can be clearly exhibited by identifying the gapless states with the boundary of the symmetry-protected topological phases, where the non-local translational symmetry of the lattice is encoded as some local symmetry in the topological phases. Hence, the boundary of the topological phases is realized in a stand-alone lattice model, and the no-go theorem for the boundary is circumvented, similar to the recent discussions of half-filled Landau levels and topological superconductors. Hence we provide a unifying view of Lieb-Schultz-Mattis theorem, quantum anomaly, and symmetry-protected topological phases.

Keywords:
topological insulator,Lieb-Schultz-Mattis theorem

Coulomb anomaly at the Mott-Anderson metal-insulator transition

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Abstract:

In Anderson insulators the Coulomb interactions between localized electrons remain essentially unscreened and give rise to a strongly correlated low temperature state, the so-called electron or Coulomb glass. This state of matter is expected to occur in strongly doped, but insulating semiconductors, in granular metals, as well as in dirty thin metal films. Such systems were long ago predicted to exhibit glassy properties due to their inability to reach the ground state on experimental time scales. The latter leads to experimentally observable out-of-equilibrium phenomena such as the slow relaxation of conductivity and compressibility, aging as well as memory effects. We study the low temperature phase and the transport behavior of the three-dimensional Coulomb glass within a Hartree-Fock treatment of disordered, Coulomb-interacting spinless fermions. We see that, in the regime of weakly disordered metals, the local density of state has a dip at the Fermi level with due to the Altshuler and Aronov corrections. In the insulating regime, the Ldos at the Fermi level shows either the classical behavior (Efros-Shklovskii gap) or the exponential law , depending on the degree of compensation. In doped semiconductors, the former is attributed to the coulomb interaction of an isolated particle-hole pair whereas the latter is associated to the polaronic interaction mediated by multiple particle-hole excitations. We discuss the mechanism behind the Coulomb anomaly at the Mott-Anderson metal-insulator transition and prospects for the realization of Coulomb glass phases in correlated electronic systems.

Keywords:
Anderson insulator, disorder, Coulomb glass

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Impurity-driven Insulator-to-Metal Transition in VO_2

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Abstract:

How is a relation between impurities and the insulator-to-metal transition (IMT) explained in strongly correlated systems ? A representative strongly correlated Mott insulator VO_2 ($3d^1$) has the direct gap (Δ_{direct}) of 0.6 eV and the indirect gap (activation energy) of $\Delta_{act}/2$ 0.15 eV coming from impurity indirect band. At T_c, Δ_{direct} = Δ_{act}=0 is satisfied and the IMT occurs. The metal carriers near core region can be trapped when the critical onsite Coulomb repulsion U_c between carriers exists. Then, U_c = (2/3)C(n_{tot}+N_{tot})2/3(1 + (N_{tot}/n_{tot})(1-exp(- $\Delta_{act}/k_B T$))) is expressed by simple calculations in terms of N_{tot}, where C is a proportional constant, n_{tot} is the carrier density in the metal band, N_{tot} is the impurity density in the indirect band. At the IMT, when Δ_{act}=0 is given and N_{tot} is excited, U_c =(2/3)C$(n_{tot}+N_{tot})^{2/3}$ (1+(N_{tot}(T)/n_{tot}) is reduced as U=(2/3)C(n_{tot}) 2/3<U_c. Then, the correlated insulator becomes metal by the breakdown of U_c --> U induced by excitation of N_{tot} from bound state to conduction band. The IMT can be switched by the doping (excitation; Δ_{act} 0, N_{tot} goes to conduction band, so N_{tot}=0) and the de-doping (de-excitation; Δ_{act} 0.15, N_{tot} is bound from conduction band to indirect band) of $\Delta\rho$=N_{tot}/n_{tot} to the bound state, by applying external parameters such as heat, pressure, doping etc. This is an impurity-driven IMT and can be applied to all strongly correlated systems. [1] New J. Phys. 6 (2004) 52. [2] J. Phys.:Condens. Matter 28 (2016) 085602.

Keywords:
Mott Insulator, Metal-Insulator Transition, Strong correlation

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Observation of a metallic chain in monoclinic VO_2 by coherent phonons

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Abstract:

VO_2, a prototypical strongly correlated material, undergoes an insulator-to-metal transition (IMT) and monoclinic-to-rutile structural phase transition (SPT) at a critical temperature $T_c \approx 340$ K. Since the IMT goes hand in hand with the SPT, clear understanding of the initiation and further pathway of the transition remains a stumbling-stone in condensed matter physics. Is it the electron-correlation-driven Mott transition, the structural-rearrangement-driven Peierls transition or their synergy (see Fig.)? In this work we clarify the obscurity through simultaneous navigation of the crystalline and electronic systems pathway on the transition by analyzing the coherent phonons dynamics. We discover two kinds of phonons, originated from a second monoclinic structure. One type, coming from antiferromagnetic insulator-chain with strong Coulomb interactions, is sensitive to the electronic state and undergoes fast damping on IMT (indicating emergence of a metallic chain after breakdown of electron-electron correlations). Another type, coming from a commensurate charge-density wave (CDW) substructure, is able to withstand corresponding screening by carriers and, thus, provide an extended monitoring of the crystalline state. These two kinds of phonons enable the discovery of the metallic chain in the monoclinic structure, thus, supporting the Mott IMT. Obtained results reveal the nature of the insulator-to-metal transition in VO_2, used as a model material. But beyond this, they contribute to understanding of driving force for emergence and evolution of different phases in other strongly correlated materials.

Keywords:
Vanadium dioxide, strongly correlated materials, metal-insulator transition, Mott transition, coherent phonons

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The trailing flexoelectric field in a system of motion with contact

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Abstract:

Strain engineering enables modification of various properties thanks to the coupling between strain gradient and polarization known as flexoelectricity. Until now, the way of utilizing flexoelectric field is far from fully understood, probably due to the lack of knowledge on the shape of the 3-dimensional flexoelectric field. Guided by phase field simulation, here we report an approach to utilize both out-of-plane and in-plane flexoelectric fields by applying force on the sample using probe tip while it is in lateral motion. During the investigation using scanning probe microscopy, the physical contact between materials and probe tip deforms the materials and induces strain gradient, resulting flexoelectric field. By adjusting scanning direction, it is possible to control the direction of flexoelectric field, that is applied to the last, which we will call trailing flexoelectric field. We demonstrate control of ferroelectric switching path in rhombohedral $BiFeO_3$ by exploiting trailing flexoelectric field. This trailing flexoelectric field should appear ubiquitously in any system under moving contact load. It can provide the functioning principle of a nanoscopic stylus pen for information record in ferroelectric domain.

Keywords:
flexoelectricity, $BiFeO_3$, phase field simulation

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2016.10.19 - 2016.10.21

In situ strain engineering of epitaxial perovskite oxide thin film

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Abstract:

Strain engineering via external compressive or tensile strain arising from a lattice mismatch between substrate and film has been employed to manipulate electromechanical behaviors of thin films comprising of perovskite oxide materials. A main stream of recent studies is a utilization of constant misfit strain by varying substrate or thickness of thin film in order to induce a constant external strain to perovskite oxide materials. However, these experimental studies have exhibited extrinsic contribution arising from boundary conditions, including interfacial or thickness effects such as space charges or depolarization fields. In order to systematically study the influence of external strain applied to thin films, it is essential to control the misfit strain without variation of substrate or film thickness. In this study, we found that strain-dependent piezoelectricity of single-domain $PbZr_{0.2}Ti_{0.8}O_3$ (PZT) and $BiFeO_3$ (BFO) films on piezoelectric $0.72PbMg_{1/3}Nb_{2/3}O_3-0.28PbTiO_3$ (PMN-PT) substrate using the electromechanical properties of substrate. A DC voltage up to 400 V is applied across the PMN-PT substrate through the oxide electrode on the substrate's top and an Ag electrode on the substrate's backside in order to control the biaxial in-plane strain of PMN-PT substrate. The biaxial in-plain misfit strain of both PZT film and PMN-PT substrate is about -0.13% when 400V was applied to PMN-PT substrate. We monitored the piezoelectric response of PZT and BFO films under a triangular electric field using time-resolved X-ray micro-diffraction technique at 9C beam line of Pohang Accelerator Laboratory. The both PZT and BFO films shows a larger decrease of piezoelectric coefficient than theoretical predictions along with an increase of tetragonality.

Keywords:
Ferroelectric, Strain dependency, in situ strain, Time resolved X-ray diffraction

Interface control of ferroelectricity in a $SrRuO_3/BaTiO_3/SrRuO_3$ capacitor in ultrathin limit

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Abstract:
The atomic-scale synthesis of artificial oxide heterostructures offers new opportunities to create novel states that do not occur in nature. The main challenge related to synthesizing these structures is obtaining an appropriate sequence of atomic layers with the level of precision required for the desired abrupt interface. Here, we demonstrate synergetic experimental and theoretical approach to producing abrupt oxide interfaces by controlling the surface termination. We fabricated prototypical $SrRuO_3/BaTiO_3/SrRuO_3$ (SRO/BTO/SRO) ferroelectric capacitors by pulsed laser deposition (PLD). Compared with unit-cell-by-unit-cell growth, which is commonly assumed to occur, the top interface of the BTO layer was reported to have a mixture of BaO and TiO_2 terminations. Using first-principle calculations, we examined the thermodynamic stability of different surface terminations of BTO. By adjusting the oxygen partial pressure, we obtained an abrupt BTO top interface with a TiO_2 termination. The interface-controlled BTO exhibits a robust ferroelectricity down to a thickness of 3.5 unit cells (u.c.)— a theoretical limit that has to date remained elusive in experiment.

Keywords:
Interface engineering, ferroelectric critical thickness, ferroelectricity, $BaTiO_3$

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New Opportunities in High Energy Density Science with PAL-XFEL

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Abstract:
The ultrafast, ultraintense, and coherent x-ray pulses generated by x-ray free electron laser (XFEL) have opened the new era for various fields of research. High energy density science (HEDS), investigating materials properties under extremely high temperature - pressures and their interactions with photons and particles, is one of those benefited enormously from the new light source. In this talk, I'll introduce possible HED experiments at PAL-XFEL, such as isochoric x-ray heating of matter, saturable and reverse saturable x-ray absorptions, ultrafast XANES for warm dense matter. The open questions and future direction of HEDS will be also discussed. This work is supported by the NRF (No. NRF-2016R1A2B4009631).

Keywords:
Xray free electron laser, high energy density science, ultrafast x-ray

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Diffracted signal enhancement by multi-particle diffraction in single-shot imaging using XFEL

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Abstract:

In usual diffraction imaging, the image resolution is determined by the incident X-ray wavelength, the numerical aperture of the detector, and the radiation damage. After the advent of X-ray free-electron laser (XFEL), it has opened up an opportunity to acquire high-resolution images without considering the radiation damage to specimens by 'diffraction before destruction' method. The maximum diffracted intensity with good signal-to-noise ratio (SNR) is key to determine image resolution. The diffracted signal from multi-particle can show distinct interference patterns due to interference effect by large coherent volume of X-rays. In this talk, we consider the image resolution dependence on the number of particles from single-shot diffraction patterns.

Keywords:

X-ray free electron laser, XFEL, Single-shot imaging,Coherence, Multi-particle diffraction

Ultrafast X-ray absorption in NiO studied using femtosecond laser plasma hard X-ray pulses

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Abstract:

NiO is a wide band gap and typical antiferromagnetic material having highly correlated electronic system. It is still a material of interest and a prototype candidate for studying correlated electronic structure of transition metal oxides. The ultrafast response of NiO has been realized in magnetic switching upon illuminated with ultrafast laser pulse [1]. This phenomenon is connected with the transitions of electrons to in-gap (d-d) states. However the data is scarcely available on the effect of excitation of the valence electrons to the in-gap states and above the band-gap on core shell electrons. In this contribution, we present the effect of excitation of valence electrons by femtosecond laser pulse on the response of the core shell electronsusing a femtosecond laser plasma X-ray source (LPXS). A laser-pump X-ray-probe method was adopted to investigate the evolution of X-ray absorption of excited sample. NiO (4 μm thick) sputtered on polyimide was pumped with a fluence of 10 mJ/cm^2 of NIR pulse in 50 fs .X-ray absorption spectra were registered at various time delays with respect to the probe pulse. A sudden shift of K absorption edge to lower energy was observed followed by the quick recovery when electrons are excited with 1.55 eV (800 nm) possibly to the in-gap states [2]. The shift occurred at the rate of 223 ± 3 fs, and a maximum of ~3.2 eV red shift of K- absorption edge was registered after 400 fs of excitation. On the other hand upon pumping with the combination of NIR and UV (800 nm and 400 nm) an abrupt blue shift of K-absorption edge was recorded after ~ 400 fs at the rate of 234 ± 5 fs. This is possibly due to the filling of the lowest unoccupied orbital above the band gap in the conduction band. Using femtoseconds pump-probe x-ray absorption spectroscopy, we observed that there occurs ultrafast electronic rearrangement in NiO after excited by the laser pulse We believe that ultrafast electronic rearrangement can now be investigated usinga laboratory scale table top x-ray source. Additionally, the study of such evolution will augment the understanding of ultrafast nature of transition metal oxides. 1-G. Lefkidis and W. Hübner, Phys. Rev. B76, 014418 (2007) 2- R. NewmantandR. M. Chrenko,Phys. Rev. Volume 114, Number 6 (1959)

Keywords:
Laser plasma source, XANES, NiO, electron dynamics

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2016.10.19 - 2016.10.21

Construction of a compact size 4He magnetic force microscope

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Abstract:

We have constructed a low temperature magnetic force microscope (MFM) with a fiber-optic interferometer. The MFM has several features: (1) home-built scanner and x-y-z coarse positioner, (2) two fiber walkers, (3) sample holder loading multiple samples, (4) compact size of an MFM probe, 1-inch in diameter [1]. The small size of the probe allows us to use our MFM for a versatile approach in selecting cryogenic dewars such as a liquid helium dewar and a cryogen free magnet whose inlet diameter is as close as 1 inch. Furthermore, our unique designs of miniatured scanners and walkers can contribute the development of other experimental tools which need nano-motor systems. In this talk, we will introduce details of our home-built probe and discuss the applications for low temperature physics. [1] Jinho Yang, et al., Rev. Sci. Instrum. 87, 023704 (2016).

Keywords:
Force Microscopy, Instrumentation, Superconductivity, Magnetism

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Comparison of AuNi alloy nanoparitcles fabricated by different heat supply method by x-ray imaging

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Abstract:
We report quantitative compositional analysis of crystallization processes of alloy nanoparticles using x-ray imagings. AuNi alloy nanoparticles are fabricated by different heat supply method: continuous heat supply by rapid temperature annealing (RTA) process and pulsed heat supply by nanosecond laser. As a result, it is clearly distinguishable the different phases at AuNi alloys by RTA process. However, by the laser, the boundary of phases is vague. The difference is supposed that the time for atomic movement is sufficient so that it can reach at equilibrium state for the former but it is limited then atoms are mixed randomly for the latter. The results are nondestructively visualized by 3-dimensional coherent x-ray diffractive imaging (CXDI), and atomic compositions are quantitatively analyzed by CXDI and soft x-ray nanoscopy (SXN).

Keywords:
Coherent X-ray Diffractive Imaging, rapid temperature annealing process, nanosecond laser, x-ray imaging

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Synchrotron X-rays Scattering Study of MIT Transition in VO_2 Nanowires

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Abstract:

In the diverse potential applications such as catalytic, photo electronic, sensor, battery, energy harvesting systems and thermoelectric devices based on the metal-insulator transition in vanadium oxides, controlling their nanoscale morphology is an important issue. We report a systematic study of the metal-insulator transition in VO_2 nano-wires with different morphologies grown by the vapor transport method on c-plane Al_2O_3 and r-plane Al_2O_3 substrates using vanadium-dioxide (VO_2) as powder source under hydrogen reduction environment. In-situ XRD studies of these VO_2 nanowires, having triangular and vertical dot type shapes, show a distinct structural phase transition between the low T monoclinic and high T tetragonal phases which exhibit insulating and metallic properties, respectively. In addition, electron microscopy results reveal that the grown VO_2 nanowires are highly crystalline monoclinic structures. We also employed Reciprocal Space Mapping (RSM) method of X-ray diffraction, based on two dimensional X-ray CCD to understand the diffuse scattering near the transformation of single crystalline VO_2 Nanowire. The 3D RSM indicates that the single nanowire method is in a single domain in the high T tetragonal phase, while it is broken into few domains in the low T monoclinic phase.

Keywords:

VO_2Nanowires,Vapor Transport Method, MIT, Phase Transition, in-situ xrd, 3D Reciprocal Space Mapping (RSM)

Suppressing Kondo singlet by breaking the SU(2) Kondo symmetry

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Abstract:

In this work, we study the entanglement of a Kondo system, based on a bosonization method. We derive the analytic expression how the Kondo-singlet entanglement of the ground state is suppressed by perturbation that breaks the SU(2) Kondo symmetry. We propose how to detect the suppression in experiments.

Keywords:
Kondo effect, Kondo entanglement, quantum dot

Staggered Exciton-Photon Lattice driven by SAW

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Abstract:

In this work we consider the behaviour of exciton polaritons in a micro- cavity where both the optical and excitonic components are manipulated by a periodic potential. We also consider excitons are localized in a moving SAW (surface acoustic wave). Due to the shifted potential profiles, one can observe a momentum-dependent coupling between the excitons and photons, which one can see formation of an unusual dispersion with degenerate ground states at zero and non-zero momenta. Surface acoustic wave is one of the candicates to generate the potential profile. By using the SAW as a moving potential profile, we can investigate the evolution of the polariton condensate and study transition from regular BEC at k = 0 to the condensation at nonzero-k: with the movement of the SAW, the potential varies with time periodically.

Keywords:

surface acoustic wave, exciton-polaritons

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Vacuum bubble of non-Abelian anyons

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Abstract:

In Fermionic and Bosonic many-body physics, vacuum bubbles do not affect physical observables, known as the linked cluster theorem [1]. However, it is shown that certain vacuum bubbles of Abelian anyons contribute to physical observables, disobeying the linked cluster theorem. These vacuum bubbles, named as topological vacuum bubbles, represent the virtual anyonic excitation which braids the real anyonic excitation. In this work, we show that certain vacuum bubbles of non-Abelian anyons can also affect physical observables. We propose a Fabry-Perot interferometer operated in the fractional quantum Hall system at filling factor 5/2 to detect the topological vacuum bubbles of non-Abelian particles. [1] C. Han et al., Nat. Commun. 7: 11131 (2016)

Keywords:
Fractional quantum Hall effect, non-Abelian statistics, anyon interferometer

Aharonov-Bohm effect without topology in a charge qubit

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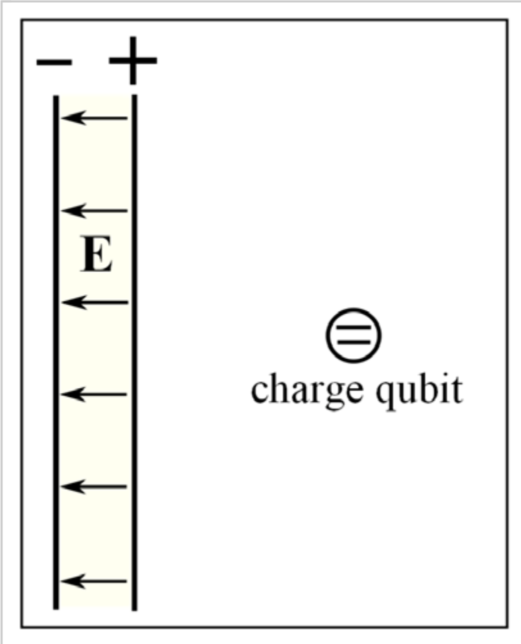

Abstract:
아라노프-보옴(Aharonov-Bohm) 효과의 핵심은 전하가 국소적으로 상호작용하지 않는 원거리의 전자기장에 의해 영향을 받는다는 점이고, 이는 기본적으로 비국소적인 상호작용에 바탕을 둔 토폴로지(topology) 현상으로 받아들여지고 있다. 이와는 대조적으로, 본 연구에서는 아라노프-보옴 효과가 실제로는 국소적인 현상으로 이해할 수 있음을 고리(loop) 구조가 아닌 초전도 전하 큐빗을 통해 보인다. 그림과 같이 전하 큐빗이 서로 반대 전하로 대전된 두 개의 무한 평행 대전판 바깥에 놓여 있는 경우에 큐빗의 전하는 축전판의 전기장과 직접 상호작용하지 않는다. 로렌츠-공변 국소 장 상호작용(Lorentz-covariant local field interaction) 이론[1,2]을 적용하여, 우리는 큐빗 상태의 양자 위상(quantum phase)이 두 대전판 사이의 퍼텐셜 차이와 관계 있음을 보인다. 흥미로운 것은 이렇게 발견된 위상은 계의 토폴로지와는 무관하다는 점이며, 전통적인 퍼텐셜 기반의 양자 전기 상호작용 기술 방법으로 예측할 수 없다는 점이다.
[1] K. Kang, "Aharonov-Bohm effect, local field interaction, and Lorentz invariance", arXiv:1308.2093. [2] K. Kang, "Locality of the Aharonov-Bohm-Casher effect", Phys. Rev. A 91, 052116 (2015).

Keywords:
아라노프-보옴(Aharnov-Bohm) 효과, 초전도 전하 큐빗, 로렌츠-공변 국소 장 상호작용 (Lorentz-covariant local field intereaction)

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A new non-topological geometric phase of an electric dipole under a magnetic field at a distance

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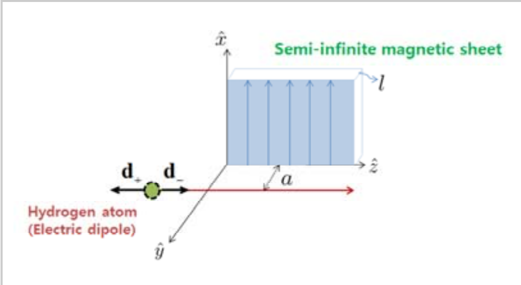
Abstract:



We predict a geometric phase of an electric dipole interacting with an external magnetic field at a distance. Based on the Lorentz-covariant field interaction approach [1], we show that a geometric phase appears under the condition that the dipole is moving in the field-free region, which is distinct from the topological He-McKellar-Wilkens phase [2] generated by a direct overlap of the dipole and the magnetic field. We discuss the experimental feasibility of detecting this phase with atomic interferometry. Detecting this phase would result in a deeper understanding the nature of electromagnetic interaction. A successful experiment will confirm the locality of the interaction in general, which is in sharp contrast to the conventional interpretation of the Aharonov-Bohm effect. References: [1] K. Kang, arXiv:1303.7019; K. Kang, Phys.Rev.A 91, 052116 (2015). [2] X.-G. He and H.J. McKellar, Phys.Rev.A 47, 4 (1993); M. Wilkens, Phys.Rev.Lett. 72, 5 (1994).

Keywords:
non-topological phase, geometrical phase, electric dipole, atomic interferometer

Fano resonance and the unexpected band structure in flat band lattice models

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Abstract:

We investigate the Fano resonance and the unexpected band structure in a single particle transport in flat band lattice models. The imperfection of channel opening makes the particle to destructively interfere between transmitted and localized states due to the broken symmetry. In case of the non-Hermitian systems in which complex band structures can appear, PT symmetry gives rise to degenerate points, so-called exceptional points, and the band gap emerges nearby flat band from this symmetric system.

Keywords:

Flat band, Fano resonance, PT symmetry

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Peculiar Quantum Hall Conductance of Topological Edge States at p-n Junctions in Graphene

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Abstract:

In quantum Hall regime, the quantum Hall conductance exhibits stepwise increasing behavior in unit of the conductance quantum. However, in this study, we find that the quantum Hall conductance is expected to be non-integer when a p-n junction is formed in graphene. Such a peculiar quantum Hall conductance basically stems from the coupling of the topologically protected states at the interface of the p-n junction, leading to the beam splitting of the topological edge states. We also discover that the peculiar quantum Hall conductance is quite robust against the smoothening of the p-n junction.

Keywords:
Topology, Quantum Hall Effect, Graphene

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Status of PAL-XEL and its advanced operation mode

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Abstract:
2016년에 포항가속기연구소는 세계에서 3번째로 경엑스선 자유전자레이저장치 (Free Electron Laser)를 성공적으로 완료하였다. 2011년에 시작된 건설 프로젝트가 성공적으로 진행되어, 건물은 2014년에 완료되었고, 2015년에는 가속기와 빔라인의 설치가 완료되었다. 2016년 4월부터 시작된 FEL 커미셔닝이 순조롭게 진행되어 지난 6월에 0.5 nm FEL 의 발진에 성공하였고, 2016년 말까지 0.1 nm 급의 FEL 발진을 추진 중이다. 포항 4세대 방사광가속기 (PAL-XFEL)의 완공을 기하여, 최첨단 자유전자레이저 가속기기술이 구현된 PAL-XFEL 의 가속장치와 가속기 기술을 소개하고, FEL 커미셔닝 현황을 소개하고자 한다. 또한 PAL-XFEL 의 설계에 반영된 첨단 운전모드와 future plan를 소개함으로써, 국내 연구자들에게 새로운 아이디어 및 연구분야를 모색할 수 있는 정보를 제공하고자 한다.

Keywords:
경엑스선 자유전자레이저, 가속기

Femtosecond timing distribution and synchronization of PAL-XFEL

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Abstract:

For the stable operation of SASE based FEL and time-resolved experiments with high time resolution, timing jitter and drift for each component should be minimized. In PAL-XFEL, several microwave and optical oscillators are synchronized to a low phase noise master oscillator with <15 fs RMS jitter. Each signals are used to generate and accelerate electron bunches, to diagnose arrival time of the electron bunches, and to synchronize the experimental laser oscillators. The timing drift in a 750m long electron accelerator is measured as small as ~ 1ps for a week. To reduce the drift further, our plan of implementing a drift compensation using timing stabilized optical link will be discussed.

Keywords:
femtosecond timing distribution, femtosecond synchronization

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2016.10.19 - 2016.10.21

Toward Generation of Isolated Tera-watt attosecond X-ray laser pulse

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Abstract:

X-ray free-electron lasers (XFELs) are excellent tools for the study of ultrafast phenomena in atoms and molecules in the fields of physics, material science, chemistry and biology. XFEL facilities can currently supply femtosecond XFEL pulses with a few tens of gigawatt power, generated in the self-amplified spontaneous emission process. However, these pulses are not sufficiently fast to follow the dynamics of electrons in atoms, molecules and nanoscopic systems in their real time. To follow the electronic motions, an intense attosecond X-ray pulse is demanded. Such pulses would allow the investigation of phenomena that have not been previously explored in ultrafast science and X-ray nonlinear science. One of the immediate applications of such a pulse is the observation of real-time changes in the probability distribution of the electron's position. This apparent holy grail of diffraction experiments, paves the way to 4D imaging with picometer spatial and attosecond temporal resolutions. Here, we discuss a new scheme for a terawatt attosecond x-ray pulse in X-ray free-electron laser controlled by a few cycle IR pulse, where one dominant current spike in an electron bunch is used repeatedly to amplify seeded radiation to a terawatt level. The generated attosecond x-ray pulse is synchronized to the driving few cycle pulse, well suited to the pump-probe experiments in the study of ultrafast dynamics. The viability of this scheme is demonstrated in simulations using Pohang accelerator laboratory (PAL)-XFEL beam parameters.

Keywords:
ultrafast science, attosecond science, X-ray science, attosecond pulse

PAL-XFEL을 활용한 천체-플라즈마 물리 연구

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Abstract:
세계에서 3번째로 구축된 포항 4세대 방사광가속기(PAL-XFEL)는 X-선 영역 대(파장으로는 약 0.1 nm - 10 nm, 에너지로는 약 0.12 keV - 12.4 keV)의 광자를, 결맞음 상태로 잘 유지하면서도 펨토초(10^{-15} 초) 펄스 길이로 방출한다. 이러한 최고 성능의 방사광원을 활용하면 물리, 화학, 생명, 약학, 신물질 분야에서 새로운 연구를 수행할 수 있을 뿐 아니라, 극한의 천체 현상을 실험실 환경하에서 탐색하는 것도 가능하다. 예를 들면, 목성과 같이 기체로 형성된 행성들의 중심부는 온도는 그리 높지 않지만 높은 밀도의 상태인 '따뜻한 고밀도 물질 (Warm Dense Matter 또는 줄여서 WDM)'로 이루어져 있다고 알려져 있다. 가시광선대의 초강력 레이저를 알루미늄과 같은 고체에 조임으로써 아주 짧은 시간 동안 WDM을 만들 수 있는데 PAL-XFEL의 초고속 X-선 관측 기능을 활용하면 이렇게 만들어진 WDM의 물리적 특성을 실험적으로 연구할 수 있고, 이를 통해 목성과 같은 기체 행성들의 내부 구조를 이해할 수 있다. 또한, PAL-XFEL에서는 X-선의 높은 에너지 및 밝기를 활용해 이전에는 불가능했던 고전리 이온(Highly Charged Ions 또는 줄여서 HCI)의 초고해상도 분광선 측정이 가능하다. 우주에서 흔하게 발견되는 철(Fe)과 같은 원자는 은하단 플라즈마 혹은 블랙홀이나 중성자별 주변에 형성되는 강착원반 등의 극한의 환경에서 수소 혹은 헬륨과 같이 전자가 1-2개만 남아 있는 HCI 상태(Fe^{25+} 혹은 Fe^{26+})로 존재하며, 이러한 HCI에서 방출되는 X-선의 정확한 분광선을 측정하면 고해상도 X-선 관측 자료를 보다 정확히 분석할 수 있고 이를 통해 X-선 방출 천체의 물리적 환경을 추적할 수 있다. 본 구두발표에서는 한국연구재단 선도연구센터(Science Research Center) 사업의 지원을 받는 울산과학기술원(UNIST)의 고에너지 천체물리 연구센터(Center for High Energy Astrophysics)에서 추진중인 PAL-XFEL을 활용한 WDM 및 HCI 연구를 소개하며, Electron Beam Ion Trap (EBIT)에 기반한 HCI 발생 장치 개발 및 빔라인 업그레이드 방향에 대해 논의하고, 마지막으로 국내외 유관 기관간의 협력연구 방안을 모색하고자 한다.

Keywords:
PAL-XFEL을 활용한 천체-플라즈마 물리 연구

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2d (0,2) gauge theories, triality, and Calabi-Yau singularities

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Abstract:

We review latest developments in 2d (0,2) supersymmetric gauge theories arising from D1-branes probing toric Calabi-Yau 4-fold singularities. The theories are described by periodic quivers or their dual graphs called brane-brick models. Some CY geometries admit several gauge theory descriptions which exibit identical infrared dynamics. The infrared equivalence is a manifestation of the Gadde-Gukov-Putrov triality. We elucidate how triality works by computing the elliptic genus of the gauge theories and also by rederiving the gauge theories from the mirror CY point of view.

Keywords:

string theory, quantum field theory, supersymmetry, Calabi-Yau geometry

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2016.10.19 - 2016.10.21

Testing 5d-6d dualities with fractional D-branes

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Abstract:

6d SCFTs compactified on a circle can often be studied from nonperturbative 5d super-Yang-Mills theories, using instanton solitons. However, the 5d Yang-Mills theories with 6d UV fixed points frequently have too many hypermultiplet matters, which makes it difficult to use the ADHM techniques for instantons. With the examples of 6d N=(1,0) SCFTs with Sp(N) gague symmetry and 2N+8 fundamental hypermultiplets, we show that one can still make rigorous studies of these 5d-6d relations in the `fractional D-brane sectors'. We test the recently proposed 5d duals given by Sp(N+1) gauge theories, and compare their instanton partition functions with the elliptic genera of 6d self-dual strings.

Keywords:
5d gauge theories, 6d SCFTs, D-branes, ADHM.

6d strings from new chiral gauge theories

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Abstract:
We present the 2d gauge theories for the self-dual strings of 6d N=(1,0) SCFTs. We focus on the 6d theory with smallest non-Higgsable gauge symmetry SU(3), and its applications like (E6, E6) matter. We study the physics of these strings from the elliptic genera and anomaly polynomials.

Keywords:
6d SCFTs, self-dual strings, GLSM

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M5-branes, orientifolds, and S-duality

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Abstract:

We study the instanton partition functions of 5d maximal super Yang-Mills theories with all classical gauge groups. They are computed from the ADHM quantum mechanics of the D0-D4-O4 systems. Our partition functions respect S-dualities of the circle compactified Yang-Mills theories and various orientifold backgrounds. We also compute and study the S^5 partition functions that correspond to the 6d (2,0) superconformal indices. Our SO(2N) index takes the form of the vacuum character of W_D algebra in a special limit, supporting the W algebra conjecture. We propose new indices for (2, 0) theories with outer automorphism twists along the temporal circle, obtained from non-simply-laced SYMs on S^5.

Keywords:
Instanton partition function, 5d Super Yang-Mills theory, S-duality, Orientifold, 6d (2,0) superconformal theory, W-algebra

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The rotation curve of a point particle in stringy gravity

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Abstract:

Double Field Theory may suggest to view the whole massless NS-NS sector as the gravitational unity. The doubled diffeomorphisms and the O(D, D) covariance determine precisely how the Standard Model as well as a relativistic point particle should couple to the NS-NS sector. The theory also refines the notion of singularity. We derive analytically the most general, spherically symmetric, asymptotically flat, static vacuum solution to D = 4 Double Field Theory. The solution contains three free parameters and consequently generalizes the Schwarzschild geometry. Analyzing the circular geodesic of a point particle, we obtain the orbital velocity as a function of radius, which generically features maximum. We attempt to simulate the observed rotation curve of galaxy.

Keywords:

differential geometry, string theory, double field theory, cosmology, galaxy rotation curve, spherical symmetric solution

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Revisit to thermodynamic relations in the AdS/CMT models

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Abstract:

Motivated by the recent unified approach to the Smarr-like relation of AdS planar black holes in conjunction with the quasi-local formalism on conserved charges, we revisit the quantum statistical and thermodynamic relations of hairy AdS planar black holes. By extending the previous results, we find the additional hairy contribution in the bulk and show that the holographic computation can be improved so that it is consistent with the bulk computation. We argue that the first law can be retained in its universal form while the relation between the on-shell renormalized Euclidean action and its free energy interpretation in gravity may be deformed to contain the hairy contribution in hairy AdS black holes.

Keywords:
Scalar hairy black hole, Quasi-local charge, Smarr relation, Quantum statistical relation, AdS/CMT

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Matrix models from localization of five-dimensional supersymmetric noncommutative U(1) gauge theory

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Abstract:
We study localization of five-dimensional supersymmetric U(1) gauge theory on S^3 × R_θ^2. The theory can be mapped to three-dimensional supersymmetric U(N → ∞) gauge theory on S^3 using the matrix representation. Therefore, the noncommutative (NC) space allows for a flexible path to derive matrix models via localization from a higher-dimensional supersymmetric NC U(1) gauge theory in various dimensions.

Keywords:
Matrix model, Noncommutative field theory, Supersymmetric localization

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Quantum correction to the IR entanglement entropy

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Abstract:

Using the holographic technique, we investigate the IR entanglement entropy representing the entanglement between quantum states. In the IR limit described by a large subsystem, the entanglement entropy of excited states is thermalized and reduces to the thermal entropy. Especially, for a two-dimensional CFT the leading quantum correction to the IR entanglement entropy is given by a logarithmic term, which is very similar to the quantum correction of the thermal entropy in CFT.

Keywords:

Holography, entanglement entropy

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Explicitly reconstructing the entanglement wedge from modified mode sum approach

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Abstract:
The problem of bulk locality, or how the boundary encodes the bulk in AdS/CFT, is still a subject of study today. One of the major issues that needs more elucidation is the problem of subregion duality; what information of the bulk the given boundary subregion encodes. This problem has been surveyed by many authors, Czeck et.al.(arxiv:1204.1330) and Almheiri et.al.(arxiv:1411.7041) to name a few. The latter conjectured that entanglement wedge is the reconstructible bulk dual of given boundary subregion and this conjecture was claimed to be proved by Dong et.al.(arxiv:1601.05416), but no explicit procedure for reconstructing the entanglement wedge from boundary data was as of yet given. It is shown that an explicit reconstruction like the smearing functions of Hamilton et.al.(arXiv:hep-th/0606141) is possible for the entanglement wedge by generalising the mode sum approach. Although it is generally expectated that solutions to the wave equation on a complicated coordinate patch are needed, this hard problem has been transmuted to a less hard but tractable problem of matrix inversion.

Keywords:
AdS/CFT, Bulk Locality, Quantum Error Correction

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Proposal for a second Hyper-Kamiokande detector in Korea

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Abstract:

Hyper-Kamiokande (HK) is a future water Cherenkov detector with 20 times larger fiducial volume mass than the Super-Kamiokande detector and consists of two identical detectors. According to preliminary studies it is found that positioning the 2nd detector in Korea (HKK) enhances the sensitivities of the neutrino mass ordering and leptonic CP violation phase measurements than both detectors in Kamioka site. There are other benefits such as solar neutrino physics and Super-Nova neutrino detection as well as non-standard neutrino interaction. In this talk I will discuss why having the 2nd detector in Korea is a possible alternative of the current HK plan of having both detectors in Kamioka site.

Keywords:

neutrino mass ordering, leptonic CP violation, matter effects, 2nd oscillation maximum, Hyper-Kamiokande, J-PARC

Past efforts on a second HK detector in Korea

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Abstract:
Around 2005, before observation of theta13 neutrino mixing angle, ideas of new long baseline experimental setups were proposed as extension of the Tokai-to-Kamioka experiment, with Hyper-Kamiokande as the far detector. Dedicated studies showed that the sensitivity to yet-unknown neutrino properties, especially the mass hierarchy, can be improved with multiple detectors at different baselines, one at Kamioka and the other at longer baseline in Korea (hence called T2KK) where the matter effects are relevant. This talk will review past studies from early publications and following T2KK workshops.

Keywords:
neutrino

Improved physics potentials with T2HKK

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Abstract:
The Hyper-K experiment will search for CP violation and make precision measurements of the leptonic Dirac phase through which CP violation in neutrino oscillations may occur. Hyper-K will also make precision measurements of other neutrino mixing parameters, including theta_23, theta_13 and Delta-m^2_{32}. By moving one Hyper-K tank to Korea, it is possible to enhance the long baseline neutrino oscillation measurements of Hyper-K. A second detector at ~1100 km introduces sensitivity to the mass hierarchy, breaking the degeneracy between matter effects and CP violation through the Dirac phase. It also introduces measurements at the second oscillation maximum, where the CP effect is ~3 times larger, limiting the impact of systematic errors and allowing for the measurement of neutrino oscillations over two full periods. This talk will review the studies of a two detector configuration with the second detector in Korea, and will describe the enhancements to the neutrino oscillation measurements due to the second detector.

Keywords:
neutrino

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Determination of the neutrino mass ordering, separation of octant degeneracy, and the leptonic CP phase

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Abstract:
We examine physics discovery potential of placing a far detector in Korea along the baseline of the T2HK (Tokai-to-HyperKamiokande) neutrino oscillation experiments, within the three neutrino standard model. Preliminary results for the determination of the neutrino mass ordering, the CP violating phase of the lepton flavor mixing matrix, and resolution of the octant degeneracy in the 2-3 mixing angle are reported.

Keywords:
neutrino

News on Relativistic Heavy Ion Collisions

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Abstract:

The goal of relativistic heavy ion collisions is to create the deconfined state of quarks and gluons—the quark-gluon plasma—to study high density Quantum Chromodynamics (QCD). In this talk I will present news on relativistic heavy ion collisions from the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory in the U.S. and the Large Hadron Collider (LHC) at CERN in Switzerland. I will report news on hard probe measurements (high transverse momentum physics) addressing partonic energy loss in the QGP and soft probe measurements (low transverse momentum physics) addressing the collective phenomena in heavy ion collisions. I will discuss what we have learned from those measurements about the properties of the QGP and high density QCD.

Keywords:
RHIC, LHC, QCD, QGP

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Collective flow measurements at RHIC energies

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Abstract:
Recent results on collective flow measurements from RHIC experiments are shown and discussed especially on the higher order azimuthal event anisotropy measurements and their relation to the ridge like phenomena including the possible collective flow evolution in the small systems. Current results from the beam energy scan program (BES) and future programs are also discussed.

Keywords:
collective flow, RHIC, ridge, BES

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Production of the X(3872) meson by recombination in heavy ion collisions

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Abstract:

We investigate the production of X(3872) mesons in heavy ion collisions by focusing on their production by recombination from various kinds of constituents, e.g., four quarks or D and D* mesons. We evaluate the transverse momentum distributions for possible X(3872) states, and show that those of X(3872) mesons constructed from different constituents are not only dependent on the kind of constituents, quarks or hadrons, but also on the relative distribution of quarks inside multi-quark configurations. We argue, therefore, that studying the transverse momentum distribution of the X(3872) meson in heavy ion collisions provides a chance to infer its structure as well as its constituents.

Keywords:
X(3872) mesons, recombination, transverse momentum distribution

Measurements of beauty-decay electrons in ALICE at the LHC

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Abstract:

Heavy quarks (charm and beauty), due to their large masses exceeding the QCD parameter, are produced in early stage of heavy-ion collisions, compared to the formation time of the Quark-Gluon Plasma (QGP). Heavy quarks interact with the medium without changing their flavour identities. Therefore, heavy quarks are natural probe of the QGP. Furthermore, separate measurements of beauty quarks from charm quarks can test the mass dependence of the parton energy loss in the QGP. To quantify medium effects in heavy- ion collisions, measurements in pp collisions and p-A collisions are essential as references. In addition, the measurements of beauty production in pp collisions can be tests for perturbative QCD calculations. Measurements in p-A collisions allow us to study cold nuclear matter effects such as the modification of the parton densities in nuclei with respect to nucleons, kT broadening and the energy loss in cold nuclear matter. Long lifetime of the beauty hadrons leads larger impact parameter of decay products from beauty-hadron. Thanks to excellent vertex and impact parameter resolution of ITS and electron-identification capability provided by TPC and TOF in the ALICE experimental setup, measurements of beauty production in pp, p-Pb and Pb-Pb collisions were done via electrons from semi-leptonic decays of beauty hadrons. We will present the recent measurements of beauty-decay electrons in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV in ALICE.

Keywords:
relativistic heavy-ion collisions,heavy flavour, beautyquark

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Quantifying superdiffusive transport in living cells: a few examples

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Abstract:

Biological cells are a sack of living materials of various sizes and species comprised of, e.g., the proteins, biopolymers, and organelles. It is known that the cells are supercrowded with these intracellular materials beyond our naïve speculation, at volume occupancy up to ~40% of the cell volume. For maintaining the living process various intracellular transport occurs in the cell. Experimental studies based on the state-of-the-art single particle tracking tools have shown that in such crowded and viscoelastic environments the particle movement usually disobeys the Einstein's simple law of Brownian diffusion, instead carrying out anomalous transport. Over the last decade the subdiffusion of various intracellular particles has been extensively studied on both experimental and theoretical sides. Currently, a challenging task is to understand the motor-driven superdiffusive transport in the supercrowded living environments. In this talk, I discuss two distinct superdiffusive phenomena in living cells, recently studied with experimentalists, which illustrate distinguished stochastic dynamics stemming from different origins. It is shown that analogously to the passive transport the intracellular superdiffusion exhibits stochastically diverse dynamic patterns due to multiple factors. We quantify the single-molecule stochastic dynamics in detail in the framework of established superdiffusion models and elucidate the origins of the superdiffusive transport.

Keywords:
intracellular superdiffusion, crowding, stochasticity, active transport

Phase Modulation of Hormonal Oscillations

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Abstract:

Counter-regulatory elements maintain dynamic equilibrium ubiquitously in living systems. The most prominent example, which is critical to mammalian survival, is that of pancreatic α and β cells producing glucagon and insulin for glucose homeostasis. These cells are not found in a single gland but are dispersed in multiple micro-organs known as the islets of Langerhans. Within an islet, these two reciprocal cell types interact with each other and with an additional cell type: the δ cell. By testing all possible motifs governing the interactions of these three cell types, we found that a unique set of positive/negative intra-islet interactions between different islet cell types functions not only to reduce the superficially wasteful zero-sum action of glucagon and insulin but also to enhance/suppress the synchronization of hormone secretions between islets under high/normal glucose conditions. This anti-symmetric interaction motif confers effective controllability for network (de)synchronization.

Keywords:
Synchronization, homeostasis, cellular network, glucose, pancreatic islet

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Analysis of diffusion trajectories of anisotropic objects

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Abstract:

We theoretically analyze diffusion trajectories of an anisotropic object moving on a two dimensional space in the absence of an external field. In determining diffusion parameters associated with the shape anisotropy, we devise a measure based on the gyration tensor and obtain its analytic expression exactly. Its efficiency and statistical convergence are examined in comparison with the fourth cumulant of particle displacement. We find that the estimation of diffusion constants based on the gyration measure is more efficient than the analysis adopting the fourth cumulant. [1] S. Roh, J. Yi, and Y. W. Kim, J. Chem. Phys. 142, 214302 (2015).

Keywords:
diffusion, trajectories, anisotropic objects, brownian motion, fourth cumulant, gyration tensor

Voltage Generation and Relaxation at the ITO-water interface

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Abstract:
Voltage generation and relaxation were observed using a de-ionized water droplet between two ITO (Indium Tin Oxide) electrodes. The origin of voltage generation and voltage relaxation were understood by the induced charge due to the hydronium ion (H_3O^+) adsorption and charge relaxation. To study the ion distribution in the electric double layer (EDL) of solid-water interface, two different methods were applied: touching and switching modes. In the touching mode, correlation between voltage generation and water spreading is observed. It means electric signal is affected by the fluid dynamic phenomena. Somehow, if we make a circuit with the switching mode, we can selectively eliminate the water spreading effect and focus on the charge relaxation. Different voltage dynamics in the touching mode and in the switching mode were analyzed by using an EDL capacitor model.

Keywords:
Electronics, Charge, Water, Fluid

Emergence of Sparsely Synchronized Rhythms and Their Responses to External Stimuli in An Inhomogeneous Small-World Complex Neuronal Network

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Abstract:

By taking into consideration the inhomogeneous population of interneurons in real neural circuits, we consider an inhomogeneous small-world network (SWN) composed of inhibitory short-range (SR) and long-range (LR) interneurons, and investigate the effect of network architecture on emergence of sparsely synchronized rhythms by varying the fraction of LR interneurons p_{long}. The betweenness centralities of the LR and the SR interneurons (characterizing the potentiality in controlling communication between other interneurons) are distinctly different, although they have the same average in- and out-degrees (representing the potentiality in communication activity). Hence, in view of the betweenness, SWNs we consider are inhomogeneous, unlike the "canonical" Watts-Strogatz SWN with nearly same betweenness centralities. For small p_{long}, the average betweenness centrality of LR interneurons is much larger than that of SR interneurons. Hence, the load of communication traffic is much concentrated on a few LR interneurons. However, with further increase in p_{long} the number of LR connections (coming from LR interneurons) increases, and then the average betweenness centrality of LR interneurons decreases. Consequently, the average path length becomes shorter, and the load of communication traffic is less concentrated on LR interneurons, which leads to better efficiency of global communication between interneurons. Sparsely synchronized rhythms are thus found to emerge when passing a small critical value $p^{(c)}_{long}$ (~ 0.16). This transition from desynchronization to sparse synchronization is well characterized in terms of a realistic "thermodynamic" order parameter, and the degree of sparse synchronization is well measured in terms of a realistic "statistical-mechanical" spiking measure. These dynamical behaviors in the inhomogeneous SWN are also compared with those in the homogeneous Watts-Strogatz SWN, in connection with their network topologies. Particularly, we note that the main difference between the two types of SWNs lies in the distribution of betweenness centralities. Unlike the case of the Watts-Strogatz SWN, dynamical responses to external stimuli vary depending on the type of stimulated interneurons in the inhomogeneous SWN. We consider two cases of external time-periodic stimuli applied to sub-populations of LR and SR interneurons, respectively. Dynamical responses (such as synchronization suppression and enhancement) to these two cases of stimuli are studied and discussed in relation to the betweenness centralities of stimulated interneurons, representing the effectiveness for transfer of stimulation effect in the whole network.

Keywords:
Short-range and long-range interneurons, Inhomogeneous small-world network, Inhomogeneous betweenness centrality, Sparsely synchronized rhythms, Synchronization suppression and enhancement

Cross-species essentiality landscape for the evolution of the metabolic networks

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Abstract:

Living organisms perform diverse functions to handle continually internal and external perturbations. Such stability must be supported by the structural and functional organization of cellular networks, which remain to be understood. In particular, multiple pathways can be beneficial to help the related elements to remain connected when a pathway is broken as long as they are organized efficiently. Here we investigate the genome-scale metabolic networks of hundreds of species. We first compute the biconnected components, in which every pair of nodes are connected by at least two paths, and find their difference from those in randomized networks. This result allows us to define the cross-species biconnectivity of individual metabolites, which turns out to be a indicator of the metabolites' vulnerability, quantified by the average prevalence of their associated diseases. Next, we compute the contribution of each reaction to generating biomass components by flux-balance analysis to classify the functional importance of each reaction into four ranks and identify the pairs of reactions which back up each other. We find that the fraction of backup pairs is widely varying from species to species while that of essential reactions is not significantly varying. Inferring the rank of each reaction in all the nodes in the phylogenetic tree by the maximum parsimony, we find that essential reactions, which absence may stop the biomass generation, tend to change to active ones, implying backup pathways may have been introduced to reduce their lethality. Cross-species analysis allows us to define the essentiality and backups of individual reactions, which are correlated with each other and with the evolutionary age as well, helping us to understand how cellular networks organize multiple pathways by evolution.

Keywords:
metabolic network

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Demonstration of Structured Magnetic Illumination Microscopy

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Abstract:
Structured illumination microscopy (SIM) provides wide-field super-resolution image. SIM exploits interference of counter-propagating incident light to spatially modulate electric field intensity. If an object is sensitive to optical magnetic field, we can obtain super resolution image of the object using the same principle of SIM, but with magnetic field intensity modulation. As a demonstration, in this work, we obtained super resolution image of light scattering of gold nanoparticles which depends on the incident magnetic field according to Mie theory. With 785 nm wavelength and 0.55 NA objective lens, particles in the image show FWHM of ~220 nm, which is about three-fold enhancement compared to FWHM of ~710 nm obtained with conventional microscopy. Scattering intensities show good quantitative agreement with Mie theory.

Keywords:
optical magnetic field, super resolution, structured illumination.

Near-ultraviolet structural color in aluminum nanoantenna array

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Abstract:

Recently, structural color generation by micro- or nano-structures has gained much interest as a good alternative to the conventional pigment based color generation. While the conventional pigment uses light absorption to produce complementary colors, the structural color generation occurs based on scattering of light. Since the scattering strongly depends on shape, material and polarization, structural color generation enables sensitive color tuning as well as low photodegradation. [1] Structural colors are widely accepted for applications such as filter-free image sensing [2] and omnidirectional color reflection. [3] With the needs of higher resolution and higher brightness and contrast, structural color generation from plasmonic resonance has been widely investigated. At resonance, light scattering of the metallic nano-structures is strong and polarization sensitive. Aluminum is a good metallic medium for generating structural color not only in the visible region but also in the ultraviolet region, while its interband transition is located in the near-infrared wavelength. Structural color generation in ultraviolet region is beneficial for further applications including color multiplexing with more degree of freedom [4], image steganography for anti-counterfeit [5], and denser optical data storage [6]. In this work, we report near-ultraviolet structural color generation in aluminum nanodisk arrays on a quartz wafer. The localized plasmonic resonance of the aluminum nanodisks arranged in a square lattice strongly backscatters the incident ultraviolet light. The generated structural colors are studied with polarization resolved reflectance measurement and finite-difference-time-domain (FDTD) numerical simulation. The resonance wavelength (λ_{res}) in the reflectance spectrum of each arrays continuously increases from ~327 to ~401 nm, as we change the diameter of the nanodisk and the period of the square lattice from 74 to 94 nm and from 190 to 260 nm, respectively. Here, the filling ratio of the nanodisk in a unit cell is fixed to ~11 %. At the resonant condition, the nanodisk arrays with only thickness ~35 nm shows high reflectance values of ~35 % on average. Measured typical full-width at half-maximum of the resonance peak ($\sim\lambda_{res}/5$) is narrow enough to generate vivid structural color. The numerically calculated results and the experimental results show a good accordance. The bright-field microscope images under different illumination conditions using various ultraviolet bandpass filters demonstrate a new functionality of aluminum nanodisk arrays as thin near-ultraviolet color pixels. Finally, we realize near-ultraviolet anti-counterfeit image printing. [1] Zhao, Y. et al. Chem. Soc. Rev. 41, 3297 (2012) [2] Park, H. et al. Nano Lett. 14, 1804 (2014) [3] Chung, K. et al. Adv. Mater. 24, 2375 (2012) [4] Huang, Y.-W. et al. Nano Lett. 15, 3122 (2015) [5] Dean, N. Nat. Nanotech. 10, 15 (2015) [6] Mansuripur, M. et al. Opt. Express 17, 14001 (2009)

Keywords:
Structural color, Plasmonics, Aluminum, Ultraviolet

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Bio-inspired structural coloration realized by thin-film rolling technique

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Abstract:
뚜렷한 광자결정 구조를 통해 구조색을 발현하는 몇몇 새 깃털들과는 다르게, 까치 깃털의 경우 결정성이 약함에도 보는 각도에 따라 색이 변하는 구조색을 나타낸다. 까치 깃털의 전자현미경 관찰을 통해 구조색을 나타내는데 구성요소간 수직방향의 거리가 일정함이 중요함을 확인했고, 컴퓨터 시뮬레이션을 통해 서로 다른 결정구조에서도 층간의 거리가 같으면 같은 색이 발현됨을 보였다. 나아가 이에 착안해서, 1차원 그레이팅이 새겨진 고분자 막을 원통대칭성을 갖도록 둥글게 마는 방법을 이용해서, 측면 방향으로 정렬되어 있지는 않지만 표면에 수직한 방향으로는 일정한 거리를 가지는 공기튜브 배열로 이루어진 구조를 만들었고, 이 구조가 수직방향의 일정한 거리에 의해 구조색을 나타냄을 광학적 측정 및 컴퓨터 시뮬레이션과의 비교를 통해 확인했다. 수직방향의 거리를 조절함으로써 다양한 색의 발현이 가능함을 보였고, 만들어진 구조가 유효-매질-이론을 통해 1차원 브래그 거울로 근사될 수 있음을 확인하였다.

Keywords:
Bio-inspired, photonic crystal, structural coloration

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시간역행 거울을 이용한 미세 광집속

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Abstract:

시간역행거울은 빛의 시간진행방향을 거꾸로 뒤집는 거울이다. 단일파장을 가진 빛의 경우에는 빛의 위상공액(phase conjugation)을 통해 시간역행거울을 구현할 수 있다. 위상공액거울에 의해 위상이 뒤집힌 빛은 진행방향이 반대로 되어 원래 왔던 길을 되돌아가게 된다. 이러한 시간역행거울을 이용하면 빛이 불투명한 매질을 투과해 무작위한 방향으로 산란되었다고 해도, 이를 다시 원래의 지점으로 되돌려줄 수 있게 된다. 하지만 시간역행거울을 이용한다 하더라도 일반적으로 빛의 파장보다 작은 정보는 되돌려줄 수 없다. 이는 빛이 진행하면서 높은 공간주파수 성분을 나타내는 근접장 성분이 지수적으로 감소하기 때문이다. 본 연구에서는 다중산란과 시간역행거울을 이용하여 빛의 파장보다 작은 광초점을 되돌려 주는 기술을 구현하였다. 먼저, 근접장 주사 광학 현미경을 이용하여 초고해상도 광초점을 생성하였다. 광초점에서 나온 빛은 무질서한 나노구조를 가진 산란매질에 의해 다중산란이 되며, 근접장 정보가 원격장으로 변환된다. 산란된 원격장 정보를 위상공액거울을 이용하여 되돌려줌으로써 빛은 시간역행하여 원격장 정보가 근접장 정보로 변환되고 다시 초고해상도 광초점을 형성한다.

Keywords:
다중산란, 근접장, 시간역행, 파면제어

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2016.10.19 - 2016.10.21

초점가변렌즈를 이용한 구조조명 기반의 3차원 표면형상측정 방법

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Abstract:
일정한 패턴을 지닌 조명을 사용하여 형광영상의 축상 분해능을 향상시키는 구조조명 (Structured Illumination, SI) 기법은 3차원 표면형상을 3차원으로 영상화하는 기술로도 사용된다. 시료의 3차원 표면영상을 얻기 위해서는 축상 방향의 스캐닝이 필요한데, 이를 위해서 시료를 이동시키거나, 결상광학계의 렌즈를 움직여 결상초점 위치를 이동시키는 방법이 사용된다. 하지만 이러한 기계적 이동방법은 시스템에 불필요한 움직임을 유발해 3차원 표면형상 측정 시 다양한 오차를 유발할 수 있다. 본 연구에서는 결상초점을 축상으로 스캐닝 시 기계적 움직임에 의해 발생될 수 있는 에러를 최소화 하고자 인가전류에 따라 초점거리가 달라지는 초점가변렌즈를 3차원 표면형상 측정을 위한 축상 스캐너로 사용하였다. 시스템의 최적화를 위해 초점가변렌즈에 가해진 전류에 따라 변화하는 초점위치와 이로 인한 측정영상의 배율 변화를 시뮬레이션 하였고, 이를 실제 실험으로 측정한 결과와 비교 분석하였다.

Keywords:
Structured illumination, Electrically tunable lens. Surface measurement

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2016.10.19 - 2016.10.21

Measurement of wafer morphology using interferometer for the overlay correction

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Abstract:

반도체 소자의 제조 공정은 웨이퍼 위에 패턴을 형성, 적층하는 과정으로 이루어져 있다. 각 층의 패턴들 간 정렬도는 반도체 소자의 전기적 특성에 관여하여 제품의 품질과 생산 수율에 영향을 미치게 된다. 반도체 소자의 집적도가 고도화되어 선폭이 1x~2x nm까지 발달하여 패턴의 오정렬 정확도의 중요성이 더욱 부각되어가고 있다. 기존 오버레이 계측 방식은 웨이퍼 위에 오정렬 계측 패턴을 올려 놓고, 좌우 측 모서리에서 오정렬 계측 패턴의 중심선이 어긋난 정도를 측정한다. 기존 방식으로는 제작 공정 중 기판위에 증착, 열처리 등의 공정 시 발생하는 잔류 응력으로 인해 생기는 웨이퍼의 공정 변위(Process variation) 로 인해 오버레이 에러(Overlay error)가 생기게 된다. 오버레이 계측의 정확도 개선을 위해서는 공정상에서의 응력으로 인한 웨이퍼의 변형을 측정하여 측정 단계에서 보정해주어야 한다. 본 연구에서는 오버레이의 정확도 개선을 위해 공정 변위로 인한 웨이퍼의 변형을 측정하기 위한 검사장비를 간섭계로 설정하였고, 오버레이 계측 허용 오차, 공정 과정, wafer의 변형 정도, 크기 등 검사장비의 정밀도를 최적화하는 데 있어서 필요한 요소들에 대하여 연구를 진행하였다.

Keywords:
Overlay error, process variation, Phase shifting interferometer

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2016.10.19 - 2016.10.21

반도체 웨이퍼 상의 결함 검출용 고효율 조명계의 애너모픽적 접근에 관한 연구

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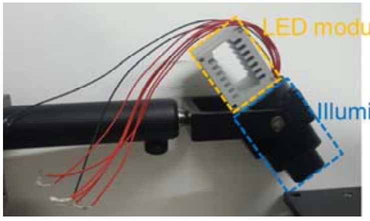
Abstract:



반도체 웨이퍼 공정과정 중 발생하는 결함을 신속 정확하게 검출하기 위해서는 대물렌즈의 성능뿐만 아니라 광원의 조명 방식과 형태, 조도의 균일도 등 조명계의 역할 또한 매우 중요하다. 결함의 검출감도는 대물렌즈의 NA와 광원의 파장에 따라 λ/2NA=Resoulution의 관계가 있기 때문에 NA가 고정된 대물렌즈에서 짧은 파장의 광원을 사용할수록 결함의 검출감도를 높일 수 있다. 짧은 파장의 광원을 사용하는 것 만큼이나 광원을 효율적으로 사용하여 조명되는 영역의 밝기와 균일도를 높이는 것 또한 검출감도와 밀접한 관련이 있다. 본 연구에서는 dark field로 조명하는 areal, near field, linear 세 가지의 조명계를 anamorphic적인 부분을 고려하여 설계하는 연구를 진행했다. 먼저 anamorphic areal illumination의 경우 objective plane에 30° 로 조명이 입사될 때 생기는 X-Y비율 차이를 보상하기 위해 prism을 이용해 조명계를 지나는 beam shape을 anamorphic하게 변형시키는 방식을 이용했다. 다음으로 anamorphic near field illumination은 SIL(Solid Immersion Lens)를 이용하는 대물렌즈에 대응하도록 설계 된 것으로 대물렌즈와 objective plane사이에 조명을 할 수 있는 충분한 공간이 없기 때문에 SIL옆면을 통해서 조명을 하도록 설계했다. 이 경우에는 SIL의 옆면에 의해 key stone distortion이 발생하게 되고 이를 보상하고 광원을 효율적으로 사용하기 위해 광원의 형태를 anamorphic하게 변형시키는 방법을 이용했다. 마지막으로 anamorphic linear illumination은 LED chip 6개를 일정한 간격을 두고 일렬로 배열하여 광원을 구성했고 이를 실린더 렌즈를 이용해 anamorphic한 line 형태의 조명을 설계 및 제작했다.

Keywords:
illumination, wafer inspection, anamorphic, dark field

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2016.10.19 - 2016.10.21

다중 광 산란 제어를 이용한 다기능 광학소자 구현

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Abstract:
빛이 무질서한 매질에 입사되었을 때는 매우 복잡하고 불규칙한 형태의 다중산란이 일어난다. 하지만 이러한 다중산란현상은 맥스웰방정식으로 풀이되는 결정론적인 현상이다. 따라서 무질서한 매질에 입사되는 빛과 투과되는 빛의 관계를 분석하면 다중산란을 효과적으로 활용 할 수 있다. 불규칙한 매질에 입사되는 빛의 위상을 제어하면 투과되어 나온 빛의 다양한 광학적 성질을 제어 할 수 있는데, 이는 불규칙한 매질에 담겨져 있는 수많은 자유도를 활용할 수 있기 때문이다. 본 연구에서는 빛의 다중산란을 활용한 다기능 산란광학소자(scattering optical element)를 제안한다. 산란광학소자는 무질서한 산란매질과 홀로그래픽 필름으로 이루어져있다. 홀로그래픽 필름이 산란매질에 입사되는 빛의 파면을 제어함으로써 산란매질을 투과해 나온 빛의 광학적 성분을 제어한다. 본 연구에서는 산란광학소자를 이용하여 빛의 세기, 편광, 파장, 근접장 등의 다양한 성분의 제어가 가능함을 보였다. 산란광학소자를 이용하면 복잡한 광학적 설계 및 제조공정 없이 빛의 다양한 성질을 제어할 수 있으므로, 향후 리소그래피, 광통신, 바이오 이미징 기술 등 당양한 분야에 응용 될 수 있을 것이라 기대된다.

Keywords:
다중산란, 파면제어, 광학소자, 홀로그래피

Curved image sensors for biologically inspired vision systems

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Abstract:
Curved image sensors inspired by animal eyes represent a direction of recent development in next-generation vision systems. Single lens type eyes, found in mammalian, fishes and birds, provide an idea for hemispherical cameras, where Petzval-matched curvature in the image sensor can dramatically simplify lens design without degrading image quality (i.e. wide field of view and minimized image distortion). Arthropods eye gives the inspiration for imaging systems that have an extremely wide field of view without abberations and nearly infinite depth-of-field. Nanostructures on the corneal of night active insects or on the wings of Hawk moth give a motivation for the high efficiency optoelectronic devices. Biomimetic approaches with these natural designs accelerate progress in both fundamental science and practical applications. In this report, we present new type of optic designs inspired by the various animal species for advanced image sensors.

Keywords:
Curved image sensors for biologically inspired vision systems

Semiconductor Quantum Dots for Quantum Information Technologies

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Abstract:

Quantum dots (QDs) have been studied intensively as they are promising both as hosts of static quantum bits and as triggered sources of single and entangled photons (flying qubits). In this talk, I will present our recent work of tuning the excitonic properties of QD devices by combing flexible growth protocols and post-growth engineering. I will first show the growth of symmetry variable GaAs QDs on GaAs(001) substrates [1-3]. The optimized sample has low density (〈 1μm-2), narrow excitonic-emission linewidth (〈 4μeV) and very small fine structure splitting (FSS〈 2μeV). I will also present a systematic study of FSS as a function of QD size and shape. Then I will show how the excitonic property of QDs can be switched from the conventional heavy-hole (HH) like to light-hole (LH) like under biaxial tensile strain [4]. I will also report briefly our recent exploration of the dark exciton emission of QDs [5]. Finally, I will demonstrate applications of strain-tunable fast speed QD LED devices in generating single and entangled photons [6, 7] and in establishing QD-atomic hybrid quantum interfaces [8]. These will pave the way to explore fundamental properties of various QDs and their potential relevance in the future quantum technologies. References [1] Y. H. Huo, et al., Appl. Phys. Lett. 102, 152105 (2013). [2] Y. H. Huo, et al., Phys. Rev. B 90, 041304 (R) (2014). [3] J. P. Jahn, et al., Phys. Rev. B 92, 245439 (2015) [4] Y. H. Huo, et al., Nat. Phys. 10, 46 (2014) [5] Y. H. Huo, et al., (in preparation) [6] J. X. Zhang, et al., Nano Lett. 15, 422 (2015) [7] J. X. Zhang, et al., Nature Commun. 6, 10067 (2015) [8] H. Hui, et al., (under revision)

Keywords:
Quantum dots, Quantum Information

Nanowire photovoltaics

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Abstract:

Silicon nanowires (Si NWs) can enable low-cost and efficient photovoltaics, although nonideal electrical characteristics and insufficient control over absorption properties have precluded the promise of Si NWs for next-generation solar cells. We have overcome these limitations through controlled synthesis of core/multishell Si NWs (i.e. p-type/intrinsic/n-type NWs) with highly crystalline, well-defined and faceted surfaces. Photovoltaic devices fabricated from the core/shell NWs with a diameter of ~300 nm exhibit good electrical characteristics, including ultralow leakage currents of ~1 fA, and open-circuit voltages and fill factors up to 0.5 V and 73%, respectively, under one-sun illumination. Photocurrent measurements of the single NWs reveal several unique absorption properties, characterized by size-dependent optical resonances and external quantum efficiencies exceeding unity resulting from optical antenna effects. In addition, we investigated how morphological changes (i.e. different sizes and cross-sectional shapes) in NWs influence the absorption characteristics. To modulate these morphological parameters, we have developed new synthesis protocol for NW growth. Experimental, polarization-resolved external quantum efficiency spectra showed noticeable absorption properties depending on the size of NWs, including red-shifted resonant modes, increased spectral density and weakened optical antenna effects by increasing the size of NWs. Further enhancement of light absorption can be achieved using mirror substrate, vertical nanowire stack heterogeneous nanowire, and periodic axial modulation. Therefore, the ability to modulate absorption through subtle and controllable changes in NWs represents a promising route for developing new photovoltaic and optoelectronic devices.

Keywords:
Nanowire photovoltaics

Effects of reactive oxygen and nitrogen species on nucleobases, DNA, and plasmid

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Abstract:
근래에 플라즈마 장치를 멸균, 생의학, 수질 정화등 분야에 응용하기 위한 연구가 활발하다. 본 연구에서는 Nucleobases (Adenine, Guanine, Cytosine, Thymine), DNA 및 Plasmid의 구조 특성 및 광 특성에 대한 활성산소종 (Reactive oxygen species) 및 활성질소종 (Reactive nitrogen species)의 처리 효과를 연구하였다. 활성종은 Atmospheric pressure plasma jet (APPJ) 또는 Dielectric barrier discharge (DBD) 또는 Microwave plasma torch를 사용하여 발생시켰으며, 플라즈마 장치에서 발생되는 활성종은 Optical emission spectroscopy 및 Fluorescence spectroscopy를 사용하여 분석하였다. 활성종으로 처리된 Nucleobases, DNA 및 Plasmid의 구조 특성 및 광 특성은 Absorption spectroscopy, Circular dichroism spectroscopy, Fluorescence spectroscopy, Raman spectroscopy, 및 Agarose gel electrophoretic patterns를 사용하여 분석하였다. 활성종 특성과 Nucleobases, DNA 및 Plasmid의 구조 특성 사이의 관련성을 조사하였다.

Keywords:
활성종, Atmospheric pressure plasma jet, Dielectric barrier discharge,Adenine, Guanine, Cytosine, Thymine, DNA,Plasmid,Opticalspectroscopy

HAR-NDS (Hyaluronic Acid-Rich Node and Duct System) and Stem Cells

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Abstract:

HAR-NDS appeared to form a network throughout the body, on the surface of internal organs, inside blood and lymph vessels and along nervous system. The HAR-NDS was covered by a layer of EMP-3-positive spindle-shaped epithelium with, below, a layer of vWF-positive but CD31-negative endothelium. The HAR-NDS on the surface of intestine contained a variety of immune cells, usually enriched with mast cells, eosinophils, neutrophils and histiocytes as well as chromaffin cells. Secretory granules from mast cells in the node appeared to pass along the ductules, two or more of which made up a duct. We consistently found that ~ 2% of the cells in the node were immature type, and hypothesized that the system might contain pluripotent and committed stem cells. HAR-NDS contained hematopoietic progenitor cells (HPC), such as granulocytes-macrophage, erythroid, multipotential and mast cell progenitors (MCP). MCPs were the most abundant among the HPCs in the HAR-NDS. Their frequency was fivefold higher than that of the MCPs in bone marrow. The system also contained pluripotent stem cells (PSCs) capable of producing hemangioblast-like cells, which subsequently generated various types of HPCs and differentiated blood cells. We further demonstrated potential PSCs by isolating sca-1+ lin- CD45- small (3.0-5.0 μm in diameter) cells. The PSCs were named as "Node and Duct Stem Cells (NDSC)". NDSCs formed colonies on C2C12 feeders, were positive for fetal alkaline phosphatase, and could the subcultured on the feeders. They were differentiated into neuronal cells in in vitro. Injection of NDSC into mice partially repaired ischemic brain damage. Taken together, we report the discovery of potential adult stem cells that may be involved in an alternative means of blood cell production and tissue regeneration. The HAR-NDS may served as a route that delivers the stem cells to their target tissues.

Keywords:
hematopoietic progenitor cells, hyaluronic Acid, stem cells

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Computational Drug Carrier Design from Microvascular Transport to Cellular Uptake

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Abstract:
In this talk, computational methods for drug carrier design are briefly introduced from microvascular transport to cellular uptake. First of all, the microvascular transport system including red blood cells, blood plasma and drug carriers is simulated by using novel computational methods. Secondly, the journey of drug carriers in extracellular matrix (ECM) and cellular uptake is predicted by considering microvascular networks and interactions between cells and growth factors. Finally, the future direction of drug carrier design will be fully discussed.

Keywords:
drug carriers; nanomedicine, microvascular transport, physiology, rheology

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원자힘현미경 캔티레버 교정법의 현재와 차세대 개발

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Abstract:
1982년 원자힘현미경(AFM)이 발명된 이후 여러 종류의 AFM 응용 현미경들이 개발되었고, 이를 통해 고분해능의 형상, 자기 이미지, 전하 분포, 경도, 고분자 에너지 풍경(energy landscape) 등 다양한 물리량들이 연구와 산업현장에서 측정되고 있다. 캔티레버의 변위나 공진주파수를 물리량으로 변환하는데 있어 중요한 캔티레버 특성이 스프링상수와 유효길이이며, 정량적인 분석에서 많은 경우 변환된 물리량의 정확도를 결정한다. 본 발표에서는 캔티레버의 스프링상수를 교정하기 위해 사용되고 있는 방법들을 소개, 비교하고자 한다. 또한 최근 미국 NIST와 표준연에서 개발 중인 광압 기반 피코뉴튼힘 발생 교정법과 극미소힘 측정수요에 대응하기 위한 표준연 자속양자기반 펨튜뉴튼힘 발생 연구에 대해 소개하고자 한다. 또한 마이크론 크기 초전도 시료의 측정 사례를 통해 캔티레버 특성 측정의 정밀성과 한계를 논의하고자 한다.

Keywords:
원자힘현미경, 스프링상수, 피코뉴튼힘, 펨튜뉴튼힘

Construction of ^{3}He magnetic force microscope with a vector magnet

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Abstract:

We have constructed a ^{3}He magnetic force microscope (MFM), operating within a vector magnet with the base temperature of 300 mK and magnetic field range of 2-2-9 T in the x-y-z direction. We demonstrated magnetic imaging capabilities at very low temperature by imaging simultaneously superconducting vortices and magnetic stripes at T= 500 mK in the ferromagnetic superconductor $ErNi_2B_2C$ which has a ferromagnetic transition below T_{wfm}=2.3 K. The direct visualization of coexistence between superconductivity and magnetism was carried out in $ErNi_2B_2C$. The vector field performance of the apparatus was also demonstrated by the creation and imaging of Abrikosov vortices within a superconducting Nb film using a vector field. For example, an in-plane field allows creating a vortex-antivortex pair which is confined through a single flux tube, and thus showing a linear potential in distance. The 3D-magnet MFM also allows us to measure the paring symmetry of superconductors by MFM via Meissner force detection. We will show anisotropic angular dependence on the magnetic penetration depth in CeCoIn5 and a few pnictide superconductors.

Keywords:

^{3}He, MFM, superconductors, magnetic penetration depth

AFM study of nanopores in liquid environment

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Abstract:

A nanopore is a nanometer-size pore, and it can be a biological protein channel or a hole in a solid-state membrane such as silicon nitride and graphene. When a nanometer-size pore is present in an electrically insulating membrane, it can be used for a single molecule detector. We studied access resistance of a solid-state nanopore in liquid environment after modifying a commercial AFM, and constructed a tuning-fork based apparatus that can place a DNA-tethered tip near a solid-state nanopore and control the DNA moving speed through a nanopore when a DNA molecule is captured and released from a nanopore. A biological protein channel in a lipid membrane is delicate, and probing of the biological nanopore requires state of art technology. We are customizing a liquid AFM for the study of the biological nanopore.

Keywords:
AFM, Liquid AFM, nanopore

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Beyond single frequency PFM: band excitation method

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Abstract:

In the past two decades, piezoresponse force microscopy (PFM) has emerged as an indispensable tool for characterizing local electromechanical response in various materials, such as inorganic ferroelectrics and multiferroics, ferroelectric polymers, and biological systems. PFM measures electrical bias-induced sample deformation. Application of an AC bias with a frequency ω to a conductive tip generates a periodic surface displacement due to the converse piezoelectric effect. In this conventional single-frequency PFM, the response is measured by a lock-in amplifier, yielding amplitude and phase signals, which contain information about the local piezoresponse magnitude and polarization orientation, respectively. However, this single frequency PFM has many drawbacks, such as severe topographic cross-talk and low signal-to-noise ratio. To overcome these disadvantages, many advanced PFM techniques has been developed. In this talk, I will introduce one of the methods, band excitation PFM (BE-PFM) and several specific research results.

Keywords:
piezoresponse force microscopy, multiple frequency, band excitation

Large field of view wavefront shaping for deep brain imaging

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Abstract:

High resolution deep tissue imaging is hindered by multiple scattering from overlaying tissue layers. As we go deeper, aberrations accumulate which require highly accurate complex aberration corrections. The main difficulty lies in the fact that biological tissue generally impose spatially variant aberrations. Here, we will describe our recent efforts to realize large field of view wavefront control to enable high resolution in-vivo imaging over large volumes.

Keywords:
neuroimaging, multiple scattering, wavefront shaping, multiphoton microscopy

Neural map in nanoscale: analysis of serial electron microscope images

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Abstract:

Mapping the connectivity between individual neurons for each synapse is critical to understanding the functions of neural networks. Since the thickness of neuronal arbors can go below a few hundred nanometers and the scale of synaptic structures is in the order of ten nanometers, electron microscopes (EMs) have been used to study the ultrastructure of neurons and their connectivity. While terabytes of data became available thanks to the advancement in high-throughput serial EM imaging technologies, the methods to analyze those images reconstructing volumetric neural structure from serial images remain primitive. In this talk I will introduce recent discoveries in neuroscience found by the analysis of EM images with help from artificial intelligence powered by deep learning and also from EyeWire, an online community of ‘citizen neuroscientists’. We will see that anatomical difference in nanoscale discriminates the types of neurons and that sub-cellular connection specificity determines the functions of neurons.

Keywords:
Neural map in nanoscale: analysis of serial electron microscope images

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Brain imaging application of photoacoustic tomography

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Abstract:

Photoacoustic tomography (PAT) is a novel biomedical imaging technique that can provide new types of anatomical, functional, and molecular imaging information. In recent years, PAT began to attract a great amount of attention as the technique successfully demonstrated a variety of potential for biomedical applications, such as small animal whole body imaging for biological study and cancer diagnosis for clinic. Unlike conventional optical microscopy techniques, such as confocal or two-photon microscopy, PAT is capable of high-resolution tomographic imaging at several-centimeter depths in biological tissues while maintaining the high contrast benefit of optical imaging. Now, the technique is being expanded to neuroscience, forming a new active research area of biomedical photoacoustics. Over the existing brain imaging tools, such as two-photon microscopy and fMRI, the most outstanding imaging feature of PAT is that it can provide real-time functional hemodynamic information of the brain based on the label-free imaging capability and also it enables multi-scale brain imaging from small animal to primate levels. In this talk, I will explain the general principles of PAT and introduce several major neuroscientific research outcomes of the field, along with our current research subjects pursing the brain imaging application of the technique.

Keywords:
photoacoustic tomography, neuroscience, brain imaging

Ab initio materials design by an inverse method

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Abstract:

Since the Materials Genome Initiative was launched in 2011, much attention has been paid to designing advanced materials in an accelerated way and in a cooperative way of theory, computation, and experiment. In the so-called inverse method of materials design, specific material properties are first assigned and target materials are subsequently searched for. A trial-and-error approach has been widely used to develop new materials, however, its applicability to hard optimization problems is limited. Recently, we have developed a new scheme for computational materials design, called AMADEUS (Ab initio MAterials DEsign Using cSa), in which the conformational space annealing (CSA) algorithm for global optimization is combined with first-principles density functional calculations. We show the implementation and efficiency of our new scheme for materials design and the results of successful applications for searching for new materials including Si and C allotropes with direct band gaps, new high-pressure phases, and novel two-dimensional B allotropes. We discuss the implementation of neural network potentials in our scheme to predict new crystal structures.

Keywords:

Materials design, global optimization, electronic structure calculations

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Design of Active and Durable Catalysts toward Oxygen Redox Reactions in Acidic Media for Energy Devices

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Abstract:

Using density functional theory (DFT) calculations and statistical formalisms we rationally design high functional materials for renewable energy systems of fuel cell, Li-ion and Li-air batteries. In the first part of the talk, we screen hundreds of alloys to identify the best candidate of nonprecious nanocatalyst with ternary compounds for active oxygen reduction reaction (ORR) in fuel cell application. Our results indicate that nanoscale 3d-transition metal core encapsulated by Ndopedcarbon-shells can be designed as the catalyst better than conventional Pt showing excellent electrochemical stability in acidic media. The second part of this presentation demonstrates that catalytic activity towards oxygen reduction and evolution reactions (ORR and OER) in a Li–O2 battery can be substantially improved with graphene-based materials. It is accomplished via calculating free energy diagrams for the redox reactions to identify the rate-determining step controlling overpotentials. It is unveiled that the catalytic performance is well described by adsorption energies of intermediates LiO2 and Li2O2 and propose that graphene-based materials can be substantially optimized through either by N doping or encapsulating Cu(111) single crystal. Furthermore, our systematic approach with DFT calculations applied to design of optimum catalysts enables to screen promising candidates for the oxygen electrochemistry leading to considerable improvement of efficiency over a range of renewable energy devices. These two results are outstanding examples showing how to screen desired materials with more than single properties using combined multi-scale computations, which are validated by experimental measurements.

Keywords:
Density functional theory calculations, Catalyst, Energy, Oxygen, Acid

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Inclusion of Environmental Effect to Electronic Structure Calculations using Grid-based Mean-field Coupling of MD and DFT

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Abstract:

First-principles based electronic structure theory, such as density functional theory (DFT) calculation, has been employed in a variety of complex systems. Notwithstanding its wide applications and successes, the calculation often assumes the system being in vacuo due to its relatively high computational cost. To extend the applicability of first-principles calculations, it is therefore important to develop new routes to effectively include dynamic environmental effect of the solvation into electronic structure calculations. In this talk, we discuss about our recent approach of grid-based seamless coupling of classical molecular dynamics simulation (to sample the dynamical environmental effect) with planewave based DFT (to investigate the electronic structure), namely DFT in classical explicit solvent (DFT-CES). By employing mean-field approximation, the computational overhead of DFT-CES is much reduced compared with that of conventional QM/MM methods. Moreover, we coupled the fast and efficient free energy calculation method based on two-phase model (2PT) into our DFT-CES method, which enables the direct and simultaneous computation of solvation free energies as well as the electronic structure changes due to solvation effect. We further discuss how our new multiscale simulation method can be applied to investigate exotic material properties where solid-liquid interface becomes important; e.g., solvation of heterogenous catalyst surface, electrochemical interface, etc.

Keywords:

Inclusion of Environmental Effect to Electronic Structure Calculations using Grid-based Mean-field Coupling of MD and DFT

New Research Opportunities with PAL-XFEL Facility

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Abstract:

PAL-XFEL project is aiming to produce 0.1 nm coherent X-ray laser to photon beam users. In order to produce such photons, there are 10-GeV electron linac based on S-band normal conducting accelerating structures and a 150-m long out-vacuum undulator system. The project was started in April 2011, and the 1.11 km-long building was completed in February 2015. The installations of 10 GeV linac, undulator systems, and beamlines have been completed by the end of 2015. The operation permit was issued on April 12, 2016, and the beam commissioning was started immediately. On April 25, the linac was able to accelerate electron beams from RF photocathode electron gun to 10 GeV, which is the design value. By the end of June 2016, the commissioning has achieved its first goal by lasing 0.5 nm coherent X-ray photons. We will pursue our effort to have a coherent X-ray of 0.1 nm by the end of 2016. Korean scientists as well as international ones will have new research opportunities with PAL-XFEL facility from 2017, especially in the fields of ultra-fast chemical studies and structural molecular imaging.

Keywords:
PAL-XFEL, X-ray, Linac, Undulator

Materials Imaging and Dynamics Station at the European X-Ray Free-Electron Laser Facility

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Abstract:

A new international X-Ray Free-Electron Laser facility, European XFEL, is under construction in the Hamburg area in Germany. Several stations will provide new capabilities for experiments using XFEL radiation both in the soft- and hard X-ray regime. Experiments at the Materials Imaging and Dynamics (MID) station will seek to exploit the exceptional coherence properties, the high flux, and the short duration (fs) of XFEL pulses. The MID instrumentation allows experiments to be carried out in a surface sensitive grazing angle geometry, also on liquid surfaces, potentially combined with a synchronized optical pump laser for sample excitation. Experiments on solid samples in a He cryostat will be possible at MID that covers both the SAXS and WAXS regimes with a variable photon energy from 5 to 25 keV. Focusing of the beam is possible in the range from about 10 micron to 100 nm. First experiments at MID are planned for summer 2017. In the talk I will outline some novel experimental techniques, and first results, where the unique properties of XFEL radiation can bring new insight.

Keywords:
XFEL, Materials Imaging and Dynamics

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Macromolecular crystallography at SACLA

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Abstract:

X-ray crystallography is a powerful method to determine complex biomolecule structures at angstrom resolution. To date, more than 120,000 biological macromolecular structures have been deposited at Protein Data Bank (PDB) and about 90% of them were solved by X-ray crystallography. To enable structure analyses of more difficult and important targets, X-ray source, detectors, sample handling, and software have been greatly improved. Recently, femtosecond X-ray pulses from X-ray free electron laser (XFEL) became available to allow damage-free and high-resolution structure analyses at cryo or room temperature. At SACLA, two data collection methods for XFEL are currently performed; SF-ROX and SFX. SF-ROX (serial femtosecond rotational crystallography) [1] utilizes an X-ray diffractometer for conventional rotational crystallography and large crystals to collect X-ray snapshots with small rotational intervals from different positions of the crystal. High-resolution structure analysis of photosystem II was achieved with SF-ROX method using large crystals [2]. SFX (serial femtosecond crystallography) was originally developed at LCLS [3], which collects X-ray snapshots from stream of microcrystals at room temperature. An experimental setup for SFX consisting of a helium chamber, an injector holder, and a multiport charge-coupled device (MPCCD) detector was developed, which provides easily interchangeable several experimental options [4]. To enable highly efficient data collection, grease matrix method [5] was developed and sample consumption was greatly reduced. For SFX experiment, data processing pipeline including Cheetah for hit-finding [6] and CrystFEL [7] was developed for real-time feedback in experiment [8]. At SACLA, several SFX experiments such as damage-free [9], experimental phasing [10,11], and time-resolved structure analysis have been performed. I would like to introduce the methods and some results. References [1] Hirata, K. et al. Nature Methods 11, 734–736 (2014). [2] Suga, M. et al. Nature 517, 99–103 (2015). [3] Chapman, H. N. et al. Nature 470, 73–77 (2011). [4] Tono, K. et al. J. Synchrotron Rad. 22, 532–537 (2015). [5] Sugahara, M. et al. Nature Methods 12, 61–63 (2015). [6] Barty, A. et al. J. Appl. Cryst. 47, 1118–1131 (2014). [7] White, T. A. et al. J. Appl. Cryst. 45, 335–341 (2012). [8] Nakane, T. et al. J. Appl. Cryst 49, 1035–1041 (2016). [9] Fukuda, Y. et al. PNAS 113, 2928–2933 (2016). [10] Yamashita, K. et al. Sci. Rep. 5, 14017 (2015). [11] Nakane, T. et al. Acta Cryst. D71, 2519–2525 (2015).

Keywords:
Macromolecular crystallography at SACLA

Evolution of Internal Strain Development during the Catalytic Process using X-ray Free Electron Laser

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Abstract:

The recent advent of hard x-ray free electron lasers (XFELs) opens new areas of science due to their exceptional brightness, coherence, and time structure. In principle, such sources enable studies of dynamics of condensed matter systems over times ranging from femtoseconds to seconds. In this talk, we show the recent results of the evolution of in-situ local deformation field of Cu exchanged ZSM-5 zeolites during the nitrogen oxide reduction catalysis using coherent X-ray diffraction imaging technique with X-ray free electron laser. The use of additional hydrocarbon to activate the Cu ions at relatively low temperature, results in the observation of unusual strain during the catalytic process and is the signature of the inhomogeneous distribution of hydrocarbons adsorbed at particular areas of the zeolites. The strain is then released during the subsequent steps of the catalytic process of the reduction of the nitrogen oxides.The observed time dependence of the strain development during the catalytic process should therefore be considered as a major factor in the design of future catalytic materials. This research was supported by the National Research Foundation of Korea (Nos. NRF-2014R1A2A1A10052454, 2015R1A5A1009962, 2016R1A6B2A02005468) and Samsung Electronics and Samsung Display.

Keywords:
X-ray Free Electron Laer,Coherent X-ray Diffraction Imaging,Catalysis, Zeolite

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Strongly enhanced Rashba-Dresselhaus splitting in the perovskite oxide heterostructure

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Abstract:

One reason behind the widespread interest in the two-dimensional electron gas (2DEG) emerging at the surface of the perovskite oxide heterostructure is the Berry phase physics it hosts due to its Rashba-Dresselhaus spin-orbit interaction, the momentum-dependent spin splitting due to the broken inversion symmetry and atomic spin-orbit coupling. However, it has not been understood how this splitting can be maximized in a physical system without applying external electric field. Here, we present a promising route to realize significant Rashba-type band splitting using thin film heterostructure. Based on a first-principles method and analytic model analysis, a tantalate layer on $BaHfO_3$ is shown to host a two-dimensional bands originating from Ta t_{2g} orbitals with strongly enhanced Rashba-Dresselhaus spin splittings. However, the magnitude of the interaction owes to the contributions from the e_g orbitals. Moreover, the interaction magnitude is strong not only around the band bottom but also around the band saddle points. This indicates that the Rashba-Dresselhaus spin-orbit interaction removes spin degeneracy at the density of state divergence, known as the van Hove singularity, which may stabilize spin-triplet superconductivity at low temperature.

Keywords:
Rashba-Dresselhaus spin-orbit interaction, surface band, perovskite oxide, 5d transition metal, heterostructure, van Hove singularity

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Valley pseudospin in 2D transition metal dichalcogenides

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Abstract:
Atomically thin crystals, such as monolayer transition metal dichalcogenides (TMDs), provide a new platform to investigate the electrons in low dimensional solid state systems. In these materials, two inequivalent energy band extrema occur at the edges of the Brillouin zone, known as valleys, which serve as a binary degree of freedom of electrons similar like spins. The unique control of valley pseudospins by optical and electrical means are not only fundamentally interesting, but may also find applications in valley-based electronics and optoelectronics. In this talk, we discuss methods to manipulate the valley polarization in 2D TMD materials. First, we describe the valley-dependent electron transport induced by the valley Hall effect. We use optical techniques to directly image the valley polarization generated by the valley Hall effect on monolayer molybdenum disulfide (MoS2) with spatial resolution. We will also discuss the possibility to tune the valley Hall conductivity by controlling the crystal's inversion symmetry in bilayer. Second, we investigate the pure electrical generation of the valley polarization in monolayer MoS2 which is possible when the symmetry of the crystal is altered by applying strain. The dependence of the valley polarization on the crystal axis, strain, and in-plane electric field will be discussed.

Keywords:
Valleytronics, MoS2, Optical imaging

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Berry phase due to atomic orbital degree of freedom

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Abstract:
We examine properties of the Berry phase in multi-orbital cubic systems with both time-reversal and inversion symmetries. We find that the Berry curvature near the Gamma point in the Brillouin zone is proportional to the atomic angular momentum L. Considering that the Berry curvature acts as an effective magnetic field in momentum space, this result implies that trajectories of accelerated electrons are bent sideways as if an an external magnetic field is applied parallel to L.

Keywords:
Berry phase, orbital angular momentum

Dirac semimetals protected by type II nonsymmorphic symmetry

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Abstract:

Topological semimetals have energy bands near the Fermi energy sticking together at isolated points/lines/planes in the momentum space, which are often accompanied by stable surface states and intriguing bulk topological responses. Although it has been known that certain crystalline symmetries play an important role in protecting band degeneracy, a general recipe for stabilizing the degeneracy, especially in the presence of spin-orbit coupling, is still lacking. Here we show that a class of novel topological semimetals with point or line nodes can emerge in the presence of a new type of nonsymmorphic symmetries, dubbed a type-II nonsymmorphic symmetry, in systems with strong spin-orbit coupling. A type-II nonsymmorphic symmetry has momentum independent quantized eigenvalues whereas its commutation relation with other point group symmetries depends on the momentum. Such a dual nature leads to a unique band connection in the invariant space, providing a basic building block for emerging topological semimetals.

Keywords:
Dirac semimetal, nonsymmorphic symmetry, topological phase

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2016.10.19 - 2016.10.21

Shift charge and spin photocurrents in Dirac surface states of topological insulator

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Abstract:
The generation of photocurrent in condensed matter is of main interest for photovoltaic and optoelectronic applications. Shift current, a nonlinear photoresponse, has attracted recent intensive attention as a dominant player of bulk photovoltaic effect in ferroelectric materials. In three dimensional topological insulators Bi_2X_3 (X: Te, Se), we find that Dirac surface states with a hexagonal warping term carry shift current by linearly polarized light. In addition, shift spin-current is introduced with the time-reversal symmetry breaking perturbation. The estimate for the magnitudes of the shift charge- and spin-currents are 0.13 I_0 and 0.21 I_0 (nA/m) with the intensity of light I_0 measured in (W/m^2), respectively, which can offer a useful method to generate these currents efficiently.

Keywords:
Topological insulator, photocurrent, spin current, shift current, Dirac surface state

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Multi-Dimensional Hydrodynamics Simulations with Additional Features: Radiation and Reaction

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Abstract:

Numerous astrophysical phenomena have been studied by numerical simulations. As computing power increases such as parallel computing, it is now possible to perform high-resolution multi-dimensional hydrodynamics simulations with additional physics such as radiation and reaction. In this presentation, I briefly review numerical algorithms which incorporate the additional physics into the hydrodynamics code. For the astrophysical applications, there are three interesting reactions, nuclear, atomic, and molecular. Some example studies that include these three reactions are given in this presentation.

Keywords:
numerical, hydrodynamics, radiation, reaction

Static-Fluid Black Holes

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Abstract:
We present new black-hole solutions produced by static perfect fluid. In particular, we consider the base spatial geometry to be S_3 and H_3. We shall classify the solutions, and discuss the spacetime structure including the horizon, the singularity, the geodesic motions, etc. We shall finally discuss the fate of the black holes from the stability study.

Keywords:
black hole, perfect fluid

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2016.10.19 - 2016.10.21

Blackholes with anisotropic fluid

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Abstract:
We study a blackhole geometry in a closed space geometry with anisotropic fluid. The spacetime geometry is classified in terms of the anisotropic parameters of the fluid. The presence of an outer boundary and inner horizon are shown to depends on the anisotropic parameters.

Keywords:
blackhole, anisotropic fluid

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2016.10.19 - 2016.10.21

The bound on radiation energy in the collision of two Myers-Perry black holes

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Abstract:
We have investigated the upper bound of the radiation energy in the head-on collision of two Myers-Perry black holes. Initially, the two black holes are far away from each other, and they become one black hole after the collision. We have obtained the upper bound of the radiation energy thermodynamically allowed in the process. The upper bound of the radiation energy is obtained in general dimensions. The radiation bound depends on the alignments of rotating axes for a given initial condition due to spin-spin interaction. We have found that the collision may not be occurred for a initially ultra-spinning black hole.

Keywords:
black hole, gravitational radiation, thermodynamics

General Relativistic Modification of Goldreich-Julian Model

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Abstract:
We consider a magnetic dipole model of a pulsar and investigate general relativistic effects on electromagnetic radiation from the pulsar. Among such effects, modification of Goldreich-Julian model would be the most interesting and challenging issue. In the strongly curved spacetime around the pulsar magnetosphere, we compute the induced electric field due to the rotation of the pulsar. We extend our investigation to a pulsar model with a general configuration, one in which the magnetic dipole moment is not aligned with the rotation axis. To implement our analysis, we develop a perturbation method, by which we can handle the effect of the rotation coupled with the inclination angle between the rotation axis and the axis of the magnetic dipole.

Keywords:
pulsar, general relativity, Goldreich-Julian model

Hamiltonian analysis of nonlocal gravity

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Abstract:

Nonlocal gravity is recently studied for explaining the late time acceleration of the Universe. We investigate the Hamiltonian structure of nonlocal gravity. There are some debates on the existence of the ghost mode in the localized nonlocal gravity action in which two scalar fields are introduced. We try to clarify the ghost modes with the Hamiltonian analyis.

Keywords:
nonlocal gravity, accelerating universe, Hamiltonian analysis, ghost

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2016.10.19 - 2016.10.21

Tunneling decay of false vortices with gravitation

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Abstract:
We investigate the tunneling decay of vortices initially trapped in the false vacuum of scalar electromagnetic theory with gravitation in three spacetime dimensions. This paper is the extension of our previous paper, tunneling decay of false vortices, with gravitation. In this study, the false vacuum contains metastable vortex solutions instead of the homogeneous configuration at the initial moment. The vortex solution can have inside true vacuum state and the magnetic flux with the thin-wall in the present of gravitation. We present the numerical solutions for the gauge, scalar field, and metric functions. We construct the junction condition to see indirectly if the vortex can expand dynamically after tunneling.

Keywords:
decay of false vortices, gravitation, junction condition

Ion Acceleration from Relativistic Laser Plasma: Progress and Perspectives

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Abstract:

Experiments on ion acceleration driven by high intensity laser pulses over the past ~15 years have demonstrated the generation of multi-10s of MeV proton and ion beams with remarkable properties such as ultrashort burst emission, high brilliance, and low emittance over a wide range of laser and target parameters. The unique exploratory mission of this research is to build the scientific foundation needed to develop high energy laser-particle accelerators, to expand the fundamental understanding of matter at very high temperature and density conditions and its dynamics. After short survey of relevant background, this presentation will discuss the recent experimental findings on ion acceleration obtained on 1.5 PW laser facility at CoReLS, IBS, Korea. We will discuss the newly found scenario where ions are accelerated in the electrostatic field of charged cavity created by relativistic ultra-short and high contrast laser pulses at the target front and by the enhanced sheath field established by relativistic electrons at the target rear surface via so-called Target Normal Sheath Acceleration mechanisms (co called enhanced TNSA). In particular, those scenarios are offering more favorable proton energy scaling with laser intensity than it is known for "ordinary" TNSA scenario. Additionally, the proton source and beam properties at PW laser power will be discussed. The latter are essential for potential applications of laser driven ion beams. Our measurements are closely related to recent development or imminently anticipated development of laser technology to bring the existing laser systems to a multi-PW level. Our findings pave a way to achieving an ion source and beam desire parameters and they encourage further activities for optimisation of laser plasma-based accelerators.

Keywords:

Ion Acceleration from Relativistic Laser Plasma:Progress and Perspectives

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Rapid and uniform heating of matter with laser-driven quasimonoenergetic aluminum ions

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Abstract:

With the development of several novel heating sources, scientists can now heat a small sample rapidly above 10,000 K. Although matter at such an extreme state, known as warm dense matter, is commonly found in astrophysics (e.g., in planetary cores) as well as in high energy density physics experiments, its properties are not well understood and are difficult to predict theoretically. A sufficiently large warm dense matter sample that is uniformly heated would be ideal for these studies, but has been unavailable to date. On the Trident laser facility at Los Alamos National Laboratory, we have used a beam of quasi-monoenergetic aluminum ions to heat gold and diamond foils rapidly and uniformly. For the first time, we visualized directly the expanding warm dense gold and diamond with an optical streak camera. We developed a new technique to determine the initial temperature of these heated samples from the measured expansion speeds of gold and diamond into vacuum. We anticipate the uniformly heated solid density target will allow for direct quantitative measurements of equation-of-state, conductivity, opacity, and stopping power of warm dense matter, benefiting plasma physics, astrophysics, and nuclear physics.

Keywords:

Rapid and uniform heating of matter with laser-driven quasimonoenergetic aluminum ions

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2016.10.19 - 2016.10.21

고체 발생 플라즈마를 이용한 레이저 기반 전자빔 가속

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Abstract:
레이저 기반 전자빔 가속기는 고출력 레이저와 플라즈마 사이의 상호 작용에서 발생하는 plasma wakefield를 이용하여 전자를 가속하는 기술이다. 이때 플라즈마는 강한 가속장을 생성할수 있으므로 소형 고에너지 전자빔 가속기 제작이 가능하다. 또한 가속영역이 좁아 펨토초 전자빔을 가속할수 있으므로 극초단 시분해용 방사전원 제작이 가능한 기술이다. 이 레이저 기반 전자빔 가속기는 통상 기체 표적을 사용하여 플라즈마를 생성한다. 즉 고압의 기체를 진공에 분사하여 균일한 기체 매질을 형성하고 이곳에 레이저를 집속하여 전자를 가속한다. 이 경우 많은 양의 기체를 진공에 분사하여야 하므로 진공에 민감한 방사광 가속기등에 사용이 제한적이된다. 본연구를 이 문제를 해결하기 위하여 고체 표적에 나노초 레이저를 입사하여 laser ablated plasma를 생성하고 이를 이용하여 전자를 가속하였다. 알루미늄 표적에 나노초 레이저를 선형 집속하여 플라즈마를 생성하였다. 이때 전자빔 가속을 위한 플라즈마의 밀도는 이 나노초 레이저를 강도의 조정을 통하여 플라즈마의 확산 속도를 조정하여 미세하게 조정할 수 있었다. 이 플라즈마를 이용하여 55 MeV의 유사 단일 에너지 전자빔을 가속할 수 있었다. 이 전자빔의 전하는 10pC이었으며 발산각은 수평 11 mrad, 수직 6 mrad 이었다. 또한 위치 안정도는 3 mrad의 안정적인 전자빔을 가속할 수 있었다. 알루미늄과 같은 높은 Z 원자로 이루어진 플라즈마에 고출력 레이저가 입사하는 경우 이온화에 의한 발산(ionization defocusing)으로 인해 전자 가속 거리까 짧아지게 된다. 본 실험에 상용된 레이저의 강도는 알루미늄의 이온화에 필요한 에너지에 비해 10 배 이상으로 2D PIC 계산을 통해 확인한 결과 이정도의 강도를 가지는 레이저의 경우 ionization defocusing의 효과가 낮아저 실험결과와 같은 높은 에너지의 전자를 가속할 수 있음을 확인하였다.

Keywords:
laser wakefield acceleration, laser ablation

Selectively Enhanced Emission of Radiation from a Current Source Embedded in Cut-off of a Plasma-like Medium

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Abstract:

Radiation source of narrowband, strong coherent emission is a great interest in many research fields. Various ideas based on wave-particle interaction were studied, such as X-ray free-electron-laser and coupling structures in vacuum tubes in microwave or THz regime. However, the wave-particle interaction usually requires complicated structures such as magnetized cavity (for example, gyrotron) or periodic magnetic field like an undulator. The underlying fundamental idea of these systems is that narrowband radiation can originate from narrowband current oscillation. In this presentation, however, we introduce a fundamentally different way of generating narrowband radiations. Instead of making the current oscillation narrowband, we selectively enhance the emission with a desired frequency from a given, generally broadband current source. We can accomplish it by embedding the current source in a cut-off region of a general plasma-like medium. Since the radiation impedance is infinite at cut-off, this leads to unphysical situation where, from Ohm's law, the radiation power becomes infinite. This means that a steady-state analysis is not valid. From solving 'driven time-dependent Schroedinger equation', we show that the radiation grows temporally. Direct result of such growth is the selectively enhanced emission (SEE) at the cut-off frequency, from a general broadband current source. Ideally the spectral density can be enhanced by an order of magnitude. We provide examples of SEE, which are mostly from laser-plasma interactions. However, we discuss that SEE is quite general, not specific just for laser-plasma interaction. We introduce on-going researches on coherent transition radiation (CTR) and beam-waveguide systems, where SEE can be observed potentially. The applications of SEE are considered to be in strong narrowband THz sources and X-ray.

Keywords:
Radiation, Plasma emission, cut-off

Quarkonium Physics/Some College Physics Problems

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Abstract:
We review remarkable progress in our understanding of quarkonium production mechanism since 1990s. The discussion is concentrated on the resolution of the prompt J/psi polarization puzzle. As a separate subject, we also introduce a few heuristic studies on college physics problems including complete energy-momentum transfer in three-body collisions and mechanical Snell's law.

Keywords:
Quarkonium Physics/Some College Physics Problems

Probing the top-quark with diboson production at the LHC

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Abstract:

The threshold behavior of top-quark loop amplitudes deserves much interest for the determination of top quark properties. In this study we calculate the amplitudes of the gluon-gluon scattering to diphoton, and to Z boson + photon final states at the LHC, via quark loops. Including the effect of ttbar bound-state formation, the final diboson mass spectrum has a wiggled dip and peak structure around the ttbar threshold region, which has high sensitivity to the top quark mass and width parameters. With the advantage of using the cleaner final state objects from dibosons, we demonstrate the precision measurement of the top-quark mass and width parameters which is achievable using the future run at the LHC.

Keywords:
top-quark mass, top-quark width,ttbar threshold region, ttbarbound state, Coulomb resummation, diboson spectrum

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Apparent unitarity violation in top quark's mass off-shell region from a new physics at high energy colliders

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Abstract:

Perturbative unitarity conditions have been playing an important role by estimating the energy scale of new physics, including the Higgs mass as one of the most important examples. In this letter, we show that there is a possibility to see the hint of a new physics (top quark partner) indirectly by observing an "apparent" unitarity violation in M_{bw} distribution well above top quark mass in a process of a heavy resonance decaying into a pair of top quarks.

Keywords:
Large Hadron Collider, Large extra dimension, Supersymmetry

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2016.10.19 - 2016.10.21

Hunting Composite Higgs model UV embeddings in di-boson, top-pair and other exotic searches at the LHC

FLACKE Thomas Dieter*
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Abstract:

Models of compositeness can successfully address the origin of the Higgs boson, as a pseudo-Goldstone of a spontaneously broken global symmetry, and flavour physics via the partial compositeness mechanism. If the dynamics is generated by a simple underlying theory defined in terms of a confining gauge group with fermionic matter content, models which contain a Higgs and top partners at the same time also contain additional light scalars in the composite spectrum. We study the phenomenology of these additional scalars in light of the di-boson, top-pair and other exotic searches at LHC.

Keywords:

composite Higgs models, strongly coupled models, LHC BSM searches

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2016.10.19 - 2016.10.21

Searching for Relaxions through the Higgs Portal

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Abstract:

Relaxion models provide a novel approach to solving the hierarchy problem of electroweak symmetry breaking. The smallness of the electroweak scale is explained dynamically, through the rolling of a background field -- the relaxion -- which couples to the Higgs. We show that relaxion models generically predict mixing of the Higgs with the relaxion field. As a consequence, the relaxion couplings to Standard model particles can be parameterized though the mixing angle with the Higgs and its mass. We present a survey of bounds on relaxion models from particle physics, fifth force experiments, astrophysics, and cosmology.

Keywords:
Relaxions, Higgs portal, very weakly interacting particles, very light scalars, fifth force experiments

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2016.10.19 - 2016.10.21

Peccei-Quinn inflation and the stability of Higgs potential

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Abstract:

We consider a simple extension of the Standard Model with Peccei-Quinn scalar field as a UV completion of Higgs inflation and discuss the stability of Higgs potential and cosmological constraints on the model from CMB anisotropies and dark matter relic density. Some of issues beyond the Standard Model such as baryogenesis, neutrino masses and hierarchy problem will be addressed.

Keywords:
Higgs inflation, Axion, Vacuum stability

Investigating the jet activity accompanying the production at the LHC of a massive scalar particle decaying into photons

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Abstract:
We study the jet activity that accompanies the production by gluon fusion of a new physics scalar particle decaying into photons at the LHC. In the considered scenarios, both the production and decay mechanisms are governed by loop-induced interactions involving a heavy colored state. We show that the presence of large new physics contributions to the inclusive diphoton invariant-mass spectrum always implies a significant production rate of non-standard diphoton events containing extra hard jets. We investigate the existence of possible handles that could provide a way to obtain information on the underlying physics behind the scalar resonance, and this in a wide mass window.

Keywords:
Jet activity, Massive scalar particle, Diphoton, LHC

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2016.10.19 - 2016.10.21

Ultra high energy cosmic ray as a probe of electroweak sphaleron

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Abstract:
We study the Ultra High Energy Cosmic Rays (UHECR) as a probe of the electroweak sphaleron processes. Indeed the sphaleron process could be sizable above O(10) TeV according to the recent argument by Tye and Wong (TW). Our focuses are on the high energy proton-proton and neutrino-nucleon collisions for the cosmic ray observatories such as TA and Pierre Auger and the IceCube neutrino detector. Various types of signatures are suggested to trigger for electroweak sphaleron events, which clearly show distinguished features from TeV scale microscopic blackhole events and conventional QCD air shower events.

Keywords:
Electroweak Sphaleron, Baryon-Number violation, Lepton-Number violation, 100 TeV Phenomenology, Ultra-High-energy Cosmic Rays, IceCube detector

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2016.10.19 - 2016.10.21

원자핵건판 검출기를 이용한 중성미자 실험들

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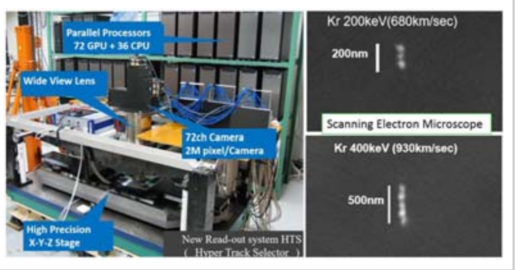

Abstract:
원자핵건판은 오늘날까지 입자물리 실험에 쓰이는 가장 오래된 입자 검출기로서 1970년대부터는 FNAL E531, CHORUS, DONuT 및 OPERA 와 같은 중성미자 실험들에 사용되어왔으며, 앞으로 SHiP 실험에도 사용될 예정으로 있다. 이러한 실험들은 ~수 μm 정도의 위치분해능을 가지는 원자핵건판의 잇점과 더불어, 원자핵건판에 전자공학적 검출기를 결합한 하이브리드 방법과 고속 자동스캐닝 장치들의 개발로 인해 가능해졌다 [그림 좌 참조]. 이러한 방법은 현재 J-PARC 의 이중 기묘핵(S=-2 핵)의 탐색에도 적용되고 있으며, 더욱이 최근에는 특수 목적에 적합한 원자핵건판(예를 들어, 1 μm 이하의 위치분해능을 가진)들이 개발됨에 따라 [그림 우 참조] 암흑물질 탐색, 감마선 망원경 및 뮤온 라디오그래피 등에도 쓰이고 있다. 본 발표에서는 원자핵건판을 사용하는 중성미자 실험들뿐만 아니라, 이러한 다양한 응용에 대해서 소개하고자 한다.

Keywords:
원자핵건판, 중성미자 실험

Study of B -> D(*) tau nu at Belle and other B-factories

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Abstract:

The semi-tauonic decay B -> D(*) tau nu is well understood within the framework of the Standard Model (SM), and because of heavy lepton tau involved in the decay it is sensitive to new physics beyond the SM, for exmaple type-II 2HDM. Recently, the B-factory experiments, Belle and LHCb, have reported their measurements of these decays, which, in combination with the existing results from BaBar, show approximately 4-sigma deviation from the predictions of SM. In this presentation, we will report recent Belle measurements on these decays, involving not only the branching fractions but also measurement of tau polarization in this decay.

Keywords:
Belle, B meson, Standard Model, B-factory

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2016.10.19 - 2016.10.21

An Intriguing Burst from UFFO-pathfinder space telescope

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Abstract:
A Gamma-Ray Burst dedicated satellite payload, UFFO(Ultra-Fast Flash Observatory)-pathfinder, was launched onboard the Lomonosov spacecraft in April 28, 2016. Its primary aim is to capture the rise phase of the optical light curve which is one of the least known aspects of GRBs. During last three months the UFFO-pathfinder has been going through careful check-up processes and calibrations in orbit prior to its full operation. We will report an intriguing burst-like event which was captured in the middle of a calibration run in space.

Keywords:
Gamma-ray burst, cosmic ray

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2016.10.19 - 2016.10.21

Measurement preparation for anti-Hydrogen (ion) production cross-section between anti-Proton beam and Positronium

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Abstract:

In the general theory, Equivalence principle is the basis of the theory which states about equivalence of gravitational mass and inertial mass. But there's no mention about equivalence of gravitational mass between particle and anti-particle and even there's almost no experiment which measured gravity between particle and anti-particle. By measuring free fall acceleration of Ultra-cold anti-Hydrogen in the terrestrial gravitational field, GBAR project plans to test the equivalence principle. In order to produce ultra-cold anti-Hydrogen, we plan to produce and measure dense Ortho-Positronium cloud to make anti-Hydrogen ions by collision with anti-proton beam. With dense Positronium cloud, we plan to measure production cross-section for (anti-)hydrogen and (anti-)hydrogen ion from collision between (anti-)proton and Positronium as framework for GBAR. Positronium intensity measurement and cross-section measurement between proton beam and Positronium has been prepared.

Keywords:
Positronium, anti-hydrogen, GBAR, gravity, equivalence principle

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2016.10.19 - 2016.10.21

Measurement of the cross section ratio ttbb/ttjj using dilepton final states in pp collisions at 13 TeV

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Abstract:
The measurement of the cross section ratio ttbb/ttjj is presented using a data sample corresponding to an integrated luminosity of 2.3 fb−1 collected in pp collisions at 13 TeV with the CMS detector at the LHC. Events with two leptons (e or mu) and at least four reconstructed jets, including at least two identified as b quark jets, in the final state are selected. The measured ratio is 0.022 +− 0.003 (stat) +− 0.006 (syst) and cross section ttbb is 3.9 +− 0.6 (stat) +− 1.3 (syst) pb and ttjj is 176 +− 5 (stat) +− 33 (syst) pb in the full phase space. The measurement is compatible with the expectation obtained from the POWHEG simulation interfaced with PYTHIA.

Keywords:
top, higgs

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2016.10.19 - 2016.10.21

Measurement of Normalized Differential Cross Section for the ttbar Production in the Dilepton Channel in pp Collisions at 13 TeV

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Abstract:

The normalised differential cross section for top quark pair production is measured in the dilepton (e+e−, μ+μ−, and μ∓e±) decay channel in proton-proton collisions at a center-of-mass energy of 13 TeV. The measurements are performed with data corresponding to an integrated luminosity of 2.2 fb−1 collected in 2015 using the CMS detector at the LHC. The cross section is measured differentially as a function of the kinematic properties of the leptons, b jets, top quarks, and top quark pairs at particle level. The results are compared to several models of perturbative QCD and found to be in agreement with the standard model predictions.

Keywords:

Top quark, CMS, LHC

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 E14.07
2016.10.19 - 2016.10.21

Recent results of higgs boson on/off-shell production and decay width using double W boson leptonic decay mode

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Abstract:
We present the results of higgs boson coupling and decay width using proton-proton collision data with center-of-mass energies 8 and 13 TeV. The events are selected by the configuration of double W boson decaying leptonically.

Keywords:
Higgs boson, coupling, width

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 E14.08
2016.10.19 - 2016.10.21

Search strategies for vector-like quark partners at LHC run-II

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Abstract:
We present results on several new search strategies for heavy vector-like quark partners at the LHC run-II. Run- II has sensitivity to single- and pair-produced quark partners with masses beyond 1 TeV. Decays of such heavy particles yield highly boosted tops, Higgses, and weak gauge bosons, all of which decay dominantly hadronically. At high boost, the SM background of hadronic final states can be substantially suppressed when applying jet-substructure techniques. We present several case studies where the identification of hadronically decaying tops, Higgses, and/or electroweak gauge bosons allow to make new search channels competitive at run-II.

Keywords:
vector-like quark searches, top-partners, LHC exotics searches, jet substructure, composite Higgs models

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2016.10.19 – 2016.10.21

Randall-Sundrum Type Microscopic Black Holes at the LHC

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Abstract:
The Randall-Sundrum(RS) model has been introduced to explain the well known Planck-weak hierarchy problem via a warped extra dimension. One of the important features of the RS model is that it provides a unified geometric explanation of the hierarchy problem and the flavors of the SM particles assuming the SM fields are propagating in the warped bulk and the fermions are localized on the branes. The RS model also predicts the production of microscopic black holes at LHC energies. We study the production and decay of microscopic black holes in the framework of the RS model using Monte carlo simulations. The existing Charybdis black hole generator program is modified to generate the RS-type microscopic black holes. The physical features of the RS-type black holes are extensively investigated for various sets of theoretical and experimental parameters.

Keywords:
microscopic black hole, extra dimension, Randall-Sundrum, LHC

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Fission properties of neutron-rich actinide nuclei using multi-nucleon transfer reactions

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Abstract:

Recent results on fission properties of neutron-rich actinide nuclei using multi-nucleon transfer reactions will be presented. In multi-nucleon reaction, a wide variety of nuclei around the target nucleus is produced by identifying transfer channels, fission data of more than 15 nuclei can be obtained in one experiment. Another feature is that excited states of a compound nucleus is populated f up to several tens MeV, allowing us to study the excitation energy dependence of fission properties. Experiment was carried out at the tandem accelerator facility in Japan Atomic Energy Agency, Tokai, Japan. The obtained data are fission barrier height, average spin of the fissioing nucleus, fragment mass distributions. We studied the reactions of 18O + 232Th,238U,237Np and 248Cm, and we are planning the reactions of 18O + 243Am, 249Cf, 254Es. Correlation measurement of fission fragments and prompt neutrons is planned.

Keywords:
Fisson, neutron-rich atinide nuclei, multi-nucleon transfer reaction

Nuclear Physics with Slow and Stopped Beams at RIBF

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Abstract:

Slow and stopped ion beams are important for high-precision studies. The key reason for this is the ability to perform relatively long-duration observations. This allows for such studies of laser spectroscopy. Such beams can also be purified to much greater levels than is possible for highly-energetic beams. Using such high-purity beams allows for powerful studies of e.g. decay branching by means of mass spectroscopy. In recent years, advances in multi-refelction time-of-flight mass-spectrographs has begun to allow high-precision direct mass measurements of even short-lived, heavy species. At RIBF, we have implemented multiple gas cells for the purpose of thermalizing energetic RI beams for such precision studies. We will provide an overview of these various studies which are being undertaken at RIBF.

Keywords:
slow and stopped beams, RI beams, RIBF

Experimental study of density dependent nuclear symmetry energy by using heavy RI collision at RIBF-SPiRIT

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Abstract:

The nuclear Equation of State (EoS) is the fundamental property of nuclear matter. There is large uncertainty in the symmetry energy term of the nuclear EoS. This term is important in terms of astrophysics, such as structure of neutron star and supernovae dynamics. The first experiment by using the heavy RI collision was performed by SPiRIT international collaboration at RIKEN-RIBF towards giving a constraint on the nuclear symmetry energy especially for dense region. One of the main devices of experimental setup is a Time Projection Chamber (TPC) which was installed in the SAMURAI dipole magnet at RIKEN-SAMURAI beam line. By using the TPC, pions, protons and light ions were measured simultaneously in heavy RI collisions with Elab=300MeV/u neutron rich Sn isotope and neutron deficient Sn isotope. In this talk, the overview of the SPiRIT project and the status of data analysis for first run will be given.

Keywords:

Equation of State, SPiRIT, TPC, symmery energy, RIKEN-RIBF

Impact of Biased Edge Weights and Generalized Modularity for One-Mode Projection of Weighted Complete Networks

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Abstract:

A common form of competition is one where judges grade contestants' performances which are then compiled to determine the final ranking of the contestants. Unlike in another common form of competition where two contestants play a head-to-head match to produce a winner as in football or basketball, the objectivity of judges are prone to be questioned, potentially undermining the public's trust in the fairness of the competition. In this work we show, by modeling the judge--contestant competition as a weighted bipartite network, how we can identify biased scores and measure their impact on our inference of the network structure. Analyzing the prestigious International Chopin Piano Competition of 2015 with a well-publicized scoring controversy as an example, we show that even a single statistically uncharacteristic score can be enough to gravely distort our inference of the community structure, demonstrating the importance of detecting and eliminating biases. In the process we also find that there does not exist a significant system-wide bias of the judges based on the the race of the contestants.

Keywords:
Competition, Bipartite Networks

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The dynamics of the Olympic rivalry

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Abstract:
Every four years Olympics is held for nations to fiercely compete for medals. In celebrating the end of the 2016 Rio Olympics, this paper analyzes the rival network of medal winning nations. Dataset from the 1988 Seoul Olympics to the recent 2016 Rio Olympics is used to analyze the overall rival structure of the Olympics. Maximum Spanning Tree (MST) based approach is applied to evaluate rivalry clusters. Also, this paper observes whether the gravity model can be applied in explaining the dynamics of the Olympic rivalry.

Keywords:
MST, Gravity model, Olypic games, Cultural distance

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2016.10.19 - 2016.10.21

What does Big Data tell? Sampling the social network by communication channels

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Abstract:
Big Data has become the primary source of understanding the structure and dynamics of the society at large scale. The network of social interactions can be considered as a multiplex, where each layer corresponds to one communication channel and the aggregate of all them constitutes the entire social network. However, usually one has information only about one of the channels or even a part of it, which should be considered as a sample of the whole. Here we show by simulations and analytical methods that this sampling may lead to bias. For example, while it is expected that the degree distribution of the whole social network has a maximum at a value larger than one, we get with reasonable assumptions about the sampling method a monotonously decreasing distribution as observed in empirical studies of single channel data. We also find that assortativity may occur or get strengthened due to the sampling method. We analyze the far-reaching consequences of our findings.

Keywords:
complex networks, social networks, sampling bias

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Knowledge structure of nuclear fusion research

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Abstract:
Understanding big science is very important in policy making as it requires enormous budget, manpower and diplomatic effort. Nuclear fusion, which is a representative field of big science, has intensively been studied since it can directly promote human welfare as an ultimate future energy source. In order to figure out the key factor of success in big science, we investigate the network structures of paper citations and institutional collaborations on nuclear fusion through an open access bibliometric database, Microsoft Academic Graph (MAG). In the citation network, an interdisciplinary character is found out by community detection for major subfields coincident with existing classification. In the collaboration network, we extract the major institutions and derive the gravity-type interactions from fractional collaboration weights between institutions. In addition, the impacts by big events such as the ITER (International Thermonuclear Experimental Reactor) agreement, the IAEA Fusion Energy Conferences and fusion device establishments will be discussed. We expect that this study would contribute to managing research activities and suggesting national science & technology policies.

Keywords:
scientometrics, big science, nuclear fusion,citation network, collaboration network

Understanding the spatiotemporal patterns of geographic places in large-scale historical documents: The Annals of the Joseon Dynasty

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Abstract:
The Annals of the Joseon Dynasty (Joseonwangjosillok) are the historical records of the Joseon Dynasty, one of the major kingdoms in the history of Korea, composed of 1893 books covering 472 years (1392-1863) and 25 reigns of kings written in chronological order. The aim of this study is to understand the spatiotemporal occurrence pattern of geographic places - coarse-grained into the modern cities - over the entire history of Joseon through information theory and network science. We conduct the pairwise analysis to understand how geographical distance between two cities influenced on strength of two types of connections of cities: degree of co-occurrence and category similarity of two cities in the Annals. We find that extent of both types of connections are stronger if their geographic distance is shorter. However, the influence of geographical distance on both connections of cities significantly decreased as time passes. Our study demonstrates how statistical methods combined with large-scale digitized historical documents can reveal an interesting geographic relationship between cities which enriches our understanding on history and culture.

Keywords:
The Annals of the Joseon Dynasty, korean history, culture, city network, information theory

Extension of group-based ranking system

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Abstract:
Since the validity of ranking system is up to evaluator's sincerity, determining their sincerity is an important problem. As a way to measure sincerity, the group-based ranking(GR) method has been suggested to give each individual the reputation value which is determined by the majority of their evaluation. Extending this method, we focus on the fundamental statistical difference between each evaluator's appraisal standard. As a result, we propose a new model of evaluation mechanism and compare to various empirical data sets.

Keywords:
Ranking system, Opinion dynamics, Data science

Analytic critical exponents featured by real fluids

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Abstract:
The conventional paradigm for critical phenomena in statistical physics typically assumes the thermodynamic limit with the intension of achieving non-analyticity. Yet, a counterproposal based on the 'analyticity' of a finite-system partition function has been suggested which relies solely on the existence of a spinodal curve and predicts its own universal values for the critical exponents especially under an isobaric situation, i.e. the condition of constant pressure. Here we analyze the experimental data available at NIST for twenty major molecules including H2O(Water), O2(Oxygen), CO2(Carbon dioxide) , etc. and report that they are in good agreement with the latter analytic prediction: For each molecule, there is a characteristic natural number, n = 2, 3, 4, 5, 6, which determines its critical exponents for T 〈 T_c as $\alpha = \gamma$ = n/(n+1) and β = 1/δ = 1/(n+1). For the opposite T 〉 T_c , all the fluids feature the universal value of n = 2. These critical exponents fit well both Rushbrooke and Widom scaling laws. We urge to reassess the conventional paradigm of pursuing the non-analyticity.

Keywords:
critical exponent, scaling law, universality, analyticity, finite system, spinodal curve, real fluid, critical index, isobar

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2016.10.19 - 2016.10.21

고등학생들의 협력적 문제 해결 과정에서 나타나는 모형구성의 특징

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Abstract:

물리 문제 풀이의 어려움을 해소하기 위해서 또는 물리 문제 해결 자체가 갖는 학문적인 의미로 인해 물리 문제 해결은 전통적으로 물리교육연구에서 중요한 이슈로 다루어져 왔다. 이런 배경 하에 많은 물리 분야에서 다양한 문제 풀이 전략이 개발되어 왔으나 물리 문제 해결을 단순한 개념의 적용이나 기술의 일종으로 파악했던 한계로 인해 많은 연구에서 학생들의 문제해결전략의 근본적인 변화가 나타나지 않았거나, 설사 변화가 있다 하더라도 문제 풀이 활동이 물리 개념의 발달을 의미 있게 이끌어내지 못하고 있다는 비판의 시각이 존재한다(변태진, 2012; Kim & Park, 2002). 동료와의 협동을 강조한 몇몇의 연구에서는 문제해결능력에 대한 의미 있는 성과를 보고하고 있으나 (Mason & Singh, 2010; Crouch & Mazur, 2001) 모둠별 상호작용의 내적 과정을 충실히 탐구한 연구는 찾아보기 힘들며(Enghag et al., 2007), 이로 인해 문제해결의 협동 학습은 전략 차원에서만 머물고 협동 과정에 대한 면밀한 인지적 분석은 부족한 실태이다. 이에 본 연구에서는 고등학생들이 물리 문제를 협력적으로 해결해가는 과정을 모형구성의 관점에서 분석하여 동료와의 상호작용이 학생의 개념세계와 문제해결에 어떠한 긍정적인 기여를 하는지 확인하고자 한다. 이를 위해 'Learning Catalytics' 이라는 모바일 환경을 활용하여 진행된 수업에서 일반계 고교 2학년 학생 17명이 역학 문제를 협력적으로 해결하는 과정을 관찰하였다. 학생들의 발화 총 334건 중에서 모형구성과 관련된 발화는 115건으로 전체의 34.4%를 차지하였으며, 모형구성으로 분류된 발화들은 문제상황에 대한 분석과 관련된 대면(way of facing) 40건, 변수들 사이의 관계를 나타내는 조작(operative work) 75건으로 세분화되었다. 또한 협력적 해결과정에서 드러난 학생들의 정신모형을 Halloun(2007)의 모형도식으로 분석한 결과, 상태-상호작용-인과 세 가지 분면을 모두 언급하고 나름의 해에 도달한 학생은 전체의 총 8명이었으며, 세 가지 분면을 모두 언급하였으나 최종적인 해를 제시하지 않은 학생이 1명, 세 분면 중 일부만 언급한 학생이 3명, 분면을 전혀 언급하지 않은 학생이 5명인 것으로 나타났다. 마지막으로 학생들의 토의를 거쳐 모둠의 모형 구조가 정립되어 가는 과정을 분석한 결과 학생들은 대화 초기에는 조작(operative work) 차원과 관련된 담화를 주로 나누지만, 조작에 대한 질의 응답 과정에서 문제 상황에 대한 분석이나 사용되는 물리 개념의 특성을 묻는 대면(way of facing) 차원이 나타나는 것으로 확인되었다. 특히 명확한 정신모형을 가지지 못한 학생들은 경우 동료 학생과 조작 차원에 대한 담화만을 나눌 때보다 대면과 조작 차원을 병행하면서 대화할 때 상호작용이 활발해지면서 동료의 정신모형을 쉽게 받아들이는 것으로 나타났다. 또한 상태-상호작용-인과 세 분면의 일관성을 고려하지 않은 모둠의 경우 모형의 모순을 인식하지 못하고 의미 있는 발전을 이끌어내지 못했으나, 분면간의 일관성을 고려한 모둠의 경우는 모형의 문제점을 파악하고 물리 개념에 대해 숙고하는 것으로 나타나 분면간의 일관성이 물리 문제 해결 및 개념이해에 있어 중요한 요인임을 확인할 수 있었다.

Keywords:
협력적 문제 해결,상호작용,모형 구성, 정신모형

시선 추적 검사를 이용한 과학용어에 대한 친숙도와 문장 이해도와의 상관 분석

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Abstract:

과학 언어를 읽고 이해하는 능력은 과학에 대한 태도나 흥미, 개념 습득, 사고 확장 등에 중요한 영향을 미친다(Alberts, 2010). 그러나 많은 학생들이 과학 교과서에 제시된 텍스트를 읽고 이해하는 데 어려움을 겪음을 호소하고 있으며, 그 원인 가운데 하나로 어려운 용어의 사용이 많음을 언급하고 있다(윤은정, 박윤배, 2016). 과학 용어에 대한 어려움을 해소하기 위해서는 체계적인 용어 교육이 필요한데, 이를 위해서는 개별 과학용어들에 대한 교육적 중요도와 함께 학생들의 친숙도나 이해도를 고려할 필요가 있다. 본 연구에서는 초등학교 학생들을 대상으로 과학 교과서에 제시된 과학용어들에 대한 친숙도를 조사함에 있어 시선 추적 검사(Eye-tracking)의 도입에 대한 타당성을 알아보기 위해 실시되었다. 7차 교육과정과 2009 개정 교육과정에 따른 초등학교 과학 교과서에서 사용된 과학용어들을 수집한 뒤, 사용 빈도가 높은 단어들을 대상으로 하여 2009 개정 교육과정의 초등학교 과학 교과서에서 해당 용어들이 사용된 문장들을 추출하였다. 이 문장들로 검사 문항을 제작한 뒤 초등학생 50명을 대상으로 시선 추적 검사를 실시하였다. 검사는 총 10개의 텍스트 장면과 함께 각 문장에 대한 이해도 문항으로 구성하였으며, 검사가 끝난 뒤 검사 대상 용어에 대한 자기 보고식 설문을 함께 실시하였다. 검사 결과 과학용어에 대한 친숙도와 문장 이해도 사이의 관계를 분석하였으며, 이를 통해 과학용어에 대한 친숙도 및 이해도 검사 방법으로서의 시선 추적 검사 도입의 타당성을 논의하고 과학 문장 이해도의 한 요인으로서의 친숙도에 대해 이야기한다.

Keywords:
과학용어, 시선추적검사, Eye-tracking, 과학 문장 이해력

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시스템 개념에 대한 대학생들의 인식과 적용 분석

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Abstract:
시스템은 물리학을 비롯한 과학교과의 여러 개념들과 연계되어 있으며, 탐구에서는 대상의 선정과 해석에 관련된 개념이다. 한국을 포함한 여러 나라들은 국가교육과정 및 과학교육표준에서 시스템 개념을 핵심 개념 등으로 제시하며, 선행연구들에서도 시스템 개념이 학생들의 개념 발달 및 통합적 사고 발달에 기여한다고 보고하고 있다. 본 연구는 사범대학 물리교육 전공 학부생 6인을 대상으로 진행된 면담 내용을 분석하였다. 면담의 주요 질문은 '물리학에서의 시스템 개념 설명', '시스템 개념의 기능 또는 역할', '물리 상황에서의 시스템의 선택', '물리 학습에서의 시스템 개념의 역할'로 구성하였다. 분석 결과는 다음과 같다. 첫째, 대학생들은 시스템을 주로 물질과 에너지의 모임으로 설명하였다. 학생들은 시스템을 "여러 입자들의 모임", "자연을 이루는 여러 가지 요소들의 집합", "공통된 관점을 이용해서 인지하고자 하는 것들의 모임" 등으로 서술하였다. 둘째, 대학생들은 시스템의 선택이 해석하고자 하는 현상과 목표 물리량에 따라 결정된다고 설명하였다. 이에 따라 학생들은 시스템을 "공간에 대한 해석", "확연히 달라지는 구역", "물질과 에너지의 경계" 등으로 서술하였다. 셋째, 대학생들은 물리적 상황에서 시스템을 선택하고 법칙을 적용할 때 어려움을 겪었다. 넷째, 대학생들은 물리적 상황을 시스템을 중심으로 접근할 때 인지 수준의 확장을 가져올 수 있다고 설명하였다. 이를테면, 일부 학생은 시스템을 선택할 때 특정 요인을 추가 및 제거하는 과정을 반복해 보는 것이 물리학을 깊이 있게 이해하는 데 도움이 된다고 서술하였다. 본 연구는 시스템 개념에 대한 대학생들의 인식과 적용을 분석하였으며, 이를 통해 시스템을 중심으로 한 문제 상황 인식과 해석에 대한 학습을 제안한다.

Keywords:
시스템, 대학생, 인식, 적용

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20세기 초현실주의 미술을 통해 바라보는 현대물리학의 이해: 마그리트와 달리의 사례를 중심으로

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Abstract:
과학과 예술은 사회문화적 배경에 의해 서로 영향을 주고 받는다. 특히, 20세기 과학과 예술은 뉴턴 역학에서 상대성이론으로, 재현이 중심이 되는 사실주의 선원근법에서 표현 중심의 새로운 미술 사조로 변화를 경험하였다. 당대의 예술가 및 대중들은 과학에서 일어난 변화에 관심을 가지고 있었고 이는 자연스럽게 영향을 미쳤다. 그 일례로 초현실주의 화가인 르네 마그리트와 살바도르 달리는 독특한 화풍 속에 물리학의 기본 개념인 시간과 공간에 관한 요소들을 포함시키고 있다. 본 연구에서는 르네 마그리트와 살바도르 달리의 그림을 통해 나타나는 시공간의 표현을 중심으로 현대물리학의 특성을 이해하고, 나아가 오늘날 물리교육에서 과학과 예술의 통합적 접근을 지도하기 위한 방안에 대해 논의하고자 한다.

Keywords:
Magritte, Dali, surrealism, modern physics, theory of relativity, science and art

중등물리교사 임용시험문항의 분야복합성 분석

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Abstract:
본 연구에서는 2002학년도부터 2016학년도 사이의 중등물리교사 임용시험을 내용 분야에 따라 분석하고, 융복합적 측면에서 분야복합도를 구하여 경향성을 파악하고자 하였다. 이를 위해 각 분야별로 문항 수와 배점의 상대적인 비율을 알아보고, 2개 이상 분야의 정보를 포괄하여 출제된 문항의 비율을 구하였다. 분석 결과에 따르면, 우선 각 분야별로 지난 15년간 출제된 평균 문항 수와 배점의 비율은 거의 변화가 없었다. 대체로 물리교육론, 전자기학, 역학, 파동 및 광학, 양자물리, 열 및 통계물리, 현대물리 순이었다. 둘째, 최근으로 올수록 교과교육학은 분야복합성이 증가했으며 2014학년도부터는 모든 문항이 복합문항으로 출제되었다. 반면에 교과내용학은 전반적으로 분야복합성이 낮았으며, 복합적으로 출제된 문항도 특정 분야의 정보가 집중적으로 제시되었다. 셋째, 2002학년도부터 2016학년도까지 물리 임용시험의 분야복합성은 지속적으로 증가하는 경향이 있었다. 특히, 2009학년도부터 2013학년도 사이에 있었던 논술형 2차 시험에서는 분야복합성이 두드러졌다. 이를 토대로 몇 가지 시사점을 제안하고자 한다.

Keywords:
중등물리교사 임용시험 분야복합성

Mechanical Snell's Law

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Abstract:
We investigate the motion of a massive particle constrained to move along a path consisting of two line segments on a vertical plane under an arbitrary conservative force. By fixing the starting and end points of the track and varying the vertex horizontally, we find the least-time path. We define the angles of incidence and refraction similar to the refraction of a light ray. It is remarkable that the ratio of the sines of these angles is identical to the ratio of the average speeds on the two partial paths as long as the horizontal component of the conservative force vanishes. As an application, we compute the corresponding relative indices of refraction for various potentials that are proportional to positive powers of the vertical coordinate.

Keywords:
Snell's law, Fermat's principle, Least-time path

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Totally Symmetric Isotropic Tensors

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Abstract:

We illustrate a systematic approach to express the totally symmetric isotropic tensors of arbitrary rank in an n-dimensional Euclidean space as a linear combination of products of Kronecker deltas. By making fully use of the symmetries, one can greatly simplify cumbersome angular integrals in n dimensions into a straightforward combinatoric counting. The method is generalized into the cases in which such symmetries are present in subspaces. As an application, we demonstrate the mechanism of the tensor-integral reduction that is widely used in various physics problems such as perturvative calculations of gauge-field theories in which divergent integrals are regularized in d = 4 − 2☼ space-time dimensions. While the main derivation in an n-dimensional Euclidean space can be taught to undergraduate students who are not acquainted with advanced-level tensor analysis, it has enough generality to be used as a manual for advanced readers of graduate level who can deal with problems in Minkowski space.

Keywords:
Isotropic Tesnor, Combinatorics,loop integral

Fabrication and PL properties of a single Ge quantum dot embedded in a photonic crystal microcavity

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Abstract:
In this paper, we first present results on the controllable growth of Ge single QD and double QD nanostructures on nanohole-patterned Si substrates via molecular beam epitaxy. Their growth mechanism is investigated. Then we report PL properties from a Ge single QD embedded in a L3-type photonic crystal microcavity. The growth of site-controlled Ge QDs on patterned silicon-oxide-insulator substrates as well as the accurate embedding of a Ge single QD into a modified L3-type slab cavity is demonstrated in detail. A sharp resonant luminescence peak is observed at 1498.8 nm, which is enhanced by more than three orders of magnitude. Our devices provide a CMOS-compatible way of developing silicon-based low-power consuming light emitters, and are promising for realizing on-chip single photon sources.

Keywords:
quantum dot, photonic crystal microcavity

Quantum dot cascade laser

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Abstract:
Quantum cascade lasers are semiconductor laser sources based on intersubband transitions in multiple quantum well systems. Their unique operation principle and good performance have established themselves as the leading tunable coherent semiconductor source in the infrared and terahertz ranges of the electromagnetic spectrum. In principle, such lasers are restricted in broad tunability, surface emission, and wallplug efficiency. Theoretical works have predicted that these issues can be raveled out in a quantum dot cascade laser (QDCL), in which quantum well active region is replaced by quantum-dot active region. Here we show, by making use of self-assembled quantum dots and two-step strain-compensation active region design, quantum dot cascade laser structures are successfully grown. The prototype generates stimulated emission at wavelength of 6.17 microns and a broad electroluminescence band with full width at half maximum over 3 microns. What is more, this QD-based quantum cascade laser can be processed as an infrared photodetector with distinct normal incident photoresponse, giving the fingerprint of QD infrared photodetector. The combined experiment results proving the direct evidence of quantum dot cascade laser. After optimizing design and growth techniques, a room-temperature continuous-wave operated QDCL emitting at wavelength of 7.15 microns is also developed. These results are promising for extending the present laser concept to terahertz quantum cascade laser References [1] R. A. Suris, NATO ASI Ser.E 323, 197(1996). [2] N.S.Wingreen and C.A.Stafford,IEEE J. Quantum Electron.33,1170(1997). [3] N. Zhuo, F.-Q. Liu et al. Nanoscale Research Letters 9, 144(2014).

Keywords:
Quantum dot, cascade laser

Temperature dependent photoluminescence quenching in GaP-InP lateral nanowires

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Abstract:

The general behavior of the exciton diamagnetic shift is quadratic in low magnetic fields ($\Delta E_{dia} \sim B^2$) and linear in high magnetic fields ($\Delta E_l \sim B$). A negative energy shift is difficult to imagine when using the features of the normal diamagnetic shift. In this work, we report the magneto-exciton transitions of an InP/GaP lateral nanowire structure that was grown using a lateral composition modulation (LCM) growth technique. Linearly polarized photoluminescence (PL) measurements were made under pulsed magnetic fields to 50 T. We observed the normal diamagnetic shift from the direct InP nanowire transition and PL intensity quenching below 60 K at B=0T. However, the indirect InP-GaP transition exhibits no energy shift or negative energy shift depending on the magnetic field directions. The direct PL transition exhibits PL intensity quenching behavior below 60 K. We will discuss negative diamagnetic shift and PL quenching by exciton center of motion and mobility enhancement, respectively

Keywords:
Photoluminescence, lateral nanowires

Application of Bionano Photonics for Early Disease Diagnosis

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Abstract:

A novel surface-enhanced Raman scattering (SERS)-based lateral flow immunoassay (LFA) biosensor was developed to resolve problems associated with conventional LFA strips (e.g., limits in quantitative analysis and low sensitivity). In our SERS-based biosensor, Raman reporter-labeled hollow gold nanospheres (HGNs) were used as SERS detection probes instead of gold nanoparticles. With the proposed SERS-based LFA strip, the presence of a target antigen can be identified through a colour change in the test zone. Furthermore, highly sensitive quantitative evaluation is possible by measuring SERS signals from the test zone. To verify the feasibility of the SERS-based LFA strip platform, an immunoassay of staphylococcal enterotoxin B (SEB) and a DNA assay of HIV-1 virus were performed as model reactions. The limit of detections (LODs) for SEB and HIV-1 DNA, as determined with the SERS-based LFA strip, were estimated to be 1.0 pg/mL and 0.24 pg/mL, respectively. These values are much more sensitive than those achieved with the corresponding ELISA or PCR methods. In addition, I will also report the development of a programmable and fully automatic microfluidic sensor that integrates a gradient microfluidic device with gold-patterned plasmonic sensing platforms. This device provides a convenient and reproducible SERS-based immunoassay platform for various biomarkers. The utility of this platform is demonstrated by the quantitative immunoassay of various cancer and cardiovascular protein markers. Our proposed SERS-based immunoassay platform has many advantages over other immunoassay methods. The tedious manual dilution process of repetitive pipetting and inaccurate dilution is eliminated with this process because various concentrations of biomarker are automatically generated by microfluidic gradient generators with mixing stages. Thus, this novel SERS-based microfluidic assay technique is expected to be a powerful clinical tool for early disease diagnosis.

Keywords:
surface-enhanced Raman scattering, lateral flow assay, biomarker, protein, DNA

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Selective synthesis of functional nanowires using laser processing

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Abstract:

For the fabrication of functional nanowire based electronics, several multi-steps such as growth of nanowire, harvesting of nanowire, and manipulation/integration of nanowire to circuit are conventionally required. These multi-steps are very time consuming, expensive, and low yield process. As an alternative to the conventional multi-step process for nanowire based electronics, in this presentation, I will introduce selective synthesis method of functional nanowires for nanowire based electronics using laser processing. This process can reduce the processing lead time and simplify fabrication of the nanowire based electronics through simple one-step by laser processing. Furthermore, this approach could be extended to various functional nanowires even on heat sensitive polymer substrate.

Keywords:
Functional nanowires, Laser processing, Laser induced hydrothermal growth, low temperature synthesis

Sensing Thermal Properties in Nano-Energy Materials

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Abstract:

Thermal transport in nanoscale materials attracts increasing research attention because of both intriguing phonon physics at the nanoscale as well as growing importance of heat management in nanoscale devices. Active heat flow control is essential for broad applications of heating, cooling, and energy conversion. Like electronic devices developed for the control of electric power, it is very desirable to develop advanced all-thermal solid-state devices that actively control heat flow without consuming other forms of energy. However, experimental demonstration of thermal conductivity in the nanometer-scale or low-dimensional materials is lacking, due mostly to technical challenges in sample preparation and measurements. Here, I will introduce the method to measure the thermal properties of low-scale and low-dimensional materials, and present my recent research using the method: i) anisotropic in-plane thermal conductivity of black phosphorus nanoribbons, ii) temperature-gated thermal rectifier for active heat flow control, and iii) unusual behaviour of thermal conductivity in vanadium dioxide across the metal-insulator transition.

Keywords:

Sensing Thermal Properties in Nano-Energy Materials

Real-time structural and electrical characterization of metal-insulator transition in VO_2 wires with modulating parameters

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Abstract:

Single-crystal VO_2 wires have gained tremendous popularity for enabling the study of the fundamental properties of the metal-insulator transition (MIT); however, it remains tricky to precisely measure the intrinsic properties of the transitional phases with controlled wire growth properties, such as diameter. In this talk, we present a facile method to grow VO_2 wires with controlled diameters by separating the formation of the liquidus V_2O_5 seed droplets from the evolution of the VO_2 wire using oxygen gas. The kinetic analyses suggest that the growth proceeds via the VS (vapor-solid) mechanism, whereas the droplet determines the size and the location of the wire. In situ Raman spectroscopy combined with analyses of the electrical properties of an individual wire allowed us to construct a diameter-temperature phase diagram from three initial phases (i.e., M1, T, and M2), which were created by misfit stress from the substrate and were preserved at room temperature. We also correlated this relation with resistivity-diameter and activation energy-diameter relations supported by theoretical modeling. These carefully designed approaches enabled us to elucidate the details of the phase transitions over a wide range of stress conditions, offering an opportunity to quantify relevant thermodynamic and electronic parameters, including resistivities, activation energies, and energy barriers of the key insulating phases, and to explain the intriguing behaviors of the T phase during the MIT. Additionally, we will present the studies of modulating the properties of the wire by altering such parameters as composition, internal strain, and oxidation state using efficient real time instrumentations of Raman, optical microscopy, and transmission electron microscopy.

Keywords:

Real-time structural and electrical characterization of metal-insulator transition in VO_2 wires with modulating parameters

Modulation of electronic properties of 2D materials via adsorbents

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Abstract:

Atomically thin layers such as transition metal dichalcogenides(TMDs) and graphene have been attracted tremendous attentions due to its outstanding physical properties from scientists and engineers world-widely. Since all the atoms of 2D materials are exposed to the surface, its electronic properties could be very sensitive to adsorbents of its surface. The intrinsic characteristics of these atomically thin layered materials, which are sensitive to the environment, have been recognized as a bottleneck in stable and reproducible device fabrication and performance. However, such susceptibility to the environment or surface adsorbents can be conversely considered as an advantage from an engineering perspective as a means to control the work function of a material or fermi-level modulation, which is not available in bulk materials. Large modulation of Dirac point voltage of graphene and work function of MoS_2 was successfully observed by chemical adsorbents or gas species. Using our findings, complementary metal-oxide-semiconductor (CMOS) -like graphene based inverters using two different ionic liquids were perfectly working even at a very low source voltage (V_{DD} = 1 mV), which was not possible for previous works. The homojunction diode by partially passivating a MoS_2 transistor reveals an ideal junction with an ideality factor of almost one and perfect electrical reversibility. The estimated depletion width obtained from photocurrent mapping was ~200 nm, which is much narrower than bulk semiconductors. These results can be broadly applied in the development of flexible/stretchable, CMOS-like 2D material based electronic devices in the future. 1. Un Jeong Kim, et. al. ACS Nano , 9, 602(2015). 2. Si Young Lee, Un Jeong Kim, et al. ACS Nano, 10, 6100(2016).

Keywords:

Modulation of electronic properties of 2D materials via adsorbents

XFELs in structural investigation of biological specimens

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Abstract:
X-ray imaging technique has been advanced rapidly to establish high resolution microscopy. Notwithstanding various benefits, x-ray imaging of non-crystalline specimens has been challenged; difficulty in achieving near atomic resolution limited by the radiation damage. The coherent diffraction imaging technique provides a route to overcome this challenge using femtosecond X-ray pulses from X-ray free electron lasers (XFELs). We will introduce our research activity in structural investigation of biological systems using hard X-ray FEL pulses. Single-shot diffraction based investigations of biological macromolecular complexes, organelles, whole cells, and protein molecules have been performed to introduce new opportunity with the XFELs. We will also share our perspective of biological structural investigation with this intense, high-energy radiation from XFELs.

Keywords:
XFEL, single-shot, high-resolution

Small Angle X-ray Scattering Studies on Structures of Biological Molecules in Solution

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Abstract:

The fundamental aim of structural studies in molecular biology is to establish a relationship between the structure (or, more precisely, structural changes) and function of biological macromolecules. Over the past years, a tremendous amount of structural information has been obtained using macromolecular crystallography and nuclear magnetic resonance (NMR). These high-resolution methods apply only in rather specific conditions: it is often difficult to grow crystals of high molecular weight (MW) assemblies that are suitable for diffraction, and the application of NMR is fundamentally limited to small (MW < 30 kd) proteins. Investigation of structure of biological macromolecules in solution remains one of the most important fields of application of small angle X-ray scattering (SAXS) technique. SAXS permits analysis of biological macromolecules and their complexes in nearly physiological environments and direct study of structural responses to changes in physical and chemical conditions. Recent remarkable progress in instrumentation, in particular thanks to high-flux dedicated X-ray synchrotron radiation has significantly improved the quality of the experimental SAXS data. This method is an important complementary tool to the high-resolution techniques (X-ray crystallography and NMR). The fundamental aim of this study is to obtain more detailed information on the structure and structural differences of a variety of biological macromolecules in solution under various conditions by using SAXS technique. Ultimately, the structural evidence presented here will contribute to a better understanding of relationship between structures of macromolecules and their function, from a biophysics point of view. In this talk, current status of 4C SAXS beamline, long-term plan for advanced beamline, SAXS data processing, overall parameters, and recent research results of biomacromolecules (DNA, protein) will be discussed in more detail.

Keywords:
Small Angle X-ray Scattering Studies on Structures of Biological Molecules in Solution

X-ray Crystallography Using a High Pressure Technique

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Abstract:

A high pressure technique, called high-pressure cryocooling, has been developed as a method for biophysical and X-ray science studies. The method was developed primarily for crystal cryoprotection and dozens of macromolecular crystals have been successfully cryopreserved, including membrane protein crystals (e.g. a potassium ion channel). In addition, the method was successfully applied to stabilize ligand-protein interactions and to study the pressure effect on the structure of a yellow fluorescent protein, citrine. The procedure was then modified to entrap intermediate enzymatic states of human carbonic anhydrase. More recently, the method was used to study the phase behavior of water and its relationship with protein dynamics. In this presentation, I will discuss the technical details of high pressure cryocooling and its crystallographic applications. References 1. Chae Un Kim et al., Glass-to-cryogenic-liquid transitions in aqueous solutions suggested by crack healing. Proc. Natl. Acad. Sci. USA 112, 11765-11770 (2015). 2. Chae Un Kim et al., Tracking solvent and protein movement during CO_2 release in carbonic anhydrase II crystals, Proc. Natl. Acad. Sci. USA 113, 5257-5262 (2016).

Keywords:

X-ray scattering, High pressure

Solving Near-Atomic Resolution Protein Structures using Single Particle Cryo-Electron Microsocpy

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Abstract:

Recently, single-particle cryo-electron microscopy (cryo-EM) has emerged as a mainstream structural biology technique, as evidenced by being selected as “Method of the Year 2015” in Nature Methods. This remarkable development gained additional momentum by recent structure determination of large protein complexes to near-atomic resolution (<3Å) from which side chains of amino acids could be identified, hence allowing for de novo atomic structural analysis. Ever since the first demonstration of 3D reconstruction from 2D projection of transmission electron microscope (TEM) in 1968, the field has been steadily growing. Current success of cryo-EM has been led by pioneering groups in Europe, USA and Japan, where cooperative academia-industry R&D, thorough theoretical evaluations and ingenious practical experiments took place. In Korea, however, the field has been largely unnoticed until recent flood of high-profile publications by cryo-EM studies. Therefore, mandatory research infrastructure for cryo-EM studies, including high-end instruments and expertise, is far behind many leading groups in the world. Fortunately, the first high-performance TEM that is dedicated to high-resolution cryo-EM work (Titan Krios, FEI Co. with direct electron detector) has been installed at Korea Basic Science Institute (KBSI) recently. While issues related to the number of experts and data process scheme remains to be resolved, efficient management of the facility and earnest collaborations should lead to a prompt establishment of cryo-EM field in Korea. In this presentation, basis of cryo-EM will be introduced, especially focusing on technical and practical applications. Also major specifications and the functionalities of high-end TEM instrument at KBSI will be introduced. Finally, future prospective of constantly evolving cryo-EM field will be discussed, with an anticipation of great biological discoveries that were once considered impossible.

Keywords:
Cryo-electron microscopy, single particle analysis, structural biology, transmission electron microscopy

First-principles predictions of thermodynamically stable two-dimensional electrides

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Abstract:
Two-dimensional (2D) electrides, emerging as a new type of layered material whose electrons are confined in interlayer spaces instead of at atomic proximities, are receiving interest for their high performance in various (opto)electronics and catalytic applications. Experimentally, however, 2D electrides have been only found in a couple of layered nitrides and carbides. Here, we report new thermodynamically stable alkaline-earth based 2D electrides by using a first-principles global structure optimization method, phonon spectrum analysis, and molecular dynamics simulation. The method was applied to binary compounds consisting of alkaline-earth elements as cations and group VA, VIA, or VIIA nonmetal elements as anions. We revealed that the stability of the layered 2D electride structure is closely related to the cation/anion size ratio; stable 2D electrides possess a sufficiently large cation/anion size ratio to minimize electrostatic energy among cations, anions, and anionic electrons. Our work demonstrates a new avenue to the discovery of thermodynamically stable 2D electrides beyond the material database and provides new insight into the principles of electride design.

Keywords:
electride, anionic electron, global structure optimization, layered ionic compound

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Quantum Materials Genome in Strongly-Correlated Electron Oxides

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Abstract:
In an organism, the unique structure and subsequent function of a protein are determined singly by the gene sequence. Genome research such as the Human Genome Project, aided by advanced computation technology, have begun to unlock the complexity surrounding gene sequence and its role in determining biological function, bringing about significant advances in biotechnology. In this spirit, we initiate quantum materials genome research, which can combine many condensed-matter issues with computation. In condensed matter, well-defined order parameters such as spin, charge, symmetry, and lattice can be seen as material genes. Unlocking their coupling/combination and its manifestation in the hierarchical materials imply endless possibilities for material engineering and design, and hold the key for creating completely new phases out of old materials in strongly-correlated systems. By the genomic search, I will talk about how to induce drastic phase transitions by altering the largest magnetic interaction, which is superexchage in oxides, via its coupling to lattice distortions such as ferroelectric or Jahn-Teller. I will highlight the importance of systematic genome study of various order-parameters to reveal hidden phases in oxides and maximize functionalties such as ferroelectric ferromagnets.

Keywords:
Stronlgy-correlated electron oxides, ferroelectric ferromagnet, multiple-order-parameters transition, epitaxial strain

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2016.10.19 – 2016.10.21

Computational search for lead-free halide perovskite solar cells

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Abstract:

Halide perovskite based solar cells are a recent ground-breaking breakthrough of power conversion efficiencies exceeding 20%. This is possible because ABX_3 (A = 1+ alkali metal or small molecule; B = 2+ metal cation and X = halogen anion) exhibits strong light absorption, high carrier mobility, and long carrier lifetimes for both electrons and holes. Recent theoretical results show that these superior properties are mostly governed by low energy electronic structures, where B-site metals are crucial; both orbital hybridization and spin-orbit coupling (SOC) of B-site metal atom play important roles to determine optical as well as transport properties. However, the B-site atom of the usual halide perovskite solar cell is lead, which is known as a toxic chemical element to human. Now it becomes a key issue to find the alternatives to replace the lead in the halide perovskite solar cells. In this study, we investigate the various combinations of mixed cations to replace the lead element at B-site of the halide perovskite, via the high-throughput computational screening method based on the first principles calculations. I will dicuss the potential candidates of lead-free halide perovskite for solar cell applications.

Keywords:

Computational search for lead-free halide perovskite solar cells

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The Linac Coherent Light Source: Status, Future and Perspectives

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Abstract:

A new scientific frontier opened in 2009 with the start of operation of the world's first hard X-ray Free Electron Laser, the Linac Coherent Light Source (LCLS). LCLS provides femtosecond pulses of coherent X-rays (270eV to 12.4keV) with very high peak brightness to access new domains of ultrafast science. This required the development of experimental solutions that can cope with the fact that every shot is different and that there can be substantial jitter in many beam parameters [1]. We will review the major scientific achievements from LCLS since its inception in many areas of sciences such as atomic, molecular and optical physics ; condensed matter physics ; matter in extreme conditions, chemistry and soft matter, and biology [1,2]. We will also show how LCLS has been constantly improving its performances and capabilities by major technical improvements. LCLS is also on its way to an ambitious and exciting expansion of its capabilities by realizing LCLS II. It is based on a superconducting linac capable of producing a continuous stream of X-ray pulses at repetition rates of up to 1MHz. A brief description of its capabilities will be provided. Furthermore, much more excitement is on the horizon over the coming months, as many new FEL facilities are becoming operational (Germany, Switzerland and Korea). This will not only provide a much larger access to FEL beams to the user community, but also should allow for more great science to be performed. [1] "The Linac Coherent Light Source", W. E. White, A. Robert and M. Dunne, J. Synch. Rad. 22 (3), 472-746 (2015) [2] "The Linac Coherent Light Source : the first five years", C. Bostedt, S. Boutet, D. M. Fritz, Z. Huang, H. Lee, H. T. Lemke, A. Robert, W. F. Schlotter, J. J. Turner, and G. J. Williams, Rev. Mod. Phys. 88, 015007 (2016)

Keywords:
The Linac Coherent Light Source: Status, Future and Perspectives

Ultrafast ionization and fragmentation dynamics of molecules at high x-ray intensity

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Abstract:

The recent advent of x-ray free-electron lasers (XFELs) enables us to explore new frontiers of science, for example, femtosecond x-ray imaging and warm dense matter. In this talk, I will present a theoretical framework of XFEL-matter interaction, namely x-ray multiphoton absorption. Then I will discuss recent results of ultrafast x-ray-induced explosion of iodomethane (CH3I) molecules. By using a combined analysis of experiment and theory, we investigate detailed ionization and fragmentation dynamics of the molecules when exposed to intense XFEL pulses. It will be demonstrated that ionization of a molecule at high x-ray intensity is considerably enhanced in comparison with the isolated atomic case, due to ultrafast charge rearrangement within a molecule during x-ray multiphoton absorption. Our study provides a fundamental insight to understand how small polyatomic molecules interact with intense XFEL pulses, which is crucial for applications in many areas of XFEL-driven science.

Keywords:
XFEL, XFEL-matter interaction

Bragg Ptychography Imaging of Phase-Ordering Fe-Al Alloys

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Abstract:
We performed coherent x-ray diffraction imaging (CXDI) in Bragg scattering geometry using the ptychography [1,2] setup at beamline ID01 of ESRF. In addition, ptychography in transmission geometry was employed on a standard sample (Siemens star) to yield an independent estimate on the illumination function and provide a general test of the setup. This experimental scheme has capability of imaging the phase shift of the sample which is related to the atomic structure. Fe-Al alloys display phases where the atoms order on sub-lattices resulting in the emergence of superlattice reflections that otherwise are forbidden in the bcc structure. The degeneracy of the ordered structures results in domain boundaries that, in addition to the general strain of the lattice, will give a phase shift depending on which superlattice reflection is probed. We investigated the B2 phase of $Fe_{60}Al_{40}$ and the D03 phase of $Fe_{72}Al_{28}$ specimens [3,4] with the aim of imaging the ordered domain structures and a detailed analysis is in progress.

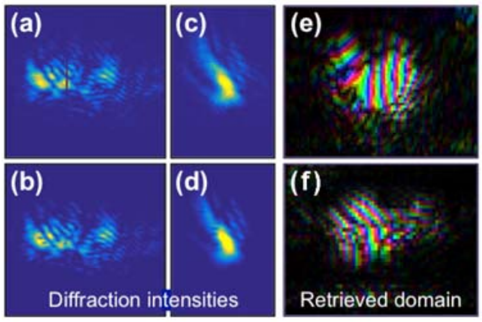

Figure 1. Result of Bragg ptychography CDI experiment performed at ESRF ID01 beamline.
(a,c) Measured intensities at certain scan position and rocking angle. (b,d) Calculated intensities at same scan point with (a) and (c). (e,f) Sectioned 2d images of retrieved domain structures (complex plot).

Keywords:
Bragg Ptychography, Coherent Diffraction Imaging, Phase-Ordering, Phase transition

Femtosecond imaging at near-atomic resolution and PAL-XFEL

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Abstract:

Interest in high-resolution, both in space and time, structure investigation has been zealous especially with the advent of X-ray free electron lasers (XFELs). The intense and femtosecond-short X-ray laser pulses have introduced new routes to explore structures and dynamics of single macromolecules, functional nano-materials and complex electronic materials. Femtosecond X-ray pulses capture atomic structures at nearly radiation-damage free conditions, which facilitates ambient temperature crystallography and environmental imaging. In the last several years, we have performed XFEL single-shot diffraction imaging to visualize ultrafast phase changes directly. Dynamic diffraction imaging was realized using femtosecond (<10 fs in FWHM) hard X-ray laser (probe) synchronized to the femtosecond (50 fs) optical laser (pump) at 1 ps resolution. Ultrafast structure deformations can be visualized at several nm resolution. We also expect that this femtosecond imaging will invigorate active multi-disciplinary research with the PAL-XFEL.

Keywords:
femtosecond, imaging, XFEL

Grain boundary free 의 비밀과 단결정은행의 찾아가는 서비스

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Abstract:
응집 물질을 실험적으로 연구하는 사람에게 연구용 시료 마련이란 양자역학이나 전자기학을 배우는 것만큼 중요하다. 특히 새로운 물성을 갖는 신물질을 처음으로 개발하는 것은 중요한 일이지만 쉽지도 않다. 역대 노벨 수상자 중 고온 초전도 물질을 개발한 베드노르츠와 뮐러, GaN 로 blue LED를 성공시킨 나카무라, Graphene 연구로 탄소 한 층의 스토리를 만들어낸 가임 모두 연구용 시료의 중요성을 잘 확인해 준다. 어떤 물질을 개발하느냐에 못지않게 중요한 것은 그 물질을 어떻게 하면 단결정 형태로 성장시킬 것이냐 하는 것이다. 우리가 고체물리학에서 배우는 대상은 항상 단결정 형태를 기반으로 한다. 본 강연에서는 25년간 경험해온 결정성장의 역사를 소개하고 150종 이상의 결정과 박막을 성장해오면서 터득한 KNOW-HOW를 소개한다. 단결정은행은 연구용 시료를 직접 성장할 수 없는 연구자에게 연구용 시료를 제공한다. 시료제공과 더불어 결정학적인 자문과 표면가공, 기초 물성의 측정 등 다양한 지원이 이루어지고 있다. 자세한 단결정은행의 역할과 지원, 그리고 초중고 및 일반인들을 대상으로 이루어지는 한국결정성장대회에 대해서도 소개할 것이다. 단결정 은행 http://www.crystalbank.com, 한국결정성장콘테스트 http://www.crystalcontest.or.kr http://crystalcontest.or.kr

Keywords:
결정성장, 단결정, 결정학, 단결정은행

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Single crystal growth of complex correlated electronic materials

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Abstract:

With heartful respects and celebrations to Prof. Se-Young Jeong's awards of the special prize of KPS, who has have devoted his time and passion to the single crystal growth of condensed matter and has propagated its importance to the general public as well as researchers for more than 20 years, I am honored to have an opportunity to introduce the recent activities on the single crystal growth of complex correlated electronic system at SNU. I'll start with emphasizing the importance of the crystal growth of our own correlated materials to cultivate research outputs uniquely named as a trademark of our country to win the competitive research races over the world. I will introduce such unique material systems that have been regarded as our group's trademark during the last 13 years of crystal growth efforts at SNU; new multiferroics, emergent superconductors, and promising transparent conductors. I will finanlly discuss my own perspectives how to develop strong material growth program in S. Korea for next young generations, and how we can overcome and why we must overcome the old but long-lasting cultural prejudices that the crystal growth is a subsidiary part of condensed matter research for the sake of promotion of our R&D program in the world.

Keywords:
single crystal growth, complex correlated materials, multiferroics, superconductors, transparent conductors

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시료 합성과 단결정 성장

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Abstract:
본 강연에서는 응집물리 실험 분야에서 가장 기초가 되는 시료의 제작과 단결정 성장의 기본 원리와 과정을 전반적으로 소개하려고 한다. 먼저 표준적인 고상소결법 (solid state reaction)을 통한 다결정 산화물의 제작, 석영관 봉인 (quartz tube sealing)이나 튜브퍼니스을 통한 비산화물의 제작 등의 다결정 시료 제작법을 소개한다. 그리고 단결정 제작 시 상도표 (phase diagram) 이용과 플럭스 방법 (flux method)과 floating zone 퍼니스 방법 등의 대표적인 단결정 제조법의 소개 및 유의점들이 논의될 것이다.

Keywords:
고상소결법, 단결정 성장, 상도표

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다금속과 칼코겐 화합물의 결정성장 및 열전재료 응용

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Abstract:
고체 신물질 시료의 합성 및 결정성장은 많은 노력을 필요로 한다. 또한 합성 시 고려해야 할 변수가 매우 많기 때문에 합성자의 know how에 시료의 품질이 크게 의존하는 경우가 많다. 따라서 좋은 시료를 합성하고 고품질의 고체 결정을 생산하기 위해서는 물질 각각에 맞는 적당한 방법을 찾고 체계적으로 합성조건을 찾아가야만 한다. 예를 들어, 다금속, 산화물, 칼코겐 고체 화합물의 합성은 합성원료의 녹는점, 끓는점, viscosity, vapor pressure 등 다양한 물리량을 검토한 후에 적당한 합성방법을 선택해야만 한다. 결정성장 방법으로써는 flux 법, Bridgman 법, Czochralsky 법, vapor transport 법, Traveling solvent floating zone 법 등 다양한 결정성장법 중에 어떤 방법을 선택할 것인가를 결정해야 하며 각각의 합성방법에 따라 그에 맞는 결정성장 조건이 탐색되어야 한다. 이 발표에서는 결정성장과 고체상 합성에 있어 올바른 합성방법 선택의 기준과 각각의 방법을 사용함에 있어 고려해야 할 물리적 화학적 인자에 대해 고찰함으로써 고품질의 시료제작의 기초에 대해 소개하고자 한다. 또한 결정성장의 한 예로써 에너지 변환재료인 열전소재의 응용에 대해 논의한다.

Keywords:
결정성장, Fux growth, Bridgman, Czochralsky, 열전

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별의 진화: 주계열에서 초신성까지

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Abstract:
빅뱅 이후 별은 중원소의 합성, 우주의 재이온화, 초신성 폭발을 통한 역학적 피드백 등 우주의 진화에 중요한 역할을 해왔다. 별의 죽음과 함께하는 초신성 폭발 현상은 초기 우주의 별형성 역사, 허블 상수와 우주 팽창 속도 측정 등, 우주론을 위한 중요한 도구로도 사용된다. 최근에는 중력파의 검출 및 다양한 형태의 초신성과 감마선 폭발체의 관측을 통해 항성진화이론의 급격한 발전이 이루어지고 있다. 이 강의에서는 항성 진화의 기본 원리를 설명하고 최신 관측을 통한 항성진화이론 연구 동향을 소개한다.

Keywords:
항성 진화, 초신성 폭발

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 T2.02
2016.10.19 - 2016.10.21

백색왜성, 중성자별, 블랙홀

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Abstract:

별의 진화 마지막 단계에서 형성되는 중성자별과 블랙홀은 2015년 중력파 발견으로 새로운 전기를 맞고 있다. 또한 백색왜성과 중성자별은 양자역학이 별의 구조를 결정할 수 있다는 것을 보여준 매우 중요한 천체이다. 백색왜성은 전자의 축퇴압력, 즉 전자기상호작용에 의해 구조가 거의 결정되는 반면, 중성자별은 양성자와 중성자와 같은 강입자들의 축퇴압력, 즉 강상호작용에 의해 구조가 결정된다. 그런데, 강상호 작용의 특성상 근사적 계산이 불가능하여 아직도 중성자별의 구조는 명확히 밝혀지지 않고 있다. 이번 강의에서는 백색왜성과 중성자별의 내부 구조, 중성자별과 블랙홀의 진화, 그리고 중력파에 이르기까지 고중력천체와 관련된 물리학 및 천체물리학적 연구 동향을 강의한다.

Keywords:
중성자별, 블랙홀, 중력파

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F12.01
2016.10.19 - 2016.10.21

Overview of KSTAR Experimental Results

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Abstract:

KSTAR is keep going toward realization of nuclear fusion by trying to achieve high performance and long pulse operation. Since the first long pulse H-mode operation in 2012, we have devoted our effort to extend the operational window in both performance and operation duration wise. During 2015 campaign, we succeed in achieving the world longest 55 second H-mode operation. Challenging 100 second H-mode operation is being tried in 2016 campaign with the enhanced plasma control abilities and active water cooling of the plasma facing components. Thanks to the auxiliary current drivers such as 3 NBI beams and the 105/140 GHz ECCD and bootstrap current, we could sustain the H-mode discharge without inductive current drive so called non-inductive-discharge for 12 second in this campaign. In addition, we observed L-mode ITB (internal transport barrier) discharges having comparable performance with H-mode discharges. While heading to the high performance and long pulse operation, we also have given efforts to solve some physical issues which are inevitable in ITER and further reactor class machine. The ELM suppression using by the external magnetic perturbation is the one of the key issues in ITER to avoid large amount of heat load on the divertor. KSTAR have been achieving very distinguishing results in this area. After achieving a very clear ELM suppression with the n=1 external magnetic perturbation, we have been trying to figure out the physical mechanism under the ELM suppression and keeping focused on the preferable experimental conditions for ELM suppression to find clues behind physics. In 2016 campaign we achieved very reliable longest 14 second ELM suppression by the external magnetic perturbation which have n=1 toroidal spectrum. Related physical topics to the inherently small magnetic error field of KSTAR also being studied. The L-H transition threshold power, influence on toroidal flow, and relations with the neoclassical troidal viscosity with the magnetic error field are being under investigation. Including above topics, the presentation will address the recent results on rotation & transport physics, newly installed diagnostics, MHD activities and the future plan.

Keywords:
Fusion, KSTAR, ELM

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F12.02
2016.10.19 - 2016.10.21

Current Status of KSTAR Diagnostics

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Abstract:

Diagnostics are key components to operate a tokamak device by monitoring and controlling the machine and to study a physic of the plasma by measuring various parameters over wide spatial and temporal range. In Korea Superconducting Tokamak Advanced Research (KSTAR), sets of diagnostics are available for these purpose, which are categorized as follows: (1) control related diagnostics, (2) one-dimensional profile diagnostics, (3) two-dimensional imaging diagnostics, and (4) physics oriented diagnostics. Current plasma control system on KSTAR is based on magnetic diagnostics and interferometers for controlling plasma current, line density and shape of the plasma. The control capability will be expanded to the profile of electron temperature and plasma current by developing real-time an electron cyclotron emission (ECE) radiometer and a motional Stark effect (MSE) diagnostics. Profile diagnostics provide a basis of the analysis for the most physics studies. Sets of profile diagnostics including a Thomson scattering, an ECE radiometer, a reflectometer, a charge exchange spectroscopy (CES), a X-ray imaging crystal spectroscopy (XICS) and a MSE system cover profiles of density, temperature and rotation velocity of the electron and the ion. There were many successful efforts to increase accuracies and reliabilities of these diagnostics. Especially, KSTAR is the best tokamak for the two-dimensional measurements of plasma properties. Two ECE imaging (ECEI) systems measure the dynamics and fluctuation of the electron temperature and density. A microwave imaging reflectometer (MIR) and a beam emission spectroscopy (BES) system measure the fluctuation of the electron density. Plentiful data from various 2D diagnostics will open new perspective on the tokamak physics and will enable verification of theories and simulation codes by comparative analysis with measurements data. In addition, there are many other diagnostics not listed above for specific physics studies. Overview on the current status of the diagnostics and future plans will be presented.

Keywords:
diagnostics, KSTAR

Identifying major factors for fuel retention behavior in KSTAR

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Abstract:

Wall retention affects fuelling efficiency, plasma density control and the neutral particle density in the plasma edge, which in turn affects plasma confinement [1]. Furthermore, excessive tritium accumulation in the first wall will introduce a safety problem for the next fusion device, such as ITER. The limit of maximum tritium retained in first wall for ITER is 700g [1, 3]. Particle balance is a simple method to calculate the wall retention, it uses the difference between injected particles and exhausted particles as retained particles. We have investigated the wall retention in KSTAR. The wall retention behavior depending on the type of discharges is studied. The results show that the wall retention is almost independence from the discharge type. The main parameters, which could affect the wall retention, are pulse length and injected particles. The daily wall retention shows that there is wall saturation after a long pulse discharges. After wall saturation, it is hard to achieve high quality plasma discharge. References: [1] G. Federici et al., Nucl. Fusion, 2001, 41, 1967-2137 [2] T. Loarer et al., Nucl. Fusion, 2007, 47, 1112-1120 [3] T. Loarer et al., J. Nucl. Mater., 2009, 390-391, 20-28 Acknowledgements Authors thank Dr. Jun-Woo Juhn and Mr. Kwang-Pyo Kim for valuable advices on KSTAR gas injection system and vacuum system. This research was partially supported by Ministry of Science, ICT, and Future Planning under KSTAR project and was partly supported by National Research Council of Science and Technology (NST) under the international collaboration & research in Asian countries (No. PG1314).

Keywords:
Wall retention, particle balance

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2016.10.19 - 2016.10.21

Diagnosing impurity elements on the KSTAR divertor surface using LIBS technique

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Abstract:

The impurity deposition on the Plasma Facing Materials (PFMs) surface of fusion device would be one of the major issues about stable operation of fusion devices. Laser Induced breakdown spectroscopy (LIBS) technique is used for diagnosis of material component from almost any conditions. It is the spectroscopic technique to measure emission lines from the excited atoms by means of the high power laser pulse. In this work, LIBS has been tested to diagnose impurity elements on Korea Superconducting Tokamak Advanced Research (KSTAR) divertor tile. Spectral lines of Fe, Cr, Ni, C and several other elements were detected from the divertor surface. Variation of spectral lines with a series of laser shots have demonstrated the depth profiling capability of the impurity layer covering the divertor. The laser produced plasma conditions has been qualitatively determined from the relative line intensities from each element and linewidth analysis. The validity of analysis has been checked with the atomic spectral simulations based on Saha-LTE model. *This work is supported by the NRF (No. 2013M1A7A1A02043864), and the TBP research project of GIST.

Keywords:
KSTAR, Divertor, LIBS

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2016.10.19 - 2016.10.21

A very light dilaton and scale-invarinat Higgs

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Abstract:

We study a very light dilaton, arising from a hidden sector that couples to the standard model of particle physics. Imposing a scale symmetry below the ultraviolet scale of the standard model, we alleviate the fine-tuning problem associated with Higgs mass, as argued by Bardeen. When the electroweak symmetry is spontaneously broken radiatively a la Coleman-Weinberg, the dilaton develops a vacuum expectation value away from the origin to give an extra contribution to the Higgs mass. The ultraviolet scale of the Higgs field can be naturally much higher than the electroweak scale, as it relaxes by the dilaton to a lower scale, as a manifestation of the a -theorem in the conformal field theory. We also show that the light dilaton in this scenario can be a good candidate of dark matter in our universe.

Keywords:
light dilaton, scale symmetry, Higgs, Naturalness

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.02
2016.10.19 - 2016.10.21

Degenerate Higgsino Dark Matter

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Abstract:

We examine the very degenerate Higgsino dark matter, whose mass splitting between the lightest neutral component and the charged component is O(1) MeV. The scenario can be realized in the minimal supersymmetric standard model by allowing small gaugino mixing. In contrast to the pure Higgsino dark matter only with the radiative splitting, various distinctive observable signatures are induced: sizable Sommerfeld enhancement and Ramsauer-Townsend suppression relevant to ~1 TeV Higgsino DM, large enough annihilation signals observable from the galactic center and/or dwarf galaxies, stable chargino signatures at collider experiments, and dark matter direct detection signals depending on the Wino mass.

Keywords:
Dark matter, DegenerateHiggsino,Sommerfeld-Ramsauer-Townsend effect

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.03
2016.10.19 - 2016.10.21

Phases of light dark matter and self-interactions

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Abstract:
We study a complete analysis of the parameter space for light dark matter in models with gauged discrete symmetries. Depending on a concrete mechanism of dark matter production, we show how self-interactions of dark matter and its interactions to visible matter are constrained. Search strategies of light dark matter are also presented.

Keywords:
Dark matter, Self interaction

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.04*
2016.10.19 - 2016.10.21

Collider and astrophysical probes of dark matter with mediators

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Abstract:

We consider a simple extension of the Standard Model with a Dirac fermion dark matter where a singlet complex scalar field becomes mediators between dark matter and SM particles via scalar portals. In this model, the mediator scalars can decay into photons through direct or cascade processes. For a sizable dark matter self-coupling or scalar self-coupling, we show that mono-jet searches and/or gamma-ray observations are complementary in constraining the parameter space of the model. In the case of cascade decay, the model is testable by the discrimination between genuine photons and photon-jets at the LHC as well as the gamma-ray searches for the cascade annihilation of dark matter.

Keywords:
Dark Matter, LHC, New Physics

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.05
2016.10.19 - 2016.10.21

Thermal effect on the co-annihilation of heavy particles

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Abstract:
Using non-relativistic effective field theory framework, we discuss thermal effects on the co-annihilation of heavy particles near the threshold. In particular, we consider bound state effect and thermal effect on heavy dark matter co-annihilation in thermal environment by use of the formulation developed in our previous work (JHEP07 (2016) 143).

Keywords:
NRQCD, dark matter, thermal effect, co-annihilation

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.06*
2016.10.19 - 2016.10.21

Perturbative calculation of and at the one-loop level using improved staggered quarks

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Abstract:
We present results of matching factors for and calculated perturbatively at the one loop level with improved staggered quarks. We calculate and with HYP-smeared staggered quarks. Final results of and at and in the scheme are given in tables.

Keywords:
Renormalization; Lattice QCD; Quantum Field Theory; staggered quarks; lattice perturbation theory

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.07
2016.10.19 - 2016.10.21

Heavy-heavy quark current improvement for calculation of semi-leptonic form factors using the Oktay-Kronfeld quark.

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Abstract:

The Oktay-Kronfeld action is a improved version of the Fermilab action and reduces heavy quark discretization effects through in HQET power counting, for the heavy-light meson spectrum. To calculate semi-leptonic form factors using Oktay-Kronfeld heavy quarks, we need to improve the heavy quark currents to the same level. We report our progress in improving currents composed of bottom and charm quarks.

Keywords:

CKM matrix elements

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F13.08
2016.10.19 - 2016.10.21

Tuning of Oktay-Kronfeld action for heavy quarks

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Abstract:

We determine hopping parameters of the Oktay-Kronfeld (OK) action for charm and bottom quarks using N_f=2+1+1 MILC HISQ ensembles. As a key ingredient, we compute the masses of pseudoscalar and vector mesons $B_s^{(*)}$, $D_s^{(*)}$ and their hyperfine splittings; the valence light quark is simulated with HISQ action. We also monitor the inconsistency parameters to confirm the improvement.

Keywords:
Lattice QCD, Hopping parameter, Heavy quark

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2016.10.19 - 2016.10.21

Neutrinoless Double Beta Decay and Sterile Neutrinos

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Abstract:

Neutrinoless double beta decay is possible if neutrinos are Majorana particles. The decay rate of that process is determined by three factors, which are nuclear matrix element, phase space factor and effective Majorana mass. Because the effective mass depends on masses and partial elements of PMNS matrix, one can draw information of absolute mass scale and mass ordering by measuring half-life of the decay. This presentation contains the study of effective mass in 3+1 scheme and a meaningful analysis in searching sterile neutrinos. Our approach takes the sensitivity bounds of AMoRE experiments to constrain the sterile neutrino model in terms of and . It is then possible to compare the neutrinoless double beta decay with short-baseline oscillation experiments in a parameter space, giving rise to a complementary strategy to test the existence of light sterile neutrinos.

Keywords:
neutrinoless double beta decaysterile neutrinoeffective Majorana mass

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2016.10.19 - 2016.10.21

F14.01*

Drell-Yan Differential Cross Section Measurement in Dimuon Channel at 13TeV with the CMS Detector

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Abstract:

Measurement of the differential Drell-Yan cross sections in the dimuon channel is presented. It is based on proton-proton collision data at 13 TeV recorded with the CMS detector at the LHC and corresponding integrated luminosity is 2.8 fb−1. The differential cross section in the dimuon mass range 15 to 3000 GeV is measured and corrected to the full phase space. These measurements are compared to perturbative QCD predictions and show good agreement with the prediction.

Keywords:
Drell-Yan, cross section, muon, CMS, LHC

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2016.10.19 - 2016.10.21

Search for High-mass Resonances in Z(ll)gamma Final State at CMS

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Abstract:
A search for a heavy resonance decaying to Zgamma, with the Z boson further decaying to pairs of electrons or muons is presented. The search strategy is to look for an excess above the non-resonant background on the ll+gamma invariant mass spectrum. The search is based on the data corresponding to 13/fb, collected with the CMS detector during Large Hadron Collider (LHC) 13 TeV run in 2016.

Keywords:
Zgamma, new particle search

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2016.10.19 - 2016.10.21

Search for leptophobic Z' decaying into four leptons in the final state at 8 TeV

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Abstract:
A search for heavy narrow resonances decaying into four-lepton final states in events has been performed with an integrated luminosity of 19.7 fb^{-1} of proton-proton collision data at 8 TeV collected by the CMS experiment. No excess of events over the standard model expectation is observed. Upper limits for the predictions of a benchmark model on the fiducial cross section times branching fraction for the production of these heavy narrow resonances are presented.

Keywords:
CMS, 8 TeV, Z', four-lepton

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F14.04*
2016.10.19 - 2016.10.21

A study of Initial State Gluon Radiation on the Drell-Yan process in LHC at sqrt(s)=8 & 13 TeV

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Abstract:
We study initial state radiation (ISR) in the LHC data. Drell-Yan event is chosen to analyze ISR effect becuase of no final state radiation (FSR). We measure the dependence of the averaged pt of dilepton on the averaged invariant mass of diletpon using the CMS data at 8 TeV and 13 TeV.

Keywords:
LHC, CMS, Standard Model

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F14.05*
2016.10.19 - 2016.10.21

Search for heavy Majorana neutrino in trilepton channel at 13 TeV using the CMS detector

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Abstract:

Due to the discovery of neutrino oscillations, non-zeroness of neutrino mass is now well known. One of the theories to explain the mass of the standard model neutrinos is the existence of a heavy Majorana neutrino at the LHC energy scale. We report studies of searches for a heavy Majorana neutrino in trilepton events corresponding to 2.3/fb of CMS 13 TeV run data. For events with three leptons and missing transverse energy, the invariant mass of the heavy Majorana neutrino can be fully reconstructed with good mass resolution. We present a study of this channel and the discovery sensitivity.

Keywords:

LHC, CMS, heavy Majorana neutrino, trilepton channel

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F14.06*
2016.10.19 - 2016.10.21

Search for Heavy Neutrinos in the Di-lepton Events at = 13 TeV Using the CMS Detector

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Abstract:

The discovery of neutrino oscillations has opened a possibility of the existence of heavy neutrinos at the LHC energy scale. In this KPS, we report sensitivity studies for heavy neutrinos in t-channel and in pair production channel of heavy neutrinos at 13 TeV. These two channels are studied using di-lepton events with 4 jets.

Keywords:
LHC, CMS, heavy neutrino

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F14.07
2016.10.19 - 2016.10.21

Search for H+ to cbbar in lepton+jets channel using top quark pair events

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Abstract:

Results on the search for a light charged Higgs boson decaying to cbbar in top quark pair events using the CMS detector at the LHC are presented. The total dataset corresponds to 19.7/fb of proton-proton collisions at sqrt{s} = 8 TeV. In ttbar decays, if one top quark decays to H+ b, instead of W b, and the H+ subsequently decays to cbbar, while other top quark decays leptonically. The final state then consists of four jets (three b quark jets), one lepton (electron or muon), and missing energy. The main observable used in the analysis is an invariant mass of two jets, one of which is identified as a b quark jet. The dijet pair is selected from at least four jets in an event by a dedicated kinematic fitter. No signal for the presence of a charged Higgs boson is observed and upper limits are set at 95% confidence level on the branching ratio for t -> H+ b from 1.1-0.4% for the charged Higgs boson mass in the range 90-150 GeV in the assumption of branching ratio of B(H+ -> cbbar) =100% for the first time.

Keywords:
2HDM, type-Y, charged Higgs

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 F14.08*
2016.10.19 – 2016.10.21

Search for H^+ AW in 13 TeV CMS data

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Abstract:

We present a sensitivity study of the search for charged Higgs boson decaying into a pseudo-scalar boson A, and a W boson from 13 TeV CMS data. When the charged Higgs, H^+ is lighter than a top quark, the H^+ can decay from a top quark instead of W^+ boson. We use top quark pair events where one of top quark decays to charged Higgs boson and a b-quark, the other top quark decays to a W boson and a b-quark, and the charged Higgs decays to W boson and pseudo-scalar boson A, and A decays to di-muon subsequently. This study was performed on the final state of 3 leptons where at least 2 of which are muons with opposite charges, at least 2 non-b tagged jets, and at least 1 b-tagged jets.

Keywords:

Charged Higgs, Pseudo-scalar Higgs, top, CMS, LHC

New energy-degraded-beam project at RIBF - OEDO project -

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Abstract:
The OEDO project is started for utilizing low-energy exotic beam down to 10 A MeV or less from high-energy beams more than 200 A MeV produced by the BigRIPS in the RIKEN RIBF facility. The OEDO system consists of a RF deflector with two STQ's after a mono-energetic degrader in the SHARAQ beam line in the RIBF. The RF deflector acts as a focusing element for a secondary beam after a mono-energetic degrader, which provide a reasonably small beam size less than 2 cm (FWHM) even for energies less than 10 A MeV. Possible physics programs are also discussed.

Keywords:
OEDO project, RIBF

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The study of structures in 18Ne and 19Ne for understanding the break-out process

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Abstract:

To study the break-out process from Hot CNO cyle to rp-process is crucial for understanding the nuclear synthesis of heavy nuclei. It is well known that there are two break-out processes. One is 14O(a,p)17F and the other one is 15O(a,g)19Ne. Because these two reactions are expected to be dominated by resonant contributions proceeding through 18Ne and 19Ne, it is important for identifying the resonant states in 18Ne and 19Ne. In this presentation, two experiments for structures in 18Ne and 19Ne will be introduced and their results will be discussed.

Keywords:

r-process, β-decay spectroscopy, EURICA project, Radioactive Isotope beam

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Mass distribution of quasi-fission fragments at heavy element synthesis

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Abstract:

We calculate the fusion and the quasi-fission cross sections of two ^{242}Cf forming rreactions, $^{34}S+^{208}Pb$ and $^{36}S+^{206}Pb$, with the di-nuclear system(DNS) model. These two systems have a small difference of the neuton distribution, but have large differences of the fusion and the evaporation residue cross sections. The fusion probability depends on the angular momentum and the excitaion energy of system. The relatively large Q-value of $^{36}S+^{206}Pb$ gives broader distributions of the excitation energy and the angular momentum, and that induces the large fusion cross section. We investigate the charge and mass distributions of DNS during the fusion process. In the heavy nucleus synthesis, the quasi-fission hinders the fusion. The quasi-fission is a multi-nucleon transfer process, and the nucleon transition rate depends on the charge and the mass distributions. We discuss the effect of the entrance channel on the charge and the mass distributions and the relation between the fusion probability and the DNS configuration.

Keywords:
fusion, quasi-fission, ^{242}Cf, di-nuclear system model,

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Development of Multiple reflection time of flight mass spectrograph in RAON

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Abstract:
Nuclear mass is a fundamental property of atomic nuclei which contains the effect of nuclear force, playing important roles in nuclear shell evolution study and nuclear astrophysics, etc. In RAON, a radioactive beam production facility being under construction in Korea, a multiple reflection time-of-flight mass spectrograph, so called MRTOF, will be developed and installed in order to perform mass measurement for the short-lived isotopes with sufficient relative accuracy of order of 1.E-07 and to improve the purity of ISOL beam with relatively-high mass resolving power of order of 1.E05. A current status of development of MRTOF in RAON will be presented.

Keywords:
rare isotope, RAON, mass measurement, MRTOF

물리학으로 보는 인간, 그리고 사회

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Abstract:
다양한 자연현상을 체계적으로 설명하는 물리학은 인간과 사회에 대해서도 독특하고 유용한 시각을 제공할 수 있습니다. 본 강연에서는 우리 인간에 대해, 그리고 우리가 서로 영향을 주고 받으며 함께 살아가는 사회에 대한 한 통계물리학자의 시각을 설명하고자 합니다.

Keywords:
통계물리학, 인간, 사회

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상대성이론에 대한 새로운 이해

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Abstract:
교과서에서 만나는 상대성이론에 대한 전통적인 설명은 많은 재미있는 측면을 강조하지 못하는 것이 사실이다. 이 강좌에서는 먼저 상대성이론을 최대한 직관적으로 다시 조명한 다음, 상대성이론의 바탕과 뜻에 대해 더 자세히 생각해본다. 전자기학이 없다면 상대성이론이 존재할 수 있을까? 빛의 속력이 일정하다는 것은 더 이상 설명할 수 없는, 받아들여야만 할 기정사실일까? 움직이는 물체는 줄어들어 보이는 것일까, 아니면 정말 줄어드는 것일까? 줄어든다면 그 효과를 어떻게 볼 것인가? 줄어든다고 해도 왜 당사자들은 자신이 줄어든다는 것을 모를까? 뉴턴의 중력은 물체들이 왜 서로를 끌어당기는지 설명할까? 아인슈타인의 일반 상대성이론은 물체들이 왜 서로를 끌어당기는지 설명할까?

Keywords:
상대성이론

A Levy walk model for mRNA transport in neurons

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Abstract:

Transport and local translation of messenger RNAs (mRNAs) are essential for the spatial and temporal regulation of gene expression in neurons. For this, mRNAs are actively transported by multiple motor proteins on microtubules in a dendrite in either anterograde or retrograde direction. For local protein synthesis, the mRNA molecules eventually become localized at multiple places in the dendrite in which they are in stationary states with broad distributed rest times. Using live-cell single mRNA tracking experiments and stochastic modeling of the obtained trajectories, we here investigate in detail the transport and localization dynamics of labeled endogenous mRNAs in live hippocampal neurons. It is shown that the motor-driven movement of mRNA follows a Levy walk interrupted by long rests of diverging mean rest time. Due to the long rests the system exhibits strong aging effects, which are shown to significantly impact on the superdiffusive characters of the mRNA transport.

Keywords:
Levy walk, mRNA, active transport, neuron

Charged biomolecules in water

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Abstract:

The presence of polar water in cell reduces ionization barrier significantly so that most biological molecules are charged either locally or globally. For this reason, the charge interaction is one of the most important long range interaction governing the behavior of these molecules. Recently, there have been intensive studies on the electrostatics of biological system in order to understand its anomalous behaviors which are originated from the inhomogeneity in electrostatic field, and explicit water dependence (specific ion effect). Some examples are attraction between like charges, repulsion between opposite charges, charge inversion, charge renormalization, phase separations of complex polyelectrolyte solutions, Hofmeister series, etc. Conventional theoretical approaches based on mean field theory often fail to explain these phenomena. Hierarchical structure and the mesoscopic nature are essential hurdles to understand these systems. In this talk, I will highlight theoretical and computational efforts to study the electrostatics of biological molecules.

Keywords:
charge, biomolecule, polymer, water

Elasticity of semiflexible biopolymers subject to contour forces

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Abstract:

The tensile elasticity of isolated semiflexible filaments has been on the focus of a significant body of literature, primarily because of its relevance to the mechanics of biological matter. In real systems, however, these filaments are subject to forces exerted along their contour, in addition to the tension applied to their ends. In this talk, I am going to present analytic results concerning two models of filaments subject to contour forces. At first, I am going to present a brief review of the random transverse force model. This random force may represent the effect of a crowded environment or a transverse electric field on a random polyampholyte. Results are obtained for the force-extension relation and also for the transverse fluctuations. The main part of the talk will be about recent results on stretching or compressing a filament with a discontinuity in its tension. This discontinuity may be due to a molecular motor or a cross-linker. We obtain results concerning its force-extension relation and the response of the two parts in which the filament is divided by the motor or cross-linker. We show that for a small tension discontinuity, the linear response of the filament extension to this discontinuity strongly depends on the external tension. PB and E. M. Terentjev, Phys. Rev. E 82, 050802(R) (2010) PB and E. M. Terentjev, Phys. Rev. E 84, 022801 (2011) M. Razbin, PB and A. Zippelius, Phys. Rev. E 93, 052408 (2016)

Keywords:
filaments, molecular motors, wormlike chain, Green functions

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WLC model and beyond in Biology

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Abstract:

The celebrated simple Worm like chain (WLC) model successfully captures DNA elasticity. However, other bio-filaments display more complex behaviors due to their mechanical heterogeneity or to their helicity. We thus refine the WLC model for helical molecules and also for mechanically heterogeneous molecules. Our refined WLC model allows us to interpret angular orientations and anomalous elasticity observed from helical molecules such as intermediate filaments and actin filaments. We also incorporated the random copolymer model within our WLC framework to treat the heterogeneity in curvature and/or modulus of various bio-filaments. The structural changes of filaments due to protein adsorption and the structural transitions induced by mechanical stimulation are also discussed.

Keywords:
Worm-Like-Chains, Elasticity, Helicity, Hetero Polymers, Random Copolymer,

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Current Status of X-ray Scattering and Spectroscopy Beamline at PAL-XFEL

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Abstract:
A new hard x-ray free electron laser facility in Pohang Accelerator Laboratory will be opened to users in 2017. One of the experimental end-station called as XSS(XFEL Scattering & Spectroscopy) in the hard x-ray beamline for x-ray pump & probe technique coupled researchs will be introduced in this talk:science, instruments, commissioning status, and plan. Since the XSS is a user facility, careful listening to future user's demand is critical. PAL-XFEL staff would like to actively communicate with many researchers in various field via this presentation.

Keywords:
X-ray Free Electron Laser, PAL-XFEL, Pohang Accelerator Laboratory

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탠덤 펌핑 Yb 광섬유 레이저

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Abstract:
광섬유 레이저는 고효율, 우수한 빔 특성, 높은 안정성 및 시스템 구현 및 유지보수의 용이함 등의 많은 장점들로 인해 지난 몇 십년간 산업, 군사, 의료 분야 등 많은 분야에서 기존의 고체 레이저 시스템을 대체하여 사용되고 있다. 현재 광섬유 레이저 중에서 가장 각광받고 있는 이터븀(Yb)이 첨가된 광섬유 레이저는 넓은 흡수 및 방출 스펙트럼, 작은 양자 결함(~9%)과 긴 형광수명을 가지면서 에너지 저장효과도 뛰어나 고출력 연속 발진 레이저를 작동의 유리한 조건을 가지고 있다. 하지만, 이 또한 kW이상의 출력을 발진시키게 되면 열, 빔 왜곡 등의 문제를 야기하게 되는데 이러한 문제를 해결할 수 있는 방법이 바로 탠덤 펌핑(Tandem pumping) 방식이다. 탠덤 펌핑 방식은 방출 파장과 가까운 파장의 레이저빔을 펌핑 광원으로 사용하여 다른 레이저를 발진시키는 방법이다. 탠덤펌핑 이터븀 레이저 같은 경우, 9xx nm의 다이오드 레이저 대신에 1010 nm~ 1030 nm 사이의 파장의 광섬유 레이저를 펌핑 광원으로 사용함으로써 양자 결함을 약 9%에서 5% 이하로 줄일 수 있기 때문에 열로 인한 문제를 크게 줄일 수 있다. 게다가 탠덤 펌핑 광섬유 레이저는 저차 모드와 펌핑 빔의 좋은 오버랩 효율로 인한 출력 빔의 빔질 향상에 도움이 될 뿐 아니라 낮은 여기밀도를 가지고 있어 광손상을 막는데 도움이 된다고 알려져 있다. 본 연구에서는 탠덤 펌핑 Yb 광섬유 레이저 시스템을 구축하고 펌핑 파장에 따른 레이저 발진 특성을 비교 연구하였다. 펌핑 광원으로 사용하는 Yb 광섬유 레이저는 60 W 급 976 nm 고출력 다이오드 레이저를 사용하여 펌핑하였다. 이때 사용한 Yb 광섬유의 코어와 클래딩은 각각 20 um, 125 um이고 NA는 0.08, 0.46이며, 흡수계수는 976 nm에서 25.8 dB/m이므로 약 1 m 길이의 광섬유를 사용하였다. 레이저의 파장 선택은 외부 피드백 공진기의 회절 격자를 조절하여 이루어졌고 그 결과 광섬유 레이저는 1017 nm ~ 1050 nm까지 출력 레이저의 파장이 조절 가능함을 확인하였다. 발진된 중심 파장이 1030 nm 에서의 최대 출력은 23.5 W이고 이때의 기울기 효율은 약 80.4%로 측정되었다. 이를 펌핑 광원으로 사용하여 ~16 m Yb 광섬유의 내부 클래딩에 입사시킴으로써 탠덤 펌핑 Yb 광섬유 레이저 시스템을 구축하였고 이때 사용된 Yb 광섬유는 펌핑 광원에서 사용된 광섬유와 동일한 사양이다. 또한 VBG를 이용하여 레이저 발진 파장을 1070 nm로 선택 고정하였다. 본 발표에서는 1020 nm에서 1030 nm까지 조절한 펌핑광원을 이용하여 1070 nm 파장의 레이저를 발진하는 탠덤 펌핑 레이저 시스템을 구축하고 펌핑 조건, 레이저 특성 등을 연구하여 보고하고자 한다.

Keywords:
광섬유 레이저, 탠덤 펌핑, 양자 결함, 열

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확장된 공진기 구성을 통한 모드잠금 Yb:KYW 고체 평면 도파로 레이저 연구 Study of mode-locked Yb:KYW planar waveguide laser by an extended cavity configuration

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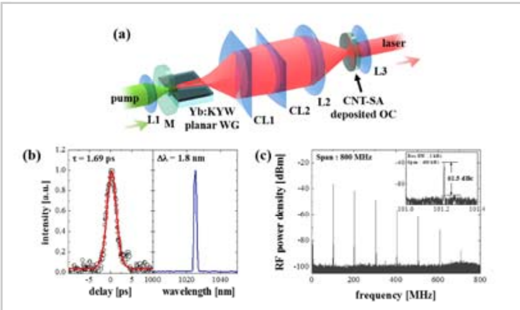

Abstract:
도파로 펄스 레이저는 도파로의 특성을 이득매질에 적용한 레이저로서 작고 단순한 구조, 낮은 이득의 레이저 동작 및 낮은 펌프 출력에서의 동작, 저렴하고 효율적인 펄스 광원으로서의 이점을 지니기 때문에 다양한 종류의 이득매질, 도파로 구조, 그리고 포화흡수체와 관련한 연구가 활발히 수행되어 왔다. 하지만 모드잠금 도파로 레이저의 경우 기존 활발히 연구되어온 cw 도파로 레이저 및 Q-스위칭 도파로 레이저와는 이득매질에 요구되는 특성이 다를 뿐 아니라 공진기 구성의 까다로움으로 인해 현재까지도 소수의 연구성과만이 보고된 바 있다. 특히 cw 모드잠금 동작을 위해서는 이득매질 및 포화흡수체에서의 높은 첨두세기가 요구되며, 따라서 평면도파로 레이저의 경우 간단한 구조로 인해 제작이 용이한 반면 상대적으로 큰 레이저 모드를 지녀 구조적으로 이를 충족시키기 까다로운 측면이 있다. 이에 따라 본 연구에서는 공진기 길이를 1.48 m 수준으로 확장한 구성을 도입하고, 탄소나노튜브를 포화흡수체로 사용하여 모드잠금 고체 평면 도파로 레이저를 제작하고 이에 대한 특성분석을 수행하였다. 그림 (a)는 탄소나노튜브를 통해 모드잠금된 Yb:KYW 평면 도파로 레이저의 개략도이다. 확장된 공진기 구성을 위해 평면도파로 외부에서 발산하는 공진기 모드는 두 원통형 렌즈를 통해 제어하였으며, 모드잠금 동작을 위해 탄소나노튜브 분산용액을 출력경에 도포하고 그 앞단에 볼록렌즈를 삽입하였다. 이와 같이 제작한 레이저는 안정적인 cw 모드잠금동작을 수행하였다. 2.4% 투과 출력경을 사용시, 최대출력은 1.95W 펌핑시 92 mW 였으며, 모드잠금문턱의 경우 0.85 W 펌핑시 15 mW임을 측정하였다. 그림 (b)는 모드잠금 동작시의 펄스폭 및 대응하는 스펙트럼 측정결과이다. 이로부터 중심파장 1025.2 nm, 반치폭 1.8 nm 일 때, 펄스폭은 $sech^2$형태로 가정시 1.69 ps임을 측정하였다. 그림 (c)는 800 MHz 범위 및 400 kHz 범위(inset)에서 측정한 RF 스펙트럼 측정결과이다. 400 kHz 범위에서 측정한 결과를 통해 본 레이저는 공진기 길이에 대응되는 101.2 MHz에서 61.5 dBc의 높은 S/N비를 지님을 측정하였고, 800 MHz 범위에서 측정한 결과로부터 본 레이저는 어떠한 다중펄스 형성없이 안정적인 단일펄스 동작을 수행함을 확인하였다. 본 연구에서는 공진기 구성을 확장하고 탄소나노튜브를 포화흡수체로 사용하여 모드잠금 Yb:KYW 평면 도파로 레이저를 제작하고 이에 대한 특성분석을 수행하였다. 본 연구는 고체 평면도파로 레이저의 모드잠금 동작을 탄소나노튜브를 통해 최초로 유도한데 그 의미가 있으며, 향후 다양한 고체 도파로 레이저의 모드잠금 연구를 위한 기초연구로서 활용될 수 있을 것으로 기대된다.

Keywords:
solid-state waveguide laserYb:KYW planar waveguidemode-lockingcarbon nanotube

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펌프 빔 크기에 따른 Er:Yb:Glass laser 출력 특성

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Abstract:
본 연구에서는 거리측정기용 Er:Yb:Glass laser를 위한 공진기를 구성하고 QCW mode에서 펌프 빔 크기 변화에 따른 Er:Yb:Glass laser의 출력 특성을 조사 하였다.

Keywords:
Eye safe laser, QCW mode, Er:Yb:Glass

~6 kW 첨두 출력의 고출력 준연속 Yb 광섬유 레이저

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Abstract:
최근에 광섬유 레이저는 소형화, 높은 효율, 쉬운 유지보수, 좋은 빔 특성과 같은 장점들로 인해 산업, 통신, 군사, 의료 등 다양한 분야에서 응용 되고 있다. 특히 벌크 고체 레이저에 비해 구조적으로 발생하는 열을 제거하는 것이 탁월하여 열로 인해 발생하는 문제가 크게 줄어들기 때문에 고출력 레이저를 발진시키는데 매우 유리하여 이미 kW 급 단일모드 연속발진 레이저가 상용화되어 사용되고 있다. 하지만 연속 발진 레이저를 이용하여 절삭, 용접, 드릴링 등 기계 가공 시 대상 물질에 불필요한 열에너지가 발생하여 가공 품질이 저하된다는 단점이 있다. 이러한 열 문제를 해결할 수 있는 방법은 Q-스위칭이나 모드잠금으로 작동하는 펄스 광섬유 레이저이다. Q-스위칭 역시 첨두 출력이 수 킬로와트 이상인 광섬유 레이저가 개발되었지만, 수 ns 이하의 짧은 선폭으로 인해서 용접과 같이 높은 에너지를 필요로 하는 산업 분야에 적합하지 않다. 이러한 연속 출력 발진 광섬유 레이저와 펄스 광섬유 레이저의 장점을 취합한 것이 바로 준연속 발진 광섬유 레이저이다. 준연속 발진 레이저는 Q-스위칭 펄스 작동에 비해 훨씬 큰 에너지의 레이저빔을 대상 물질에 가할 수 있을 뿐 아니라 펄스로 작동하기 때문에 연속 출력 발진 레이저에 비해 열 발생으로 인한 문제가 줄어들어 가공 품질 향상을 기대할 수 있다. 더 나아가 가공하는 물질이나 레이저 가공 과정에 따라 펄스모양을 쉽게 조절할 수 있어 다양한 분야에 사용 가능하다. 본 발표에서는 펄스폭 10 ms, 첨두 출력이 〉1.5 kW를 발생시키는 Yb 첨가 준연속 광섬유 레이저 시스템을 구축하고 그 특성을 보고함과 동시에, 4 대의 동일 레이저 시스템으로부터 발진한 레이저빔을 직접 제작한 비간섭성 신호 결합기로 모아서 첨두 출력 5.76 kW의 준연속 레이저빔을 획득한 결과에 대해 보고할 것이다. 그리고 더 나아가 각 레이저 시스템의 특성과 빔질, 그리고 비간섭성 신호 결합기의 특성과 함께 최종 출력 레이저빔의 특성에 대해 보고하고자 한다.

Keywords:
광섬유 레이저, 고출력 레이저, 신호 결합기, 준연속 레이저 발진

Monolayer graphene Q-switched channel waveguide lasers in three different laser configurations

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Abstract:

We demonstrate compact Q-switched Yb:YAG channel waveguide lasers in three different laser configuration. Monolayer graphene as saturable absorber is transferred onto the one end of the waveguide facet or output couplers, respectively. In the laser configuration with a incoupling mirror and a graphene coated waveguide, the most stable Q-switched operation is obtained with maximum average output power of 85 mW and highest reperition rate of 1.33 MHz.

Keywords:
Lasers, Waveguides, Q-switched, Graphene

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공간 세기 분포 조절 고출력 MOPA 레이저 시스템

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Abstract:

레이저 공진기에서 공간 모드의 선택은 레이저빔의 전파 특성 및 공간 세기 분포를 결정하므로 레이저 시스템이 처음 개발된 이후 이를 선택, 조절하기 위해 많은 노력과 연구가 이루어져 왔다. 최근 본 연구 그룹에서 개발한 이중 공진기 구조 레이저 시스템은 공진기 내 조리개의 간단한 조작으로 생성하는 레이저빔의 공간 모드를 쉽게 선택할 수 있을 뿐 아니라, 그 비율을 임의로 조절할 수 있도록 해주므로 생성된 레이저빔의 공간 세기 분포를 임의로 조절할 수 있다. 하지만 열 렌즈, 출력에 따른 이득 분포 및 손실의 변화 등으로 인해 선택된 모드와 공간 세기 분포를 갖고 >1W급 이상의 고출력을 얻는 것이 매우 어렵다. 이를 해결하기 위해 본 연구에서는 MOPA(Master Oscillator Power Amplifier) 시스템을 구축하여 고출력 레이저빔을 생성하는 연구를 수행하였다. 즉 이중 공진기 구조로부터 나오는 레이저빔을 씨앗빔으로 하여 2단 증폭 시스템을 구축, 고출력 레이저빔을 생성하였으며, 씨앗빔의 공간 세기 분포에 따라 증폭된 레이저빔의 모양 변화 및 증폭 효율을 조사하였다. 그 결과 증폭된 레이저빔의 모양은 입사되는 씨앗빔의 모드에 따라 결정되는 것을 확인하였으며 최고 16.3W의 가우시안 레이저빔과 14.0W의 LG01 모드 레이저빔을 획득하였다. 또한, 두 가지 모드가 일정한 비율로 섞여 있는 임의의 공간 세기 분포를 가진 씨앗빔이 입사 시, 증폭단을 통과한 후 레이저빔의 공간 세기 분포의 변화 및 증폭 효율을 알아보았으며, 향후 이중 공진기 MOPA 시스템의 응용과 펄스 레이저발진에 대해서 의논하고자 한다.

Keywords:
이중 공진기 레이저, 공진기 모드, MOPA, 공간 세기 분포

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Modeling and Analysis of the Influence of the Pulse Overlap in a Double-pass Laser Amplifier 이중통과 레이저 증폭기에서 펄스 중첩의 효과 분석 및 모델링

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Abstract:
레이저 빔이 증폭기를 왕복 통과하는 '이중통과 레이저 증폭기'에서, 증폭기의 (광 경로) 길이보다 레이저 펄스의 길이가 더 길 경우, 증폭기를 한번 통과하고 되돌아 나오는 펄스 앞부분과 미처 증폭기를 다 통과하지 못한 펄스의 뒷부분이 증폭매질 내에서 중첩되게 된다. 기존의 Frantz-Nodvik 공식을 그대로 적용하는 계산에는, 이와 같은 상황이 고려되어 있지 않으므로, 증폭률 및 펄스 형상 변화를 정확하게 예측하는데 어려움이 있다. 본 발표에서는 이중통과 레이저 증폭기에서 펄스의 중첩을 고려하여, 증폭률 및 증폭된 펄스의 형상 변화를 계산하는 방법에 대하여 소개하였다.

Keywords:
레이저 증폭기, 이중통과 증폭기, Frantz-Nodvik equation, 펄스 중첩

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Vapor phase synthesis of 2D tin sulfides and device applications

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Abstract:

In recent years there has been an explosive interest in research on two-dimensional (2D) van der Waals (vdWs) materials due to their unique physical properties and great potential in the application of emerging devices. In aspect of device application, it is very important to achieve the directly grown single crystal on substrate with a large area, and many researchers have focused on the synthesis method and device characterization of the versatile vdWs materials with hexagonal symmetry such as graphene, h-BN and transition metal chalcogenide compounds. However, there are only a few reports on layered crystal of group IV-VI semiconductor, which is another type of 2D vdWs family. Here, we show controlled polymorphic growth of 2D tin-sulfide crystals of either hexagonal SnS2 or orthorhombic SnS via control of the growth atmosphere and the growth behavior is supported by the thermodynamic study. Our layered crystals shows n-type for SnS2 and p-type characteristics for SnS, respectively. In addition to this, we demonstrate p-n heterojunction devices and feasibility of using the 2D crystals for thermoelectric devices.

Keywords:
2-dimensional materials, IV-VI compound, thermoelectric

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Tip-Enhanced Raman Scattering Studies of Monolayer Tungsten Disulfide

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Abstract:

Transition metal dichalcogenide (TMD) materials that exhibit a direct or an indirect band gap have been studied because of their unique electronic and optical properties [1]. Monolayer tungsten disulfide (WS_2) has been especially known for its high photoluminescence (PL) quantum yield, which is greater than that of monolayer MoS_2 [2]. Owing to the properties, there are a number of studies of WS_2 [3]. However, the conventional PL and Raman spectroscopy have a limit to analyze nanoscale structures such as local disorders, grain boundaries, dopants, and edges which affect to the optical properties of WS_2. Therefore, more researches using near-field scanning optical microscope and tip-enhanced Raman spectroscopy are absolutely necessary to analyze the structures on nanometer scale for two-dimensional TMD materials. Here, we conduct systematic studies to investigate monolayer WS_2 by using tip-enhanced Raman scattering (TERS). As measuring monolayer WS_2 on a gold foil, PL background can be quenched by a charge transfer. We also measure the surface morphology of WS_2 by a scanning tunneling microscope and scanning electron microscope to compare TERS images and observe the shift and split of Raman vibrational modes. Furthermore, Raman signals increase more than 20-fold and an enhancement factor of TERS reaches values of 2.7 x 10^4 in our studies. References [1] Q. H. Wang, K. Kalantar-Zadeh, A. Kis, J. N. Coleman & M. S. Strano, Nat. Nanotechnol. 7, 699 - 712 (2012). [2] L. Yuan, L. Huang, Nanoscale 7, 7402–7408 (2015) [3] A. Berkdemir, H. R. Gutierrez, A. R. B.-Mendez, N. P.-Lopez, A. L. Elias, C.-I. Chia, B. Wang, V. H. Crespi, F. L.-Urias, J.-C. Charlier, H. Terrones & M. Terrones, Sci. Rep. 3, 1755 (2013)

Keywords:
tip-enhanced Raman scattering, TERS,tungsten disulfide, WS_2,transition metal dichalcogenide, TMD

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Laser-exfoliation of Few-layer Transition Metal Dichalcogenides by High Power Femtosecond Laser

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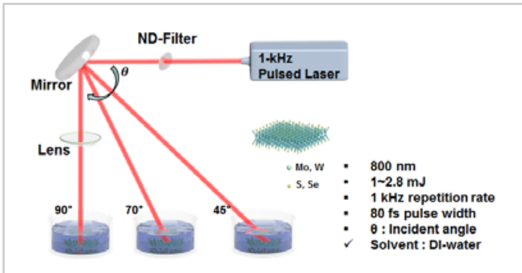
Abstract:



Since the bandgap energy increases as the thinkness of 2-d materials (MoS_2, $MoSe_2$, WS_2, WSe_2) decreases, many researchers have attempted to synthesize monolayer 2-d materials through various methods, such as mechanical exfoliation, and chemical vapor deposition (CVD). Mechanical exfoliation using scotch tape produces a high quality sample, but it takes long time to find monolayer of 2-d materials by optical microscope. Although CVD method is more convenient in method, the quality of the sample is a bit lower than one prepared by mechanical exfoliation. Recently, photoexfoliation method using femtosecond pulsed laser is proposed to detach monolayer graphene sheets from graphite with high surface quality and large quantity [1]. Here we report successful preparation of few-layer 2-d materials by the laser-exfoliation method. The number of layers and morphological characteristics were confirmed by Photoluminescence, Raman spectroscopy, and SEM measurement, we could confirm the presence of 2-d materials thin films. Fig. 1 shows the experimental scheme of the laser-exfoliation. An amplified Ti:sapphire laser with 80 fs pulse duration and 800 nm center wavelength was focused on the surface of bulk 2-d materials, and we performed the laser-exfoliation under different laser powers (1~2.8 mJ) and three different incident angles (45°, 70°, and 90°). Ethanol was used as a solvent to suspend the sheets exfoliated. Compared to the previous report [2], Raman spectra that we obtained from the laser-exfoliated sample indicate that we successfully produced few-layer 2-d materials from the bulk (0.2 nm of spectral resolution, 1800 lines/mm grating with 500 nm blaze). References 1. Y. Miyamoto, H. Zhang, D. Tomanek, Phys. Rev. Lett. 104, 208302 (2010). 2. H. Li, Q. Zhang, C. Yap, B. Tay, T. Edwin, A. Olivier, and D. Baillargeat, Adv. Funct. Mater. 22, 1385 (2012).

Keywords:
Laser Exfoliation, 2-D Materials

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2016.10.19 - 2016.10.21

The Integrity of Insulating Boron Nitride for Gate Dielectric of Metal Dichalcogenides Transistors

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Abstract:
Recently, two-dimensional (2D) materials have been demonstrated as a host material to study novel physics phenomena. Because of their characteristics of intra-layer van der Waals bonding, they could be easily exfoliated and explored. After 10 years study on graphene, alternatively, 2D materials have expanded to metal dichalcogenides such as MoS_2, WSe_2, SnS_2, hBN, and Xenes, etc. In three-terminal transistor configuration, the atomically thin body are preferred and afford thickness scalability and reduced electrostatic degradation from gate electric field. There are many studies on 2D semiconducting transistor on insulating hBN that is used for gate dielectric. Because multi-layer hBN shows ultra-smooth surface, unusually high thermal conductivity, and dielectric strength, it has been regarded to be the ideal dielectric to improve the performance of 2D transistor. However, continued studies in understanding 2D-hBN interface are still required. Here, we report various type of MoS_2 field-effect transistor which fabricated by using different gate dielectric, including hBN and SiO_2. In addition to characterization of dielectric quality, carrier transport and traps measured via electrical I-V characteristic and deep level transient spectroscopy. Carrier transport mechanism across 20-nm-thick hBN was analyzed to be Fowler-Nordheium tunneling with typical barrier height of 3.0 eV. The interface trap density of state located at hBN-2D was evaluated to be around 10^{10} states/eV·cm^2.

Keywords:
two-dimensional, boron nitride, Fowler-Nordheium tunneling, field-effect transistor

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G3.05
2016.10.19 - 2016.10.21

Photochemical Reaction in Monolayer MoS2 via Correlated Photoluminescence, Raman Spectroscopy, and Atomic Force Microscopy

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Abstract:
Photoluminescence (PL) from monolayer MoS2 has been modulated using plasma treatment or thermal annealing. However, a systematic way of understanding the underlying PL modulation mechanism has not yet been achieved. By introducing PL and Raman spectroscopy, we analyze that the PL modulation by laser irradiation is associated with structural damage and associated oxygen adsorption on the sample in ambient conditions. Three distinct behaviors were observed according to the laser irradiation time: (i) slow photo oxidation at the initial stage, where the physisorption of ambient gases gradually increases the PL intensity; (ii) fast photo-oxidation at a later stage, where chemisorption increases the PL intensity abruptly; and (iii) photoquenching, with complete reduction of PL intensity. The correlated confocal Raman spectroscopy confirms that no structural deformation is involved in slow photo-oxidation stage; however, the structural disorder is invoked during the fast photo-oxidation stage, and severe structural degradation is generated during the photoquenching stage. The effect of oxidation is further verified by repeating experiments in vacuum, where the PL intensity is simply degraded with laser irradiation in a vacuum due to a simple structural degradation without involving oxygen functional groups. The charge scattering by oxidation is further explained by the emergence/disappearance of neutral excitons and multiexcitons during each stage.

Keywords:
molybdenum disulfide, photo-oxidation, photoquenching, photoluminescence, Raman, AFM

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2016.10.19 - 2016.10.21

Laser irradiation time-dependent charge carrier dynamics in Methylammonium lead halide single crystals

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Abstract:

The optical characteristics of organo-lead halide perovskite single crystals ($MAPbX_3$; $MA=CH_3NH_3^+$, $X=Cl^-$, Br^-, or I^-) have been investigated by using steady-state photoluminescence (PL) and time-resolved PL (TRPL) spectroscopies. Perovskite single crystals ($MAPbCl_{3-x}Br_x$, $MAPbBr_{3-x}I_x$) were synthesized using the inverse temperature crystallization (ITC) with proper solvents. Then, the PL spectra were performed using confocal micro-spectroscopy (NTEGRA spectra, NT-MDT) equipped with a solid state laser with 405 nm and an objective lens with numerical aperture of 0.7, yielding a high spatial resolution of ~380 nm. For an analysis of carrier dynamics for the single crystals, TRPL, multifunctional confocal microscopy including a time-correlated single photon counting (TCSPC) system was employed (NTEGRA, NT-MDT). According to the laser irradiation times, the sharp contrast between $MAPbBr_{3.0}$ and $MAPbBr_{2.5}I_{0.5}$ PL spectra was observed. The PL spectra of $MAPbBr_{3.0}$ remained with a band edge peak of ~530 nm. However, the $MAPbBr_{2.5}I_{0.5}$ developed the additional satellite peaks at lower energy bandgaps while the bandgap peak of 540 nm gradually disappeared. Interestingly, when the single crystals are left for 15 minutes in the dark, the PL spectra reverted to the initial PL states, indicating these photo induced changes are completely reversible. To further understand the nature of lower energy peaks, power and temperature dependent PL measurements were investigated and will be further discussed.

Keywords:
organo-lead halide perovksite single crystal, Photoluminescence, Time-resolved Photoluminescence

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2016.10.19 - 2016.10.21

Raman scattering study of cation effect on vibration modes in $CH_3NH_3PbBr_3$ single crystals

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Abstract:
Methyl-ammonium lead trihalide perovskite $CH_3NH_3PbX_3$ (X= I, Cl, Br) has been attracting huge attention recently as being a promising candidate for high efficient solar cell materials. To understand the mechanisms of phase transition in $CH_3NH_3PbX_3$, we studied $CH_3NH_3PbX_3$ single crystals by photoluminescence (PL) and Raman scattering spectroscopy. We measured the temperature dependent PL spectra of a $CH_3NH_3PbBr_3$ single crystal from 80 K to room temperature. The measurement clearly showed distinctive PL emission lines in each of orthorhombic, tetragonal and cubic phases of $CH_3NH_3PbBr_3$. At low temperatures, we observed two emission bands at 2.27 eV and 2.10 eV which are associated with the emission lines of free exciton recombination and coexisting two phases of orthorhombic and tetragonal, respectively. We also measured temperature dependent Raman spectra. The internal vibrational modes of $CH_3NH_3^+$ (MA) cation are observed above 300 cm^{-1} spectrum and a number of peaks among them showed characteristic changes that reflected phase transition occurring at about 140 K, 154 K, and 235 K which is consistent with change in PL spectra. Abnormal frequency shift, changes in intensity and in FWHM of certain vibrational modes of MA cation might provide the mechanism of structural phase transition in $CH_3NH_3PbBr_3$.

Keywords:
$CH_3NH_3PbBr_3$ single crystal, Raman scattering, vibrational modes, phase transition

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2016.10.19 – 2016.10.21

Design of broadband antireflection coatings for multi-layered GaAs/AlGaAs solar cells

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Abstract:
High efficiency solar cells represented by III-V compound semiconductor solar cells have been extensively studied because the band gap of the materials can be readily controlled with various combination of composition from 0.33 eV to 2.32 eV when group V elements such as indium, gallium, and aluminum, and group III elements such as arsenic and phosphorus, are used. However, the role of antireflection coatings is also very critical to achieve broadband absorption of solar spectrum. This study focused on design of broadband antireflection coatings for multi-layered GaAs/$Al_xGa_{1-x}As$ multi-layer structures. These layered GaAs/$Al_xGa_{1-x}As$ structures with hundreds of nanometers thick, shows interference pattern, because of the optical penetration depth. Therefore, the structure cannot be considered as bulk, so the modeling of structure is necessary to efficiently reduce the constructive interference. Since this modeling contains control of multiple reflection and antireflections for the wide range of optical wavelength, systematic computer simulation was performed for reflection in various incident angle of light. Dielectric function data of $Al_xGa_{1-x}As$ for simulation was obtained from reported value. Finally, antireflection structure was experimentally realized to verify the results.

Keywords:
Antireflection coating, application to solar cell

Ultrafast demagnetization of ferromagnetic layered thin film

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Abstract:

To achieve the ultrafast magnetism in the field of two-dimensional materials is critically important for realizing low-dimensional optical femtomagnetic devices. In the present study, we suggest a metallic and ferromagnetic two-dimensional heterostructure, $CrPTe_3$+Sb(111), and demonstrate the controlling of its demagnetization process on the extreme ultrafast time span. We find that the nonequilibrium spin current from ferromagnetic $CrPTe_3$ to Sb(111) by the optical excitation and also an increase of the spin decay by the spin-orbit coupling in $CrPTe_3$+Sb(111) could speed up the ultrafast demagnetization process within the heterostructure.

Keywords:
Ultrafast spin dynamics, Demagnetization, 2D materials

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Electron beam-formed ferromagnetic defects on MoS_2 surface along 1T phase transition

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Abstract:

By using higher acceleration energies than the displacement energy of Mo atoms, the electron irradiation on the layered MoS_2 single crystals is found to be an effective and simple method to induce the diamagnetic to ferromagnetic phase transition persisting up to room temperature. The easy axis can be controllable by regulating the electron dose and the acceleration energy. The ferromagnetic states are largely attributed to the strain around the vacancies. Especially, 1T phase incorporation into 2H-MoS_2 via an optimal electron irradiation leads to induce a weak ferromagnetic state at room temperature, together with the improved transport property. In addition to the 1T-like defects, the electron irradiation on the cleaved MoS_2 surface forms the concentric circle-type defects that are caused by the 2H/1T phase transition and the vacancies of the nearby S atoms of the Mo atoms. The simple method to control and improve the magnetic and electrical properties on the MoS_2 surface provides suitable ways for the low-dimensional device applications.

Keywords:

MoS_2, Electron beam irradiation, Ferromagnetism

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Neel order and ordinary spin-orbit torques in two dimensional antiferromagnets

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Abstract:

We consider spin torque generated by an electric current flowing through a two-dimensional antiferromagnetic(AFM) layer subject to the Rashba spin-orbit coupling. In particular, we focus on the spin-orbit torque(SOT), which is the spin torque generated by the interplay between the current and the spin-orbit coupling. The damping-like component of SOT, which plays an important role for magnetization switching, arises from interband process. It thus gets larger for a system that allows band pairs with small energy separation. Such a situation is allowed in collinear AFM. We show that for perfect collinear AFM, however, the symmetry arising from the perfect collinearity prohibits such interband process and suppress SOT enhancement. To realize SOT enhancement, deviation from the perfect collinearity is required. Considering small ferromagnetic order in AFM, which arises inevitably during the AFM magnetization dynamics, we investigate the Neel order SOT and the ordinary order SOT in the field and damping like components of the SOT. We also show that the forbidden interband process in the collinear AFM can be allowed due to the ferromagnetic order, and may give large spin torque.

Keywords:
Spin orbit torque, Antiferrmagnet

Correlation between Orbital Magnetism and Dzyaloshinskii-Moriya Interaction

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Abstract:

Dzyaloshinskii-Moriya interaction (DMI) at the interface between a ferromagnetic (FM) and a heavy nonmagnetic metals (HM) has an essential role for forming chiral spin objects such as the skyrmion and the Néel-type domain wall [1,2]. The objects have attracted much attention for the next generation data storage devices [1-3]. However, the microscopic origin of the interfacial DMI is still debating issue [4,5]. Recently, the relation between orbital magnetism and DMI has been theoretically demonstrated [6]. In this presentation, we show the relation to uncover the microscopic origin of the DMI. Our nucleation measurement result based on the droplet model demonstrates the strong temperature dependence of DMI-induced effective field in the Co/Pt bilayer. On the other hand, the x-ray magnetic circular dichroism measurement exhibits that the perpendicular orbital moment increases at low temperature while the in-plane orbital moment is almost temperature-independent. The theoretical investigation based on the tight-binding model qualitatively reproduces the experimental results, showing that orbital-to-orbital electron hopping with the inversion symmetry breaking can link between the interfacial DMI and the orbital moments. This work was partly supported by JSPS KAKENHI Grant Numbers 15H05702, 26870300, 26870304, 26103002, 25220604, 2604316 Collaborative Research Program of the Institute for Chemical Research, Kyoto University, and R & D project for ICT Key Technology of MEXT from the Japan Society for the Promotion of Science (JSPS). This work has also been performed with the approval of the SPring-8 Program Advisory Committee (Proposal Nos. 2015A0117, 2015A0125). Reference 1. Dzyaloshinskii, I. E. Sov. Phys. JETP 5, 1259 (1957). 2. Moriya, T. Phys. Rev. 120, 91-98 (1960). 3. Fert, A., Cros, V. & Sampaio, J. Nat. Nanotech. 8, 152-156 (2013). 4. Emori, S., Bauer, U., Ahn, S.-M., Martinez, E. & Beach, G. S. D. Nat. Mater. 12, 611-616 (2013). 5. Yang, H. et al. Phys. Rev. Lett. 115, 267210 (2015). 6. Kashid, V., et al. Physical Review B 90, 054412 (2014).

Keywords:
Dzyaloshinskii Moriya Interaction, Orbital magnetism

Physical properties of (Sr,La)(Ru,Fe)O_3 epitaxial thin film

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Abstract:

Epitaxial thin films of the conductive ferromagnetic oxide $SrRuO_3$ has received a great interest because of its potential device applications and interesting electrical and magnetic properties. The doping in $SrRuO_3$ can significantly change its physical properties. Highly epitaxial $Sr_{1-x}La_xRu_{1-x}Fe_xO_3$ (x = 0.05, 0.10, 0.20, and 0.30) epitaxial thin films were grown on $SrTiO_3$ (001) substrates to study the transport and magnetic properties. Compared to $Sr_{1-x}La_xRu_{1-x}Fe_xO_3$ poly-crystal made by others, the epitaxial thin films do have much fewer grain boundaries and compared to Sr(Ru,Fe)O_{3-d} thin films, the $Sr_{1-x}La_xRu_{1-x}Fe_xO_3$ films do not have problems related to the oxygen vacancy. With increasing the concentration of $LaFeO_3$, the resistivity of the $Sr_{1-x}La_xRu_{1-x}Fe_xO_3$ film increased especially at low temperatures. The films displayed metal-insulator transition with a change of doping concentration and temperature. The saturation of magnetization (M_S) value of $Sr_{1-x}La_xRu_{1-x}Fe_xO_3$ (x = 0.20) was found to be 0.6 μ_B/Ru. In addition to this, we observed a large negative magnetoresistance (x = 0.30) ~- 35% (H = 9 T, T = 10 K) which was stronger at low temperature. The observed large negative magnetoresistance was strongly correlated with the $LaFeO_3$ doping concentration and symmetric around zero fields. References: A.Mamchik and I-Wei Chen, Phys. Rev. B70, 104409 (2004). A. Mamchik and I.-W. Chen, Appl. Phys. Lett. 82, 613 (2003). K.R.N. et al.J. Alloys and Comp. 657 (2016) 224-230 B. W. Lee, C. U. Jung, J. Korean Phys. Soc. 59 (2011) 322–325.

Keywords:
$SrRuO_3$, $LaFeO_3$ epitaxial thin film, Transport properties, magnetoresistance

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Large scaled graphene Hall elements array on Hexagonal-BN film fabricated following a conventional CMOS process

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Abstract:

A graphene has been suggested as an optimal material for a magnetic sensor because of its high carrier mobility, atomic thickness, and easy modulation of carrier concentration. Although these unique and beneficial features have been utilized to possess the reduced magnetic resolution (B_{min}) in micro-mechanically exfoliated graphene Hall elements (GHEs) with electron beam lithography method, that platform limits the sensor feasibility and is not preferred to modern industry. Here, we show the large-area, photolithographically patterned, and highly sensitive GHE array based on heterostructure of CVD grown 2-D materials. An outstanding performance of GHE was achieved with a bottom hexagonal-BN (h-BN) layer, that of a current normalized sensitivity of 1,986 V/AT and a minimum B_{min} of 0.5 mG/Hz$^{0.5}$ at f = 300 Hz. This work demonstrates, for the first time, GHE array fabrication via conventional CMOS process.[1] [1]M-K. Joo[+], Joonggyu Kim[+], J-H. Park, V. L. Nguyen, K. K. Kim, Y. H. Lee and D. Suh, ACS Nano (accepted) (2016) ([+]equal contribution)

Keywords:
graphene, hexagonal boron nitride, magnetic field sensor, large-area graphene device, graphene Hall element, chemical vapor deposition

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2016.10.19 - 2016.10.21

Graphene-silver nanowire transparent electrode for high performance ultra-violet light emitting diodes

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Abstract:
현재 UV-LED의 투명전극으로 실버 나노와이어가 각광을 받고 있다. 하지만 실버 나노와이어는 공기 중에 노출되면 쉽게 산화되기 때문에 LED의 신뢰성이 저하된다. 이 문제점을 해결하기 위해서 실버 나노와이어 위에 CVD-그래핀을 형성시킨 그래핀-실버 나노와이어 복합 구조를 보고하였다. 그러나 CVD 방법으로 합성된 그래핀은 결점들과 그래핀 도메인에 의해 기체 분자들이 투과하게 되어 산화 방지 응용에 한계가 있다. 본 연구에서는 2단계 성장 방법으로 그래핀의 도메인을 키우고 결점을 줄여 고품질의 그래핀을 합성하였고, 합성된 그래핀을 실버 나노와이어와 복합 구조로 형성시킨 후 UV-LED의 투명전극에 적용하였다. 소자의 전기적, 광학적 특성을 분석한 결과 2단계 성장 방법으로 합성한 그래핀이 실버 나노와이어의 산화 방지막으로써 가스 배리어 역할을 하였고, 이로 인하여 UV-LED의 신뢰성 평가에서 우수한 결과를 얻었다.

Keywords:
UV-LED, 실버 나노와이어, 투명전극, CVD-그래핀, 2단계 성장 방법, 산화 방지막

Towards a reusable graphene mass detector

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Abstract:

Here we present work involving the development of a novel device which may be utilised as a reusable graphene mass detector. There have been many recent reports published in this field, however such devices generally experience a decrease in both accuracy and reliability after multiple uses and eventually must be replaced, for example QCMB in metal evaporation chambers. Our device holds the advantage of being able to be used repeatedly, without significant loss of accuracy or reliability. We use a suspended graphene device, and through resonance frequency measurements, achieved via an optical interferometry technique, we can establish the mass added. Mass can be locally added to the device using a PMMA shadow mask. Through the application of a high bias voltage, we are able to effectively "reset" our graphene mass detector by induced heating, removing deposited metals or residues, and thus rendering it reusable. From previous experiments with similar devices, we believe the the mass resolution of this device to fall in to the attogram (10^{-18}g) range. We will introduce our recent experimental data and discuss possible techniques for improvement of mass sensitivity and reliability of our device.

Keywords:

graphene, device, reusable

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Electrical properties of single wall carbon nanotube channel and graphene electrode based transistors arrays

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Abstract:

In this research, graphene and single walled carbon nanotube (SWNT)[1-3], which are well known as promising materials for carbon based future electronic systems[4,5], were used as electrodes and channels to fabricate transistors, respectively. The integrated arrays of transistors were prepared by photolithography, reactive ion etching (RIE), electron beam evaporator processes and transferring patterned graphene electrodes on top of the aligned SWNT along one direction. The performance of transistors with both single and multi layer graphene electrodes show typical p-type transistor and Schottky diode behavior, respectively. Based on our fabrication method and device performances, several issues are suggested and discussed to improve the device reliability and finally to realize all carbon based future electronic systems.

Keywords:
graphene, carbon nanotube, transistor, carbon based device, transfer method, all carbon electronics

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Plasma Assisted Synthesis of SnS_2-SnS Heterostructure p-n Diode

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*

Abstract:
After the discovery of graphene and its extraordinary physical properties, other two-dimensional layered materials are also highlighted to become promising candidates for future nanotechnology. Sn-sulfides are one of the interesting layered materials which have different crystal phases such as hexagonal SnS_2 and orthorhombic SnS. These two materials show different properties such as SnS_2 showing n-type whereas SnS showing p-type. In this work, by simply removing sulfur atoms from the top part of as-exfoliated SnS_2 single crystal, we could achieve a facile method to synthesize SnS(p-type) and SnS_2(n-type) vertical heterostructure. To confirm our method, we conducted Raman, TEM, and XPS measurements and showed that the crystal is indeed a heterostructure. Furthermore, we fabricated Graphene-SnS_2-SnS-Graphene vertical p-n diode to confirm rectifying behavior and photoresponse of the device.

Keywords:
SnS_2, SnS, Heterostructure, Diode

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Optoelectronic applications of multilayered transition metal dichalcogenides: Flexible, transparent, and photo-sensing devices

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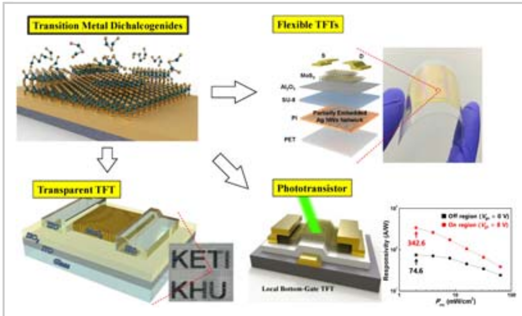

Abstract:

Transition metal dichalcogenides (TMDs) with two-dimensional layered nanostructures exhibit fascinating physical properties, in terms of high carrier mobilities, tunable energy band structures, wide spectral responses, and mechanical flexibilities, depending on number of the unit van der Waals layer. In this presentation, we report on the various optoelectronic applications, for examples flexible, transparent, and photo-sensing devices based on multilayered molybdenum disulfides (MoS_2) or molybdenum diselenides as active components of thin-film transistors (TFTs). First, novel process architecture is demonstrated for flexible TFTs with high device performances as well as stable mechanical tolerances, which are accomplished by using solution-based polyimide flexible substrate, pulsed laser-treated silver nanowires network gate electrode, and hybrid organic-inorganic gate insulator. Second, we discuss device performances and optical properties of transparent TFTs with respect to Schottky contact between TMDs active layers and transparent conducting oxides source/drain electrodes. In order to improve performances of the transparent TFT, a couple of strategies for tuning the Schottky barrier will be introduced. Finally, we present multilayered MoS_2 phototransistors consisting of patterned local bottom-gate configuration, which shows about 3 orders of magnitudes higher photoresponsivity than conventional TFT structures. Validity and expandability of the modified phototransistor structure are successfully applied to hydrogenated amorphous silicon TFTs.

Keywords:
Transition metal dichalcogenides, Molybdenum disulfides, Molybdenum diselenides, Flexible, Transparent, Photo-sensing

Raman study of stacking order in 2-dimensional GaSe

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Abstract:

We investigated Raman features of 2-dimensional GaSe from monolayer to bulk. GaSe is a van der Waals layered semiconductor with a 2.1-eV bandgap and is in the family of transition metal monochalcogenides, which show notably different optoelectronic properties from those of transition metal dichalcogenides. [1] For example, GaSe-nanosheet-based photodetectors show better performance compared to existing photodetectors such as single layer MoS_2-based photodetectors. [2] More than 40 different GaSe samples were fabricated on SiO_2/Si substrates with a 90-nm-thick oxide layer by mechanical exfoliation. We observed low frequency shear modes in the range of 10-25 cm^{-1} which come from inter-layer vibrations. These shear modes were confirmed by polarized Raman spectroscopy in cross polarization. Additionally, some domains with different low frequency shear modes corresponding to different stacking orders were observed in the same-thickness flake, which means that GaSe exists with different stacking order domains. We investigated 3-layer GaSe in particular since stacking order is explicitly distinguishable through Raman measurements. We found three-types of low-frequency Raman spectra that correspond to different stacking orders. [3] [1] Xufan Li et al., Scientific reports, 4, 5497 (2014) [2] PingAn hu et al., ACS nano, 6, 5988 (2012) [3] Jae-Ung Lee et al., ACS nano, 10, 1948 (2016)

Keywords:
Raman spectroscopy, GaSe, Gallium Selenide, Stacking order, 2D semiconductor

Oxidation Effect in Thin Octahedral Hafnium Disulfide (HfS_2)

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Abstract:

Atomically smooth van der Waals materials are structurally stable in monolayer and a few layers but some are susceptible to oxygen-rich environments. In particular, recently emerging materials such as black phosphorus and perovskite have revealed stronger environmental sensitivity than other two-dimensional layered materials, often obscuring the interesting intrinsic electronic and optical properties. Unleashing the true potential of these materials requires the oxidation-free sample preparation that protects thin flakes from air exposure. Here, we fabricated the few-layer hafnium disulfide (HfS_2) field effect transistors (FETs) using an integrated vacuum cluster system and study their electronic properties and stability under ambient conditions. By performing all the device fabrication and characterization procedure under oxygen- and moisture-free environment, we found that a few-layer AA-stacking HfS_2-FETs display excellent field effect responses (I_{on}/I_{off} = ~10^7) with reduced hysteresis compared to the FETs prepared under ambient conditions. Oxidation of HfS_2 occurs uniformly over the entire area, increasing film thickness by 250% at a prolonged oxidation time of >120 hours, while defects on the surface are the preferential initial oxidation sites. We further demonstrated that the stability of the device in air is significantly improved by passivating FETs with BN in a vacuum cluster.

Keywords:
Oxidation, hafnium disulfide, vacuum cluster, glove box, field effect transistor, boron nitride

Study of extraordinary optical transmission in Ag nano-hole array through surface plasmon dispersion

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Abstract:

Extraordinary optical transmission (EOT) is a phenomenon that shows high optical transmission in sub-wavelength hole array on metallic thin film. Since the phenomenon can be applied in various devices such as biosensors [1], color filters [2], transparent electrodes [3], understanding of fundamental transmission mechanism and designing the structure are very crucial to implement the purpose of applications. In this study, the transmission properties of EOT in Ag nano-hole array with variable periods are investigated through a comparison between optical transmission and surface plasmon polariton (SPP) dispersion, which is believed to be directly correlated with EOT [4]. To examine the optical transmission properties through sub-wavelength metallic hole arrays, we fabricated Ag nano-hole array with variable periods using electron-beam lithography. We identified that the measured optical transmission spectra are in good agreement with those of calculated optical transmission. As a result, we found that the EOT behavior can be fully explained by analyzing the parameters of the SPP dispersion such as the group velocity and the momentum matching between SPPs and photons. [1] A. J. Haes et al., A localized surface plasmon resonance biosensor: First steps toward an assay for Alzheimer's disease, Nano Letters 4, 1029 (2004). [2] D. Inoue et al., Polarization independent visible color filter comprising an aluminum film with surface-plasmon enhanced transmission through a subwavelength array of holes, Applied Physics Letters 98, 093113 (2011). [3] J. Van de Groep et al., Transparent conducting silver nanowire networks, Nano Letters 12, 3138 (2012). [4] T. W. Ebbesen et al., Extraordinary optical transmission through sub-wavelength hole arrays, Nature 391, 667 (1998).

Keywords:
Extraordinary optical transmission (EOT), Surface plasmon polariton (SPP), dispersion, metallic nano-hole array

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Mechanical Properties of High-Stress Silicon Nitride Beam Resonators

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Abstract:

The intrinsic mechanical properties of high-stress silicon nitride (SiN) beam resonators were investigated as a function of the beam length. Two different techniques, dynamic flexural measurement using optical interferometry and quasi-static flexural measurement using atomic force microscopy, were used in order to confirm the reliability of the results by comparing the results from the two different measurement techniques. In the present work, the mass density, Young's modulus and internal stress of the SiN beams were estimated by combining the techniques. We also discuss the prospect of SiN based NEMS for application in high sensitive mass sensors.

Keywords:

Nano-electromechanical system, Silicon nitride, Mechanical properties, Resonator, Mass sensor

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Electrical transport properties of $BiFeO_3$ nano-islands

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Abstract:
고속, 높은 집적도와 낮은 전력 소비 특성을 갖는 차세대 비휘발성 메모리 소자 기술에 대한 요구가 새로운 기능성 물질과 device physics에 대해 광범위한 연구를 촉진시키고 있다. 이러한 연구들 중 강유전체 기반 Nano-ferronic devices은 나노 크기에서의 강유전성과 전하 수송 특성의 상호작용 때문에 차세대 나노 전자 소자로써 기대를 받고 있다. 본 연구실에서는 $BiFeO_3$ (BFO) Nano-island / $SrRuO_3$ / $SrTiO_3$ 구조와 BFO Nano-island / Nb-doped $SrTiO_3$ 구조의 강유전체 기반 소자를 제작하여 BFO Nano-island의 저항변화 메모리 특성에 관한 연구를 수행하였다. $SrRuO_3$ 위에 제작된BFO Nano-island의 경우에는 인가된 외부 전압이 변함에 따라 전기 분극의 크기와 방향이 변하고 이에 따른 계면 포텐셜 장벽의 변화로 전하수송 특성 및 저항변화 메모리 특성의 변화가 유도됨을 규명하였다. 또한, Nb-doped $SrTiO_3$ 위에 제작된 BFO Nano-island의 경우에는 고정된 분극 방향에 의한 다이오드 효과와 비선형적인 저항변화 특성을 관찰하였다. 본 연구에서는 TEM과 HR-XRD를 이용한 결정성 분석, SEM을 이용한 구조적 분석, PFM을 이용한 강유전성 분석, C-AFM을 이용한 전기적 특성분석을 진행하였다.

Keywords:
BiFeO3, Nano-island, ReRAM

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산화 티타늄 박막의 균질성 전이 연구

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Abstract:
이산화 티타늄은 매우 큰 밴드갭을 지니기 때문에 태양광의 약 4%에 해당하는 자외선에만 반응을 하는 특성을 지닌다. 이러한 이산화 티타늄을 태양 전지와 같은 광촉매적 반응을 활용한 소자에 적용하기 위해서는 이산화 티타늄의 광촉매적 특성을 개선 시켜 태양광의 약 45% 에 해당하는 가시광에 반응 시킬 필요가 있다. 이산화 티타늄의 광촉매적 특성을 개선시키는 다양한 방법들 중에 매우 높은 전환 효율 때문에 탄소를 도핑한 이산화 티타늄에 대한 실험적으로 이론적으로 많은 연구가 되어 왔다. 이번 연구에서는 DC 스퍼터로 증착된 산화 티타늄 박막을 수소 아르곤 가스 분위기에서 온도를 달리하여 열처리 하여 탄소가 도핑된 이산화 티타늄 박막을 제작하였다. 이러한 탄소가 도핑된 이산화 티타늄 박막의 결정성 특성을 위한 XRD, 라만 분광법을, 두께에 따른 화학적 성분 조사를 위한 TOF-SIMS를, 광학적 투과 특성을 위한 UV-vis. 분광을 측정하였다. 특히, 광학적 특성 분석을 위해 유효근사방법 중 하나인 Bruggeman 모델과 실제 형상에 대한 광학적 시뮬레이션을 위한 FDTD 방법을 이용하여 광학적 모델링을 하였다. Bruggeman 모델을 위해서 전첵 박막이 완전히 산화된 TiO_2 입자와 부분적으로 산화된 TiO_xC_y 의 입자의 모양과 volume fraction 에 따라서 전체 유효유전상수 값을 계산한 다음, 이를 이용하여 transfer matrix 방법과 로렌쯔-드루드 모델을 이용하여 광학적 모델링을 하였다. FDTD 모델에서는 효율적으로 시뮬레이션을 하기위해 500×500×100 nm 의 크기를 지정하였다. FDTD 모델을 위해서 우리는 열처리를 함으로써 완전히 산화된 TiO_2 입자가 불규칙적으로 부분적으로 산화된 TiO_xC_y 내에 분포되어있다고 가정하에 시뮬레이션을 진행하였다. 게다가 열처리 하는동안 TiO 원자들이 산화되면서 움츠러들면서 원자들 사이에 void 가 발생할 것으로 가정하에 void 를 고려하였다. TiO_2 의 결정크기는 XRD 분석으로부터 얻은 21nm를 사용하였고 입자크기의 비를 계산하여 적용 하였다. TiO_xC_y 의 유전상수 값은Bruggeman 모델로부터 구한 변수값을 이용하여 계산한 값을 사용하였다. 그 결과, void 의 크기(TiO_2 의 core 반지름에서 추가된)가 1.5 nm 와 TiO_2 입자의 개수가 3024개 일 때 측정한 데이터에 가장 근접하는 것을 확인 할 수 있었다.

Keywords:
산화 티타늄, 광학적 모델링,Bruggeman 모델, FDTD 방법

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Mechanical transduction of magnetization precession via the Wiedemann effect

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Abstract:

Ferromagnetic resonance (FMR) of suspended Py/Pt bilayer strip is measured by a means of mechanical conversion from magnetization dynamics via the Wiedemann effect [1]. Internal coupling between the mechanical torsion induced by the magnetization change, which is the Wiedemann effect, and longitudinal strain facilitates detecting FMR by the resonance frequency shift of the mechanical flexural mode. The piezoresistive motional signal responding of the mechanical vibration enables to detect the mechanical resonance in all electo-mechanical manner at room temperature [2]. The mechanically detected FMR is consistent with FMR measured by spin-torque FMR measurement technique [3] which is well followed by the Kittel's formula. Additionally, spin-transfer toque contribution to the mechanical reaction is discussed with our numerical expectation. This demonstrate that our scheme guarantees the scalability to downscale for low power driving of FMR and is suitable applying nano-scale spintronics architecture for realization of integrating circuit. [1] G. Wiedemann, Annalen der Physik 179, 563 (1858). [2] H. Bhaskaran et al. Appl. Phys. Lett. 98, 013502 (2011). [3] L. Liu et al., Phys. Rev. Lett. 106, 036601 (2011).

Keywords:
Ferromagnetic resonance, Mechanical resonator, Spin-transfer toque, Wiedemann effect

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Synaptic plasticity, learning and memory function in ferroelectric tunnel junction.

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Abstract:
In neuromorphic computing, synapse plays the key of role by varying its connection weight between two neurons, which is known as synaptic plasticity. Among many different candidates for synaptic devices, two-terminal ferroelectric tunnel junction (FTJ) has demonstrated that gradual switching between on-state and off-state induced by DC voltage pulses strongly depend on their amplitude, duration or number, which simultaneously control ferroelectric domain configurations. However, its limited barrier height modulation inevitably gives rise to low on/off ratio. Here, we report a synaptic metal/ferroelectric/metal device which shows a giant on/off ratio ($\sim10^7$). The device also shows synaptic plasticity, learning and memory function by the modulation of tunneling barrier width. Its excellent performances may result from combination of ferroelectric polarization and migrated ions.

Keywords:
ultrathin ferroelectric film, giant on/off ratio

Temperature dependent negative differential resistance behavior at Pt/Nb:$SrTiO_3$ interface

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Abstract:
Bipolar resistive switching behaviors of Pt/Nb-doped $SrTiO_3$ (Nb:$SrTiO_3$) junctions were studied. Pt/Nb:$SrTiO_3$ junctions have shown clear multi-level resistance states with good endurance up to 10^3 cycles. Temperature dependence of resistance reveals insulating behavior at positive bias branch, on the contrary, metallic behavior at negative bias branch. Interestingly, after drastic current change during applying positive bias, clear negative differential resistance (NDR) phenomena are observed at negative bias branch. The NDR phenomena diminish as temperature increases and finally disappear at about 250 K. To find the origin of such NDR, electrical and optical measurements have been conducted.

Keywords:
resistive switching, Schottky, NDR

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Manufacturing of coffee grounds foaming ceramics for LED heatsink

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Abstract:
High-brightness light emitting diodes (LEDs), as a strong candidate general illumination applications for the next generation, were developed by improving luminous efficiency and installing the multi-chips in limited areas to increase the illumination. One of problems is thermal radiation of the high power LED while it works. The forming ceramics have high specific surface area by many pores. The specific surface area of foaming ceramics is advantageous for heat dissipation by increasing the surface. Therefore, we developed a new type of heatsink by applying foaming ceramics for coffee ground. In this study, we fabricated aluminum foaming ceramics with coffee ground. The compressive strength of aluminum forming ceramics with coffee grounds were measured by universal testing machine. The LED lamps was prepared by attaching the aluminum foaming ceramic to the LED module. The thermal and electromagnetic property of the LED heatsink was measured by driving our LED lamps with the original LED lamps.

Keywords:
LED heatsinkFoaming ceramicsCoffee grounds

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Evaluation of Applicability Using EM pump as Assistant Tool for the Circulation of LBE in the SMFBR

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Abstract:

SMFBR (Small Modular Fast Breeder Reactor) which is one type of GEN-IV nuclear power plants has advantages such as proliferation resistant, environmental friendly, and accident tolerant technology while large scale nuclear power plants are unstable for technical, economic, and safety limitations. As enhanced safety system, passive cooling to both normal and abnormal operations by natural circulation of coolant is applied to URANUS (Ubiquitous, Rugged, Accident-forgiving, Nonproliferating, and Ultra-lasting Sustainer) which is based on SMFBR. Although natural circulation of coolant is good for safety, cooling performance cannot be enough to be required in URANUS. As one of solutions in the situation, forced cooling using EM (Electro Magnetic) pump as well as natural circulation can be considered. The conceptual design of the experimental facility called PILLAR (Pool-type Integral Leading facility for Lead-alloy cooled Advanced small modular Reactor) is prepared for the verification of the thermal hydraulic aspect of coolant circulation. Height of scale ratio from URANUS to PILLAR is fixed as 1 considering factor in the phenomena of nature circulation while passage area of scale ratio from URANUS to PILLAR is 0.005 considering engineering perspective and thermal hydraulic similarity for the requirements with the mass flow rate of 21.37 kg/s and developed pressure of 8,456 Pa in the experimental facility subject to the natural circulation. Because EM pump is developed by Lorentz' force generated from driving current and magnetic field perpendicular to it, it has no internal structure like impellor for pumping. So, in the design of PILLAR, the EM pump is attached to lower part of riser, generating developed pressure in annular down comer to downward direction. The characteristics of the EM pump attached to PILLAR is predicted from the numerical analysis subject to the MHD (Magneto Hydro Dynamic) conditions such as magnetic field and current density distribution by using ANSYS Maxwell. From the results, developed pressure which is generated by EM pump is 14,815 Pa in the condition of 6 kW of input power while developed pressure which is generated by natural circulation is 8,456 Pa.

Keywords:
Electromagnetic pump, Nuclear power plant, Developed pressure, Thermal hydraulic system

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Unfolding the band structure of one-dimensional nanostructures within density function theory framework

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Abstract:

For systems with imperfections, such as defects, impurities, and surfaces, first-principles electronic structure calculations within the framework of density functional theory (DFT) commonly rely on a supercell geometry subject to periodic boundary conditions. Due to a number of primitive cells, supercell calculations provide a complex subband structure with the energy states folded in the reduced supercell Brillouin zone. Using a band unfolding method, one can extract the hidden translational symmetry and compare directly the unfolded band structure with experiments. Several unfolding schemes have been proposed for two- and three-dimensional systems. However, no unfolding method has been developed for one-dimensional systems embedded in a vacuum because the correspondence between the supercell and primitive crystal momenta is not well defined, compared with perfect bulk systems. In this work, we develop a band unfolding method for one-dimensional nanowires using a localized basis set combined with plane-wave DFT calculations. The nanowire wave functions are expressed in terms of Bloch waves along the periodic wire axis and confined standing waves across the wire. To verify our method, we calculate the unfolded band structure of Si nanowire and find that the band dispersion is in good agreement with that of bulk Si, recovering the hidden symmetry.

Keywords:

Density Functional Theory, First-Principles Theory, Band structure

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Avoiding performance loss from dynamic polymorphism

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Abstract:

The application of new programming paradigms have been of continued interest not only in computational physics, but also in computational science as a whole. In this talk, I will review the paradigmatic advances of high-efficiency numerical computation from the 1970s and propose how scientific codes to be written in the future can better utilize the computational technology available today. The efficiency of quantum Monte Carlo simulations of 1D fermionic systems in a harmonic trap will be presented as a benchmark.

Keywords:

computational sciencephysicsquantum Monte Carloobject-oriented programming

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Carrier-Induced Frenkel Pair Formation and Nonradiative Recombination in InGaN Light-Emitting Devices: A First-Principles Study

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Abstract:
Non-radiative recombination (NRR) of excited carriers is currently the biggest restraint on optoelectronic device efficiency, and understanding the mechanism is thus crucial for technological applications. Here, by using first-principles calculations, we propose a new NRR mechanism, where excited carriers recombine via a Frenkel-pair (FP) defect formation and the carrier energy is dissipated through defect generation and annihilation processes. While in the ground state the FP is high in energy and is unlikely to form, its formation is enabled in the electronic excited states by a strong electron-phonon coupling of the excited carriers. This NRR mechanism is expected to be generally observed in wide-gap semiconductors, rather than being limited to InGaN-based light emitting devices.

Keywords:
Non-Radiative Recombination, Optoelectronic Device, First-Principles Calculation

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50-Facet Cu2O Nanocrystals Coated with CuO Nanoparticles: Trapped CO and O2 Assisted Near-Perfect CO Oxidation

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Abstract:

As carbon monoxide (CO) oxidation is widely used for chemical processes as well as combustion in industry and vehicles, it is essential to develop highly energy efficient, inexpensive, and eco-friendly catalysts for CO oxidation. Here we report green synthesis of ~10 nm-sized CuO nanoparticles (NPs) aggregated on ~400 nm-sized 50-facet-Cu2O polyhedral nanocrystals. The CuO-NPs/50-facet-Cu2O shows remarkable and highly specific CO oxidation reactivity (4.5 μmolCO m-2s-1 at 130 ° C) and near-complete 99.5% CO conversion efficiency at ~175 ° C. This outstanding catalytic performance over the pristine multi-faceted-Cu2O nanocrystals (of 6, 8, 18, 26 and 50 facets) is attributed to surface oxygen defects of ultrafine CuO NPs facilitating the binding of CO and O2 on their surfaces. The poisoning effect of CO trapping is overcome by the attack of an additional CO molecule, and so paradoxically accelerates the catalytic reaction, leading to near-perfect CO oxidation. This new material would help in solving CO exhaust problems.

Keywords:

CO oxidation, Catalyst

Predictive continuum model of gas uptake for inhomogeneous fluids

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Abstract:

We describe a continuum model that calculates the adsorbed gas densities and uptake capacities of porous materials directly from the fluid-substrate interaction energies. The method is designed to incorporate the inhomogeneous fluid-fluid interactions arising from the non-uniform fluid-substrate interactions. Therefore, the method is applicable to general conditions and materials providing the confined fluid uniform and/or non-uniform interactions. Once the fluid-substrate interaction energies are available, it calculates the gas uptake capacities with enormously fast speed yet gives results consistent with the grand canonical monte carlo calculations. Some limitations may arise when the local gas density becomes too high, e.g. some strongly interacting sites at liquid nitrogen temperature. The proposed method may open a door to the large-scale materials discovery that can be benefited by fast but accurate computational method.

Keywords:

gas storage, gas separation, continuum model, inhomogeneous fluids,MOF

First-principles calculations of contacts between the group 13 metals and carbon nanotubes

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Abstract:
Recently, it has been reported that it is possible to observe the electronic density of state (DOS) of CNT by adopting the structure of single CNT-based FET device with indium (In) electrode. Here, we report the bonding characteristics and electronic structure of the contact interface between group 13 metals (In, Ga, Al) and (8,0) semiconducting CNT by using ab initio density-functional-theory (DFT) calculations. From our calculation results, CNTs on Al, Ga, and In surfaces not only preserve their original electronic properties, but also have lower binding energies with their contact metal surfaces. We expect that these investigations will lead to a more deep understanding of contacts between group 13 metals and CNT, and help to pave the way for observing the electronic structure of various nanomaterials through weakly bonded contact with In or Ga metal.

Keywords:
carbon-nanotube, group-13-metal, Contact, density-functional-theory, Indium, Gallium

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A van der Waals density functional study of interlayer interaction and phase stability in layered transition metal dichalchogenides MTe_2 (M=Mo, W)

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Abstract:
Layered transition metal dichalcogenides MTe_2 (M=Mo, W) has attracted significant attention because of its interesting physical and electronic properties. Based on the van der Waals density functional (vdW-DF) method, we investigate the interlayer interaction and structural phase stability of MTe_2. We show that a recently proposed revised version of the vdW-DF2 [I. Hamada, Phys. Rev. B 89, 121103(R) (2014)] improves the description of the attractive van der Waals interactions, thereby computing their most accurate lattice structures successfully while several other methods fail to reproduce them. Using the revised vdW-DF, we will discuss the several local equilibrium structures and phase transition between them.

Keywords:
$MoTe_2$, WTe_2, van der Waals interaction, Phase transition, van der Waals density functional

3-D Gold Nanoparticle Distribution Imaging in Living Cells using Optical Diffraction Tomography

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Abstract:

Gold nanoparticles (AuNPs) have been widely used in biomedical applications because of their unique properties different from usual organic molecules such as the surface plasmon resonance (SPR) and the controllability of the size and the shape. Its main use includes photothermal therapy and drug delivery. Along with the increased use of AuNPs, the imaging techniques have also been improved. The routine imaging technique is the transmission electron microscopy (TEM) which uses the electron wave in extremely high vacuum, thus, is not available for living organisms. The other imaging techniques involve the fluorescent microscopy using fluorescent-tagged AuNPs. Although fluorescent microscopy has successfully shown the AuNPs distribution in living cells, the fluorescent-tagging process is complicated and time-consuming. Moreover, there is a limit due to photobleaching and high costs of fluorescent dyes. Therefore, label-free imaging methods have been adapted to AuNPs imaging recently. Those methods include dark-field microscopy and multi photon microscopy. Those techniques are inherently immune to the use of fluorescent dyes and they are also applicable to live cells. However, in dark-field microscopy, the intensity level of the scattered light differs for the wavelength and the intensity of the irradiated light and the multiphoton signal changes along the intensity of irradiated beam making hard the quantitative imaging. Moreover, both techniques require mechanical z-sectioning for three-dimensional (3-D) images, and thus, taking time more than few minutes for acquiring one complete 3-D image. In order to get a fast, label-free, 3-D image of AuNPs distribution in live cells, we exploit optical diffraction tomography (ODT). 3-D distribution of refractive index (RI) of a live cell containing AuNPs is obtained in one second and high RI regions which do not appear in native cells are observed in AuNPs containing cells. We confirmed that those regions with relatively high RI values contain AuNPs by comparing the RI distribution with confocal microscope images of the same cells. Also, we measured the RI value of AuNPs solutions with various concentrations allowing the potential of quantitative imaging. Finally, we used this technique to observe the AuNPs distribution in HeLa cells with different incubation times and with the use of differently surface charged AuNPs.

Keywords:
Optical diffraction tomography, Gold Nanoparticle, Label-free imaging, 3-D imaging

Towards the plasmonic optical nano-bio sensor for single molecule analysis

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Abstract:
Recently there have been tremendoous interets about the fabrication of plasmonic nanopore for single molecules such as DNA, RNA, and protein by using optical detection technique. Last year, the portable DNA sequencing device called MinION by using electrical detection technique was launched into the market. However, the high errot rate was reported and the performamce of the device still needs to be improved. In this report, we will report the optical nanopore fabricated on the Au thin membrane either by diffusion of Au atoms or drilling a pore on the Au film. The Au nanopore can be utilzed for single molecule analysis due to plasmonic hot spot effect. The diameters of the Au nanopore were emasured to be 3 ~ 5 nm . Furthermore, the Au clusters were measured on the diffused Au-C membrane under the room environements and these Au cluster can also be utilized for optical detection of biomolecules.

Keywords:
nanopore, single molecule, portable nanobio sensor, Au cluster, electron irradiation

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Osteogenic differentiation of human mesenchymal stem cells in 3D cell culture system using real-time monitoring capacitance sensor

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Abstract:

Three-dimensional (3D) cell cultures have recently received attention because they represent a more physiologically relevant environment compared to conventional two-dimensional (2D) cell cultures. Moreover, 2D-based imaging or cell sensing techniques are limited for real-time monitoring of cellular behavior in 3D cell culture. Here, we report investigations conducted with a 3D capacitance cell sensor consisting of vertically aligned pairs of electrodes. We used human mesenchymal stem cells (hMSCs) in alginate hydrogel to monitor the cellular behavior in 3D cell culture system, especially osteogenic differentiation, which is important process in bone formation from stem cells toward osteoblasts, and proliferation. To promote osteogenic differentiation, we added BMP - 2 known as differentiation promoter during osteogenic differentiation. Compared to the time dependence of capacitance measured during normal differentiation, the time dependence of capacitance measured during the differentiation with BMP - 2 showed higher and more rapid increase, suggesting that hMSCs were differentiated into osteoblasts more rapidly in the presence of BMP-2. This capacitance sensor might be used for real-time and label-free monitoring of osteogenic differentiation.

Keywords:

Osteogenic differentiation3D cell culture systemCapacitance sensorReal timeLabel freeHuman mesenchymal stem cells

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2016.10.19 - 2016.10.21

일차원 입자 관측을 위한 이중 이미지 추적

고기현[1], 허승진[2], 조종회[1], 유양석[1], 김민관[2], 박충현[1], 조용훈[*1]
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Abstract:
광족집게(optical tweezers)는 강하게 집속된 레이저를 사용하여 입자를 포획하고 다룰 수 있게 해주는 도구이다. 과거에는 주로 구형 입자를 포획하였다면 최근에는 나노로드와 같은 막대 모양 입자를 포획하는 연구가 많이 진행되고 있다. 이는, 구형 입자와 다른 막대 모양 입자의 비등방적 성질을 이용하면 구형 입자에서 해결하지 못하는 많은 문제들을 해결 할 수 있기 때문이다.(1) 예를 들어, 구형 입자를 탐침으로 이용한 광자힘 현미경의 경우, 입자의 크기가 작을수록 해상도가 증가하지만 그만큼 광족집게로 포획하기가 어렵다는 한계가 있다. 하지만, 막대 모양 물체의 경우, 긴 길이를 이용해 안정적인 포획이 가능하고, 뾰족한 면을 이용할 경우, 고해상도 이미징도 가능하다.(2) 이러한 장점에도 불구하고 막대모양 입자의 경우, 병진운동뿐만 아니라 회전운동도 함께 일어나기 때문에, 하나의 평면(image plane)에서만 정보를 얻는 기존의 관측 시스템에서는 막대모양 입자의 운동을 정확히 측정할 수 없어 실제로 사용되지 못하고 있다. 본 연구에서는 직접 개발한 이중 이미지 추적 방법을 사용하여 광족집게에 의해 포획된 나노로드의 병진운동과 회전운동을 분리하여 관측하였고, 그것들의 특성을 레이저 파워와 편광을 변화시키며 측정하였다. 참고문헌 (1) Svoboda, K.; Block, S. M. Biological applications of optical forces. Annu. ReV. Phys. Biomol. Struct. 1994, 23, 247−285 (2) Maragò, O. M.; Jones, P. H.; Bonaccorso, F.; Scardaci, V.; Gucciardi, P. G.; Rozhin, A. G.; Ferrari, A. C. Nano Letters 2008, 8, (10), 3211-3216.

Keywords:
광족집게, 브라운 운동, 광자힘 현미경

A Calculation of Radiation Damage to Tumor Cell in BNCT

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Abstract:

The dose distribution of emitters in subcellular level is the most important quality to evaluate the treatment effects and side effects in Boron Neutron Capture Therapy (BNCP). In order to analyze the dose distribution in subcellualr level in BNCP, we defined the new tumor cell model. Accordingly, we summarized the interaction models for emitters and tumor cellular structures. Then, we simulated the interaction processes of emitters and tumor cellular materials using Monte Carlo program. By analyzing the simulation results, we concluded that the dose distribution of ionizing energy of emitted ions in a tumor cell nucleus depends on the types of fission reaction, the types of emitters and the location of boron atoms. Furthermore, we quantificationally evaluated these influencing factors and obtained the multiple relations of them. This is significant to improve and perfect the elementary interaction theory of energetic emitters and tumor cell in BNCP.

Keywords:
DoseDistribution, BNCT, Monte Carlo Method

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넓은 면적에서 균일하며 높은 증강을 보이는 금속 나노 갭 구조의 SERS 특성

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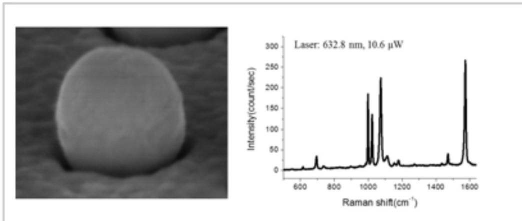

Abstract:
본 연구에서는 반도체 공정 기술을 사용하여 금속 나노 홀과 입자로 구성된 10 나노미터의 복합 나노 갭 구조를 제작하고 그 특성을 살펴보았다. 나노 갭 간격이 줄어들수록 산란 스펙트럼이 장파장으로 이동하는 것을 확인했는데 이는 FDTD 계산 결과와 일치하는 것이다. FDTD 계산 결과에 의하면 산란 스펙트럼과 전기장 증강 값 스펙트럼의 형태는 일치한다. 나노 갭의 산란이 강하게 나타나는 파장에서 전기장 증강도 강하게 나타나는 것을 확인할 수 있다. 벌크 벤젠 싸이올 분자를 측정한 결과와 나노 갭 구조 위에 단층으로 흡착하여 측정한 결과를 비교하면 10^7~10^8 사이의 라만산란 증강값을 얻을 수 있다. 측정 위치 마다 변동계수 10% 미만으로 측정 값이 균일한 것을 확인하였다. 그리고 10분 이상 레이저를 조사하여도 측정 값의 변화가 거의 없이 안정적이라는 것을 확인하였다. 또한 10 nM 보다 작은 극미량의 아데닌 분자 2 μL 한 방울을 구조 위에 흡착 시켰을 때 SERS 신호를 관찰할 수 있음을 보였다. 이는 극미량의 분자를 검출하는 센서로 사용되기에 접합하다는 것을 나타낸다.

Keywords:
나노 갭, SERS 센서, 분자 검출 센서, Plasmonics

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Label-free biosensor using a bio-hybrid polymer nanowire

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Abstract:

We reported on the biosensor (DNA or protein) using a bio-hybrid polymer nanowire (NW). The probe DNAs (p-DNAs) or aptamer were easily attached to the polymer NWs through electrostatic interaction between the negative counter-ions and the terminal amine (NH_3^+) group attached at the end of the p-DNA or aptamer. After the functionalization and their label-free recognition of target DNAs (t-DNAs) or protein onto the surface of polymer NWs, the light-emitting color and intensity of a polymer NW were dramatically changed due to the conformational changes of the dopen-polymer main chains and fluorescence resonance energy transfer. We observed color change of a polymer NW, and then luminescence intensity was dramatically enhanced by hybridizing. The conformational changes of the polymer main chains due to attaching p-DNA or aptamer were investigated ultraviolet-visible absorption and confocal Raman spectra. The enhanced PL of the bio-hybrid polymer NW can be explained in terms of the dopant-mediated fluorescence chain reaction.

Keywords:
biosensor, DNA, protein, polymer, PL, raman, conformational change

Ultimate 2D limit of metallic indium overlayers on Si(111)

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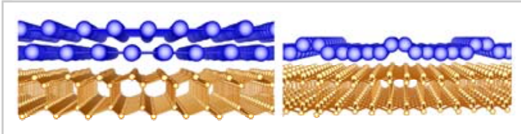

Abstract:

How thin can metal films be yet retaining the 2D nature of their metallic properties? One atomic layer might be such an ultimate 2D limit. This fundamental question is the motivation underlying extensive experimental studies of the In overlayers grown on the Si(111)-(√7×√3) surface. Contrary to the long expectation, however, the In/Si(111)-(√7×√3) surface was recently verified to represent In double layers, not single layers [1,2], and therefore it remains an interesting issue to identify a single-layer form of metallic In overlayers. Here, we report DFT formation-energy calculations that predict two new metastable single-layer In phases (1.4-ML √7×√3 and 1.43-ML √7×√7), which agree well with experimental evidences. Interestingly, these single-layer In phases display anisotropic 2D band structures and Fermi surfaces in contrast to the free-electron-like properties of double-layer In phases. This strongly suggests that the ultimate 2D limit of free-electron-like In overlayers on Si(111) could be a double layer. [참고문헌] [1] J. W. Park and M. H. Kang, Phys. Rev. Lett. 109 166102 (2012) [2] J. W. Park and M. H. Kang. Phys. Rev. B 92, 045306 (2015)

Keywords:
In/Si(111), Metal monorlayer, DFT

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Edge reconstruction and local electronic structure of ultrathin Bi(110) nanoribbon

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Abstract:
Semimetal bismuth is widely studied because ultrathin Bi layer have been predicted as 2D topological insulator in theoretical calculations and identified in experiments. However, when Bi(110) nanoribbon is formed, the geometrical structure of edge which is reconstructed and the electronic structure of the atoms which consist of the edge are not still well-known. Therefore, using scanning tunneling microscopy and spectroscopy experiments, 2 BL Bi(110) nanoribbon grown on epitaxial graphene on silicon carbide is observed and studied. Since ultrathin Bi(110) layer has distorted black phosphoruslike structure, the difference was shown between the left and right edge reconstructions and the geometrical structure was slightly different in each bias. Especially, as the bias changes, it seemed like the buckling at the same area was reversed. Furthermore, unlike the inside atoms the specific atoms of the edge shows the electronic structure which exists inside the bulk gap. We judged that it shows 2 BL Bi(110) nanoribbon has the possibility of topological insulator.

Keywords:
Edge reconstruction, ultrathin Bismuth film, scanning tunneling microscopy

STM study on p-type characteristics of SnSe

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Abstract:

SnSe is a two dimensional layered material with p-type characteristics. Recently, SnSe has attracted many researchers' attention due to its excellent thermoelectric properties showing unprecedented ZT (figure of merit) value of 2.6. Generally, the ZT value of thermoelectric materials can be maximized within the narrow charge carrier density of $10^{19} \sim 10^{20}$ carriers/cm^3. Therefore, the origin of p-type property in SnSe is an important information to optimize its charge density. Here, for the first time, we report about the origin of p-type characteristics of SnSe single crystal via home-built scanning tunneling microscope/spectroscope (STM/S) and combined density functional theory (DFT) calculation. We found three intrinsic defects such as Sn , Se and Se-Sn-Se vacancies. The most common Sn vacancies move the fermi energy inside the dispersive valence S band and produce extra holes throughout the system. On the other hand, Se vacancies create a nondispersive donor level and generate immobile electrons localized near the vacancy site. Our combined STM/DFT studies show that the p-type characteristics of SnSe originate from extra holes in the dispersive Bloch-like band created by the Sn vacancy. We expect our results will provide important information for the development of highly efficient SnSe-based thermoelectric devices.

Keywords:

STM, SnSe

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Detailed Atomic Reconstruction of Extended Line Defects in Monolayer MoS_2

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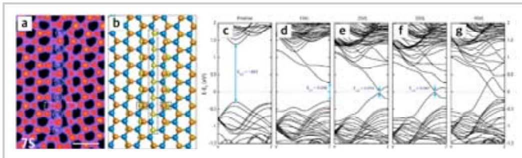

Abstract:

We study the detailed bond reconstructions that occur in S vacancies within monolayer MoS_2 using a combination of aberration-corrected transmission electron microscopy, density functional theory (DFT), and multislice image simulations. Removal of a single S atom causes little perturbation to the surrounding MoS_2 lattice, whereas the loss of two S atoms from the same atomic column causes a measurable local contraction. Aggregation of S vacancies into linear line defects along the zigzag direction results in larger lattice compression that is more pronounced as the length of the line defect increases. For the case of two rows of S line vacancies, we find two different types of S atom reconstructions with different amounts of lattice compression. Increasing the width of line defects leads to nanoscale regions of reconstructed MoS_2 that are shown by DFT to behave as metallic channels. These results provide important insights into how defect structures could be used for creating metallic tracks within semiconducting monolayer MoS_2 films for future applications in electronics and optoelectronics.

Keywords:
MoS_2, DFT, TEM, Defects, Electronic structure

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Influence of surface chemical state of ITO films on wettability and antibacterial effect

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Abstract:

DC sputtered ITO films were annealed under various environment (O_2, N_2, Ar, vacuum) at 400 °C for 10 min to examine the environmental dependent surface characteristics. Especially, we focused to understand the correlation between the variations of microscopic (structural and chemical) surface and the contact angle and antibacterial effect. As results, an amorphous as-grown ITO film revealed the smoothest surface. After annealing, RMS roughness was increased but it didn't depend on annealing environment. The contact angles with water droplet showed the highest for as-grown film and increased with the order of O_2, N_2, Ar and vacuum. The highest contact angle was related to the RMS roughness. For post-annealed films, the variation of the contact angles was related to the contents of Sn^{2+} at the surface because there was no difference in RMS roughness. For the antibacterial testing, the lower activation of Escherichia coli was appeared only on the as-grown ITO film. The Sn contents increased to the surface (i.e., Sn segregation) at all ITO films confirmed by angle-resolved X-ray photoelectron spectroscopy. In particular, this Sn segregation was dominant on the as-grown film. Therefore, the pronounced antibacterial effect of as-grown ITO film was related to the Sn segregation on the film surface. This work was supported in part by NRF Korea (NRF-2015R1D1A1A01058672) and Korea Atomic Energy Research Institute. One of authors (J. W. Kim) was supported by the GPF program (2015H1A2A1034200) of NRF. †psk@pusan.ac.kr

Keywords:
TCO; Contact angle; Antibacterial effect; Sn segregation

Cluster experiment for TGF investigation

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Abstract:

We suggest a Cluster experiment for Terrestrial Gamma Flashes (TGF) investigation. It is intended to launch four CubSat class 6U satellites as a piggyback payload of Progress transportation into LEO orbit of about 350km. Each satellite will be equipped with a payload up to 5kg of scintillation detector for gamma-ray detection. The mission consists of active and passive phases. In the initial active phase (up to 2 years) the satellites will be clustered in the orbit with mean distance between guided satellites of about 100km. In this phase the single TGF can be detected by one or more detectors, and using differences in intensity of detected signal one could make a crude localization of the source of the TGF based only gamma-ray detection/non-detection, as well as to investigate an opening angle of relativistic electrons responsible for TGF emission. Additionally in the active phase Cluster experiment will provide more tight coverage of thunderstorm areas for multiple TGF emission. In a subsequent passive phase each satellite provides TGF detection of different areas of the Earth. In both phases the Cluster experiment will also provide cosmic Gamma-Ray Burst (GRB) and Solar flares registration, and in the passive phase it provides cosmic gamma-ray source detection for un-obscured by the Earth 4π solid angle.

Keywords:
cluster experiment

Status of UFFO-pathfinder in space, and an interesting event

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Abstract:
The payload of the UFFO(Ultra-Fast Flash Observatory)-pathfinder onboard the Lomonosov spacecraft (hereafter UFFO/Lomonosov) is a dedicated instrument for the observation of GRBs. UFFO/Lomonosov was flown successfully to space from Vostochny, Russia in April 28, 2016. Its primary aim is to capture the rise phase of the optical light curve which is one of the least known aspects of GRBs. Once a GRB position is determined by the onboard X-ray telescope, UFFO Burst Alert Telescope (UBAT), the other telescope for UV/optical, Slewing Mirror Telescope (SMT), rapidly redirects the photons from that GRB onto the focal plane of the UV/optical telescope. During last three months the UFFO/ Lomonosov has been going through careful check-up processes in orbit prior to its full operation. We will report the status of UFFO/ Lomonosov after its launch, and discuss about an intriguing burst event which was captured in the middle of a calibration run in space.

Keywords:
Space payload, GRB, Telescope, Early photons

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Finding position and FOV of UFFO-p(Ultra-fast Flash Observatory pathfinder)

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Abstract:
UFFO-pathfinder, the space telescope designed for observing the early moment of GRBs(Gamma Ray Bursts), was launched onboard the Lomonosov satellite in April 28, 2016. We have obtained a sky data in the wavelength of X-ray and UV/optical from UFFO-pathfinder via satellite downlink, though a couple of matters are still to be solved out for GRBs observation. My work is to find the position of the sky to which UBAT and SMT pointed in these event. I compared the position data from TLE and satellite navigation data, and found the actual pointing positions. I present how I calculate accurate orientation and FOV of UFFO-pathfinder.

Keywords:
UFFO,Ultra-fast Flash Observatory, GRB, Gamma ray burst, Lomonosov

The study on x-ray response of UBAT of UFFO/Lomonosov in Space

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Abstract:
UFFO Burst Alert and Trigger telescope (UBAT) of UFFO/Lomonosov is the X-ray telescope utilizing a coded mask technique to localize X-ray position from Gamma-ray Burst (GRB) accurately. It was successfully launched on Apr. 28, 2016 on board the Lomonosov satellite in Vostochiny, Russia. It has done several calibration runs to check the real detector response in X-ray Space and confirm the imaging capabilities after launch. In calibration runs, we got several triggers and X-ray data from X-ray telescope and found that it has higher source rates in X-ray than we have expected. In this paper, we would like to report preliminary calibration results from our X-ray detector and show its feasibilities as GRB trigger telescope in low X-ray Space.

Keywords:
Gamma-ray Burst, GRB, x-ray, UFFO-pathfinder, Lomonosov, UBAT,

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First space tests of Slewing Mirror Telescope

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Abstract:

The Slewing Mirror Telescope(SMT) of Ultra-Fast Flash Observatory(UFFO)/Lomonosov is aimed to detect optical prompt emissions from Gamma-Ray Bursts(GRBs), which allows UFFO to pioneer an unexplored time domain, first seconds, in the observation of GRBs at the wavelength of UV and visible. The observatory was successfully launched on Apr 28 from a new Russian cosmodrome Vostochny. A series of tests have been performed to operate the SMT in space after launch and to check its sensitivity in the orbit. Optical background has been measured as well. We report results of SMT space tests and their correlation with our pre-flight calculations.

Keywords:
Space, UV,Gamma-Ray Bursts, GRB,Ultra-Fast Flash Observatory, UFFO,Lomonosov,Slewing Mirror Telescope,SMT

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2016.10.19 - 2016.10.21

Extreme UV burst, particle heating, and whistler waves in magnetic reconnection associated with Rayleigh-Taylor instability

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Abstract:

The Caltech jet experiment produces low beta, high Lundquist number, high density (~10^{22} m^{-3}) MHD-driven plasma jets and so is similar to astrophysical jets. Several interesting phenomena have been observed and identified: i) flow-driven collimation of the jet [1], ii) ideal MHD kink instability [2], iii) kink-induced, magnetic Rayleigh-Taylor instability [3], and iv) fast magnetic reconnection associated with the Rayleigh-Taylor instability. We have recently studied various phenomena associated with the magnetic reconnection using comprehensive diagnostics including a high-speed EUV movie camera, a high-frequency B-dot probe, and a high-resolution spectroscopic system. The results of these studies include the following: A spatially localized energetic EUV burst is imaged at the presumed position of fast magnetic reconnection in a plasma jet; the existence of this localized EUV burst indicates strong localized electron heating. A circularly polarized high frequency magnetic field perturbation is simultaneously observed at some distance from the reconnection region indicating that the reconnection emits whistler waves and that Hall dynamics likely governs the reconnection. Spectroscopic measurement shows simultaneous fast ion heating. We propose that the electron heating is consistent with Ohmic dissipation while the ion heating is consistent with ion trajectories becoming stochastic. [1] S. You, G. S. Yun, P. M. Bellan, Phys. Rev. Lett. 95, 045002 (2005). [2] S. Hsu and P. M. Bellan, Phys. Rev. Lett. 90, 215002 (2003). [3] A. L. Moser and P. M. Bellan, Nature 482, 379 (2012)

Keywords:
magnetic reconnection, EUV, whistler wave, plasma heating, plasma instability

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2016.10.19 - 2016.10.21

중이온가속기 빔진단시스템 구축현황

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Abstract:
현재 대전에 구축중인 중이온가속기(RAON)의 효율적이고 안정적인 운전을 위하여 다수의 빔 진단장치가 설치 운영되어야한다. Beam Position Monitor, Beam Current Monitor, Beam Loss Monitor 등의 비 파괴적인 진단장치는 물론 Faraday Cup, Wire Scanner, Emittance Scanner 등의 빔 파괴적인 진단장치의 설치 및 운영이 요구된다. 이번 발표에서는 중이온가속기의 빔진단장치 구성 및 설치계획과 함께 현재 제작하여 시험 중인 빔진단장치들의 개발 현황을 보여줄 계획이다.

Keywords:
중이온가속기 빔진단

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2016.10.19 - 2016.10.21

Error Analysis in RISP SCL3

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Abstract:
The SCL3 is a low energy part of RISP (rare isotope science project) superconducting linac. It consists of QWR (quarter wave resonator) and HWR (half wave resonator) cavities. The doublet lattice is used for transverse focusing with warm quadrupole magnets. The resonance frequency of HWR is doubled to be 162.5 MHz from 81.25 MHz of QWR cavities. In order to increase longitudinal acceptance, the amplitude and phase are ramped in the initial part of QWR and HWR cavities. In this work, we studied the misalignment and field error effects on the beam loss through the linac. It includes the displacement and rotation errors of quadrupoles and cavities, and the amplitude and phase errors of cavity fields. We also studied beam steering in the linac in order to reduce beam loss.

Keywords:
RISP, SCL3, Error Analysis, Steering

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2016.10.19 - 2016.10.21

Control System and Low Temperature Test for Half-Wave Resonator Cryomodule

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Abstract:
PLC and EPICS are developed for a half-wave resonator (HWR) cryomodule. PLC rack is fabricated for the HWR1 cryomodule. HMI of PLC and EPICS controls and monitors pumps, heaters, valves and temperature sensors through switching hub. The cryomodules are test in low temperature environment with liquid helium by using the developed PLC and EPICS. Heat loads are measured at 2 K and 4 K.

Keywords:
Cryomodule, Accelerator

Scaling and universal law for microplasma breakdown at high-frequency

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Abstract:

Single particle electron motion analysis and particle-in-cell with Monte Carlo collision (PIC/MCC) simulations are conducted to describe the mechanism of the abrupt breakdown voltage transition of radiofrequency or microwave discharges for helium and argon at the transition frequency [1]. The electron kinetics indicates that the primary electron loss mechanism shifts between the drift-dominant and the diffusion-dominant regimes depending on the neutral gas pressure (p), gap distance (d), and/or driving frequency (f). From the equation of an electron motion with an ensemble average [2], one can find that the transition frequency is proportional to the product of and where m is a positive exponent, which is confirmed by PIC/MCC. Below the transition frequency or drift-dominant regime, i.e., γ-regime, the secondary electron emission induced by the ion bombardment due to the drift motion is the key factor determining the breakdown voltage. A universal law including the secondary emission coefficient (γ) can be derived from the fluid analysis with the continuity equations for both the ion and electron density, implying that the breakdown voltage is determined by pd, f/p, γ, and d/R (R is the diameter of electrode), which extends the previous universal law without γ term [3]. Micro-sized plasmas driven by the field emission, however, contravene the universal law. PIC/MCC and fluid simulations demonstrate this universality. As a corollary, the universal law reproduces the same scaling law for the drastic breakdown voltage reduction. * This research was supported by the National Research Foundation of Korea under BK21+ program, grant No. 2015R1D1A1A01061556 (Ministry of Education), and grant No. 2015M3A9E2066986 (Ministry of Science, ICT and Future Planning). This work was also partially supported by Asia-Pacific Center for Theoretical Physics. References: M. U. Lee, S. Y. Jeong, I. H. Won, S. K. Sung, G. S. Yun, and J. K. Lee 2016 Non-Maxwellian to Maxwellian transitions of atmospheric microplasmas at microwave frequencies Phys. Plasmas 23 070704 T. Kihara 1952 The mathematical theory of electrical discharges in gases Rev. Mod. Phys. 24 45-61V. Lisovskiy, J.-P. Booth, K. Landry, D. Douai, V. Cassagne, and V. Yegorenkov 2008 Similarity law for rf breakdown EPL 82 15001

Keywords:
breakdown, transition, scaling law, universal law, PIC, fluid

Controlling transverse dynamics of the laser pulse and the electron bunch in laser wakefield acceleration

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Abstract:
Multi-dimensional particle-in-cell (PIC) simulations using OSIRIS show that the transverse frequency chirp can induce pulse front tilt (PFT) in the laser as it propagates. The PFT leads to transverse inhomogeneity in the electron density at the laser front such that the laser drifts in the transverse direction followed by its wake and the injected/self-injected electron beam inside the blowout region. We further investigate the effect of the chirp and transverse plasma inhomogeneities (linear density gradient and parabolic plasma channel) on the transverse drift by developing an analytical model based on a variational principle approach. Theory and simulations predict a linear dependence of the frequency chirp on the transverse drift. In the presence of a linear density gradient the laser drifts towards the decreasing plasma density. We show that an appropriate transverse chirp can balance the drift, and can reduce/nullify the injected electron beam pointing angle. In extreme scenarios, dispersion effects due to transverse chirp can filament the laser generating multiple bubble in the same transverse plane. We further analyze the effect of various transverse plasma inhomogeneities on laser dynamics and its influence on the electron bunch trajectories accelerating in the wake of the laser field.

Keywords:
laser wakefield acceleration, laser propagation in plasma

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Electron Acceleration by the Self-phase Locking in Laser Wakefield Acceleration

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Abstract:
Laser Wake Field Acceleration (LWFA)는 강력한 레이저 펄스를 이용해 cm 단위의 짧은 플라즈마에서 GeV의 전자빔을 만들 수 있는 가속방법이다. 레이저가 전자를 밀어내면서 만들어진 wake field (또는 bubble)은 강력한 전기장을 가지고 있으며 bubble에 전자를 injection하고 가속하는 것이 주요과정이다. 만들어진 bubble은 그 사이즈가 일정하지 못해 플라즈마 내부에서 계속 변하는데, 이 때문에 전자의 최대 가속 거리를 조정하는 것에 어려움이 있었다. 이번 발표에서는 매순간 레이저의 에너지 손실 비율이 버블 크기의 변화와 밀접히 관련이 있다는 사실을 보이고, 이를 이용하여 기존 알려진 전자의 감속구간 (dephasing length) 없이 전자를 가속시킬 수 있는 self-phase locking 조건을 제시할 것이다. 1D에서의 레이저의 에너지 손실 비율과 wake field 세기의 관계식을 이용하여 bubble 사이즈 관계식을 유도하였고, 이를 2D Particle-In-Cell 시뮬레이션을 이용하여 비교하였다. Gaussian 모양의 레이저가 깎여가는 간단한 모델로부터 레이저 에너지 변화와 bubble 사이즈 변화를 예측하였다. 이를 이용하여 self-phase locking 가능성을 예시를 통해 보일 것이다.

Keywords:
LWFA, self-phase locking, 전자가속, laser depletion

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Characteristics of laser-driven electrostatic shock ion acceleration depending on a laser polarization

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Abstract:

Electrostatic (ES) shock ion acceleration has received much attention in recent years due to its advantage for generation of quasi-monoenergetic beam and mitigation of requirement of experimental condition in comparison with target-normal-sheath-acceleration or radiation pressure acceleration. In order to form ES-shock, a laser pulse gives momentum to the compressed plasma layer and heats the plasma medium in order to satisfy ES-shock Mach number condition 1.5 〈 M 〈 3.7, where M=v/c_s and c_s= is the sound speed. In this presentation, characteristics of ES-shock ion acceleration by a linearly and circularly polarized laser pulse will be discussed using the data obtained through particle-in-cell simulations. Because of different heating mechanism and degree of density compression for different polarizations, the shock by CP and LP pulses show different characteristics. We found that the ES-shock driven by a circularly polarized pulse propagates faster and yields an ion beam with higher energy in lower density plasmas, than the LP-driven shock.

Keywords:
laser, ion acceleration, shock, plasma

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The Deep Underground Neutino Experiment (DUNE) at Long Baseline Neutrino Facility (LBNF): An ultimate neutrino oscilation experiment

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Abstract:

Matter-antimatter asymmetry is one of the most outstanding mysteries of the universe that provides a necessary condition to our own existence. In the 'Leptogenesis' hypothesis, CPV in the lepton section plays a crtical role to create the matter-antimater asymmetry at the onset of the Big Bang. Thus, experimental observation of CPV in the lepton sector could prove to be tantamount to one of the most important discoveries in our understanding of the universe. Last several years, there have been remarkable progresses in the studies of neutrino oscillations, namely, the precision measurements of the $\boldsymbol{\theta_{13}}$ by the reactor neutrino experiments and observation of appearance of electron neutrinos from a muon neutrino beam by T2K followed recently by NOvA. These findings pave the way to determine the neutrino mass hierarchy/ordering and to explore CPV in the lepton sector. In fact, there may be a slight hint of CPV in the current data. Ultimately, however, in order to establish unequivocal results on leptonic CPV, we need a next generation experiment with a more powerful beam, and a larger and/or higher resolution detector. The Deep Underground Neutrino Experiment (DUNE) in U.S. that is newly established as a truly international collaboration, is such an experiment. DUNE is designated as the highest priority particle physics experiment based in U.S. by the U.S. government as well as the particle physics community. Physics goals of DUNE include: discovery of CPV in the lepton sector, detrmination of mass hierarchy, discovery of proton decay and observation of neutrinos from the core-collape supernovae. In this talk I will introduce the rapidly developing DUNE experiment and the collaboration, and also discuss possible opportunities for participation. The DUNE and LBNF received a DOE CD-1 approval in 2015 and LBNF is expected to receive a CD-3a approval within this year which would allow construction of the far detector facilities.

Keywords:
DUNE, mass hierarchy, CP violation, long-baseline neutrino oscillation

ProtoDUNE-SP: a 0.77 kt single phase LArTPC detector in the CERN Neutrino Platform test beam

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Abstract:

ProtoDUNE-SP is the single-phase DUNE Far Detector prototype that will be constructed and operated at the CERN Neutrino Platform starting in 2017. It was proposed in June 2015 and approved as CERN experiment NP-04 (ProtoDUNE) in Dec. 2015. ProtoDUNE-SP is a significant experiment in its own. With its 0.77 kt of total LAr mass is the largest monolithic single-phase LArTPC detector to be built so far. The CERN Neutrino Platform will provide a new dedicated charged-particle test beam line and ProtoDUNE SP aims at taking first beam data before the LHC long shutdown at the end of 2018. ProtoDUNE-SP is a crucial part the DUNE effort towards the construction of the first DUNE far detector "10-kt Module" (about 17 kt total LAr mass) prototyping the designs of most of the detector components at 1:1 scale. The detector elements, the time projection chamber (TPC), the cold electronics, and the Photon Detection System are housed in a membrane cryostat that contains the liquid argon target material. The primary goal of the ProtoDUNE-SP test program at CERN is twofold: at one hand to benchmark and, if found fully adequate, to endorse the main technical solutions for the DUNE far detector components, and at the other one to perform the measurements needed to understand and possibly quantify the systematic uncertainties that will be present in the DUNE oscillation measurements. The latter goal anticipates physics outcomes relevant on their own: the unprecedented event reconstruction capability of the LArTPC technology in a well controlled charged-particle beam test environment can open the way to a deeper understanding the hadron interaction processes and modeling of the physics of intranuclear cascades in nuclei.

Keywords:
DUNE oscillation measurement, ProtoDUNE-SP, LArTPC detector,

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G13.03
2016.10.19 - 2016.10.21

Measuring leptonic CP violation and neutrino mass ordering in long baseline experiments.

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Abstract:

We discuss how to measure the leptonic CP phase and the sign of the atmopheric scale mass--squared difference ⊿m^ 2_{31} in long baseline neutrino oscillation experiments. Some ambiguities in the determinantion of CP phase and mass ordering are considered. We also present physical implications on those measurements from neutrino experiments.

Keywords:

Neutrino, oscillation, leptonic CP, long baseline experiment

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.01
2016.10.19 - 2016.10.21

Dark matter research cluster based on computational science

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Abstract:
Let me introduce the convergence research cluster for dark matter which is supported by National Research Council of Science and Technology in Korea. The goal is to build research cluster of nationwide institutes from accelerator-based physics to astrophysics based on computational science using infrastructures at KISTI (Korea Institute of Science Technology Information) and KASI (Korea Astronomy and Space Science Institute). The key of the computational science, simulation will be discussed.

Keywords:
Dark matter, Computatinal Science, High Energy Physics

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.02
2016.10.19 - 2016.10.21

Study of with conversion of Belle's data to Belle II's data format

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Abstract:
Current world best upper limit of is reported in Satoyama's paper, which use part of Belle's data set. We expect much more data in Belle II, but experiment does not start yet. So, we use conversion of Belle's data to Belle II's data format (B2BII). In this conference, we aim to report status of with B2BII.

Keywords:
Belle, Belle II, leptonic decay, B2BII

Muon identification for CMS upgrade

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Abstract:
The Large Hadron Collider (LHC) has planned upgrades during the second and the third Long Shutdown (LS), which will increase the LHC luminosity to 5x10^34cm−2s−1. Together with ageing and the expected high pile-up conditions, the performance of the CMS muon system is expected to significantly degrade. The muon system will be upgraded to improve the trigger and reconstruction performance and we present the expected muon identification performance.

Keywords:
muon, cms upgrade, identification, cms, lhc

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.04
2016.10.19 - 2016.10.21

Storage Ring EDM Experiment and Polarimeter Development at CAPP/IBS

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Abstract:
Finding a nonzero EDM (electric dipole moment) in a fundamental particle would signal strong CP violation and consequently it could explain the matter/antimatter asymmetry in our universe. The storage ring proton Electric Dipole Moment (pEDM) experiment is an EDM search aiming at a sensitivity level of 10^{-29} e·cm per year using electrostatic dipoles. In this experiment, the stored polarized protons are slowly extracted and scattered off a carbon target. Through the interactions between the polarized protons and unpolarized carbon nuclei, one can measure the integrated spin precession angle which is caused by the strong radial electric field in the storage ring. Polarimeters will record the left/right and up/down (w.r.t. the beam axis) proton hits and the spin precession rate is obtained from the asymmetry information. In this talk, we discuss the significance of EDM search and the storage ring technique as a tool for EDM search. The polarimeter development at CAPP/IBS will also be introduced.

Keywords:
Proton EDM, GEM, Polarimeter

The Test of Low-Energy Muon Beam Profile Monitoring (BPM) System in the J-PARC Muon g-2/EDM Experiment

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Abstract:

For the measurement of the muon anomalous magnetic moment, g-2, the deviation around 3σ from the standard model has been reported since the final report from BNL-E821 was published in April, 2006 (PRD73,072003). This experimental result suggests the possible existence of particles that the standard model can not predict. In order to measure more precise muon g-2 and its electric dipole moment (EDM), a brand-new experiment for muon g-2/EDM is in progress at J-PARC. This experiment requires a new beam line for stopping and re-acceleration of muons which had never been demonstrated. As part of muon beam diagnostics, checking the muon beam profile for each beam line component is essential. The low-energy muon beam profile monitoring (BPM) system is designed to measure the profile of the low energy muon beam. The BPM system was tested with surface muon beam at the J-PARC muon facility on February 28th, 2016. A short overview of the J-PARC muon g-2/EDM experiment and the preliminary analysis results from the test of the BPM system will be presented.

Keywords:
Muon beam profile monitor, Muon g-2/EDM, J-PARC H-line

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.06*
2016.10.19 - 2016.10.21

"J-PARC KOTO실험 샘플링 칼로리미터의 성능 평가"

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Abstract:
일본 J-PARC에서 지난 2013년부터 KL0->pi0 nu nubar 희소 붕괴를 탐색하는 KOTO 실험이 본격적으로 진행중이다. 표준 모형에서 예측하는 이 붕괴 현상의 갈래비는 2.8 +/- 0.4 * 10^-11 으로 매우 작기 때문에 배경 사상의 제거가 중요하다. 따라서, 기존 샘플링 칼로리미터 (Main Barrel)의 배경 사상 제거 효율을 보완하는 새로운 납과 신틸레이터의 샘플링 칼로리미터 (Inner Barrel)를 제작하여 2016년 4월에 설치하였다. 이번 학회에서는 우주선과 중성입자 빔을 이용한 Inner Barrel의 성능 평가 결과를 발표할 예정이다. 특히, 기존 칼로리미터의 경우와 비교하여 시간 분해능의 향상을 중점적으로 설명할 예정이다.

Keywords:
e14 ,KOTO, MB, Inner Barrel, scintillator

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.07*
2016.10.19 - 2016.10.21

Development of TOF detector using plastic scintillators for GBAR experiment

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Abstract:
The goal of the GBAR(Gravitational Behavior of Antihydrogen at Rest) experiment is to measure the gravitational mass of antiparticles. To do so, antihydrogen ions will be produced, trapped and then radiated with laser so that a positron is released, which initiates free fall. One of the most important steps is the measurement of TOF (time-of-flight) by a detector. It detects the signals from antihydrogen annihilation and tells us when and where it takes place. We designed the TOF detector as an array of plastic scintillator bars. To figure out whether the antihydrogen goes up or down, the time information from the detector should have a certain resolution. Thus, we have developed an analysis scheme to improve resolution and achieved satisfactory results.

Keywords:
GBAR, antihydrogen, antihydrogen ion, gravitational mass, time of flight detector, plastic scintillator

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G14.08
2016.10.19 - 2016.10.21

Simulation Study of TOF Detector for the GBAR Experiment

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Abstract:
The time-of-flight(TOF) detector system for the GBAR(Gravitational Behaviour of Antihydrogen at Rest) experiment has been studied with using the GEANT4 simulation code. The TOF detector, an array of plastic scintillator bars, will be used to measure the free fall time of an antihydrogen atom and to reconstruct the position where an antihydrogen annihilates by detecting the particles from the annihilation process. The detector geometry has been optimized to acheive reasonably high efficiency as well as to discriminate real signals from that caused by cosmic rays. Also, we have investigated the required time and position resolution of the detector and the method of the annihilation- point reconstruction.

Keywords:
antihydrogen, anti-matter, GBAR

Development of a Prototype Fast-Timing System with High Resolution for Nuclear Lifetime Measurements

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Abstract:
Recent theoretical predictions for possible variations in nuclear excited states' lifetimes attract much attention. A change in lifetime of the first excited state of ^{133}Cs has been predicted to a few picoseconds level when gamma rays are absorbed and re-emitted from a reflecting material of the ground state of ^{133}Cs. Such a small change in lifetime can only be measured at very low temperature and is triggered by the ^{133}Ba beta-decay followed by gamma-ray transitions from excited states of ^{133}Cs. A prototype fast timing system was developed to measure a short lifetime of the first excited state (5/2+) of ^{133}Cs which is about 6.28 ns. The prototype system consists of two NaI(Tl) detectors and two LaBr3(Ce) detectors. In this talk, timing characteristics of the prototype system will be presented with special emphasis on uncertainties in lifetime measurement. Preliminary design of a full-size fast-timing system will also be discussed.

Keywords:
fast timing system, lifetime of excited state, timing characteristics, uncertainties.

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2016.10.19 - 2016.10.21

Development of multi-purpose separator for low energy RI beam at RAON

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Abstract:

The multi-purpose low energy RI beam separator, named as KoBRA (Korea Broad acceptance Recoil spectrometer and Apparatus), has been developed to address two importance issues in current low energy nuclear physics: (1) production of neutron-rich RI beams with high intensity and (2) direct measurement of radiative capture reactions. For the first issue, in-flight separation employing multi-nucleon transfer reaction is considered as powerful way to produce RI beams with high intensity, but the separator adopting in-flight method in low energy was not fully exploited. For the second issue, on the other hands, a high background rejection capability is the most important virtue of a separator to measure the extremely low cross-section reaction products. Several facilities have been designed or are under construction for this purpose. The multi-purpose low energy RI beam separator, named as KoBRA, has been developed integrating features of two types of facilities at the RAON accelerator complex in Korea. KoBRA has been designed for large angular and momentum acceptances to provide RI beams following multi-nucleon transfer reaction in a range of 20-40 MeV/nucleon. In addition, a Wien filter is employed for high background rejection by high mass separation for direct measurements of radiative capture reactions. Higher order aberrations were successfully minimized using curved-edge boundary bending magnets in both separations of the RI beam and reaction products. The design features and simulation results of the KoBRA facility will be presented.

Keywords:

RI beam, in-flight separator, recoil separator, KoBRA, RAON, multi-neutron transfer reaction, radiative capture reaction

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G15.03*
2016.10.19 - 2016.10.21

Development of a TPC trigger hodoscope for the H-dibaryon search experiment E42 at J-PARC

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Abstract:

The E42 experiment aims at searching for the six-quark H-dibaryon state in the mass region near $\Lambda\Lambda$ threshold via (K , K+) reactions at J-PARC. A time projection chamber (HypTPC) is placed in the superconducting dipole magnet. The HypTPC is then surrounded by the trigger hodoscope with 32 plastic scintillators. Each scintillator will be read out with MPPCs at both ends. In this talk performance test results of a prototype hodoscope will be presented and the design of a full-size TPC hodoscope will also be discussed.

Keywords:
E42,J-PARC,TPC,hodoscope

Metallic Magnetic Calorimeter optimization for small light detectors for rare event search experiments

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Abstract:
We report on the optimization of Metallic Magnetic Calorimeters (MMCs) used for small light detectors operating at millikelvin temperature. These light detectors are to be used for phonon-scintillation detection using a scintillating crystal for rare event search experiments. The light detectors are typically composed of a 2-inch wafer as an absorber for scintillation light from a crystal and an MMC as its sensor in thermal contact with a phonon collection film on the wafer. The light detectors can be optimized to produce large signal size for distinguishing low energy events. Since the signal size from the detector depends upon the heat capacity of the light detector, the optimally small dimension of the phonon collection film along with optimized MMC can produce large signal size. We developed different sizes of meander-shaped MMCs for the largest signal size used for the small light detector. The optimization includes input couplings and inductances of current measuring SQUIDs which are required for meander-shaped MMCs. MMCs with several different sizes of meander coils have been fabricated and tested with a SQUID setup. The measured inductances of the meander coils are in a good agreement with expected values. We also discuss the expected signal size using the newly designed MMC together with a matching SQUID.

Keywords:
MMC, low temperature detector, light detector, rare event search experiment

양성자 빔을 이용한 Zr의 생성단면적 측정

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Abstract:
Zr의 양성자 유도 핵반응으로부터 생성되는 방사성핵종의 생성단면적은 경주 양성자가속기의 57 MeV 양성자 에너지를 이용하여 적층호일 방사화 방법에 의해 측정되었다. 방사화된 표적에서 방출되는 감마선은 고 분해능 감마선 검출기에 의해 측정되었으며, 다수의 표준 감마선원이 검출효율 측정을 위해 사용되었다. 양성자 플럭스는 Cu 모니터 핵반응에 의해 결정되었으며, 각 표적의 양성자 에너지는 SRIM 코드를 이용하여 계산하였다. 측정한 실험 데이터는 기존 문헌의 실험값 및 TENDL-2015의 이론적 데이터와 비교하였다. Zr의 양성자 유도 핵반응의 단면적 자료는 핵반응 모델 개선과 가속기 및 산업 등에 이용되며, 특히 치료와 진단에 사용되는 방사성동위원소 생산에 유용한 정보를 제공한다.

Keywords:
Zr, 양성자 유도 핵반응, 적층호일 방사화 방법

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G15.06
2016.10.19 - 2016.10.21

A radio-purity assay program with an alpha particle counter at the Yangyang underground laboratory.

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Abstract:
An argon gas ionization chamber at the Yangyang underground laboratory has been used to assay radio-purity of materials to be used in rare decay experiments including the KIMS dark matter experiment and the AMoRE double beta decay experiment. Measurements of ultra-low activities at the level of 0.0001 counts/hour/cm2 in the samples for the Po-210 alpha decays are discussed in this presentation.

Keywords:
alpha decay, ionization chamber

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G15.07
2016.10.19 - 2016.10.21

An upgrade of a silicon PIN photodiode based radon detector for underground experiments environment.

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Abstract:

It is important to monitor the amount of radon in the underground laboratory where rare decay and dark matter experiments are taking place. The radioactivity from the radon (Rn-222) can be a significant background source to the experiments and need to be measured precisely for a systematic study. We have been working on an upgrade of a radon detector used in the KIMS (Korean Invisible Matter Search) experiment by replacing with a Hamamatsu silicon PIN photodiode and a Hamamatsu pre-amplifier. The radon's daughter particles (Po-214 and Po-218 mostly) produced in the air of the detector chamber are positively charged and being collected by the photodiode in a negative high voltage. Those alphas emitted from the decays of the daughter particles are losing energies directly in the photodiode and give very clean signals to be be identified. The design and performance of the upgraded radon detector are going to be presented.

Keywords:

radon, silicon diode, alpha decay, underground, environment

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G15.08
2016.10.19 - 2016.10.21

Test and simulation results of prototype CsI detector for LAMPS at RAON

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Abstract:

Rare isotope heavy ion beams provided by RAON will play an important role for the study of the nuclear symmetry energy at sub-saturation densities. According to the conceptual design of Large Acceptance Multi-Purpose Spectrometer (LAMPS), Si-CsI is designed for identifying particles produced in the nucleus-nucleus collisions . Specially the CsI detector in the Si-CsI system will be used for depositing the full energy of charged particles and gammas from the collisions. In order to investigate the performance of the CsI detector, we performed the GEANT4 simulation and tested the prototype detector with various radioactive sources. In this presentation, we summarize the results of the simulation and the results of tests

Keywords:

RAON, LAMPS, nuclear symmetry energy,CsI detector, GEANT4 simulation

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 G15.09
2016.10.19 - 2016.10.21

Development of the gamma ray tracking system in KRISS

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Abstract:

The gamma ray traking system was developing in KRISS. The simulated signal was calculated by using shockey-ramo theorem. The weighting potetial was calculated by the Elemr and charge path was calculated by the paraview. The claculated signal and real one was compared and gave the uncertainty of several milimeters. This scattering events would be used for imagging of the source.

Keywords:
gamma ray tracking, segmented HPGe detector, shockey-ramo theorem

Sequencing everything on Earth: Genome Reading/Sequencing technology

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Abstract:
Genome sequencing is the starting point of genomics. There are numerous sequencing methods. The Sanger method is the first and efficient DNA sequencing method. Presently, new technologies called NGS (next generation sequencers) are available. They are much different from each other in terms of sequence length and accuracy. Although sequencing technologies are mature in many ways and the cost is extremely low per base, still sequencing technologies are far away from routine use of sequencers for personal genomes. New technologies are necessary to sequence all the humans (over 7 billion people) and every living organism on Earth. I discuss possible strategy to sequence everything on Earth.

Keywords:
sequencing, genomics, genome

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H1.02
2016.10.19 - 2016.10.21

Visualization of Large Elongated DNA Molecules

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Abstract:

Long and linear DNA molecules are the mainstream single-molecule analytes for a variety of biochemical analysis within microfluidic devices, including functionalized surfaces and nanostructures. However, for biochemical analysis, large DNA molecules have to be unraveled, elongated, and visualized to obtain biochemical and genomic information. To date, elongated DNA molecules have been exploited in the development of a number of genome analysis systems as well as for the study of polymer physics due to the advantage of direct visualization of single DNA molecule. Moreover, each single DNA molecule provides individual information, which makes it useful for stochastic event analysis. Therefore, numerous studies of enzymatic random motions have been performed on a large elongated DNA molecule. In this presentation, I will introduce mechanisms to elongate DNA molecules using microfluidics and nanostructures. Secondly, I will discuss how elongated DNA molecules have been utilized to obtain biochemical and genomic information by direct visualization of DNA molecules. More specifically, I will introduce novel fluorescent protein DNA binding peptides to safely and reversibly stain DNA backbones. Finally, I will explain the visualization of DNA damage on large elongated DNA molecules.

Keywords:

Genomic DNA Molecule, FP-DBP, Nano/microfluidics

Biophysical Studies of DNA-DNA Attraction and the Chromosome Organization

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Abstract:

The chromosome spends most of its lifetime in the interphase in which it is only loosely condensed and hence viewed as a dynamic polymer. The physical properties of DNA in vitro have been rigorously studied but its structural organization in a living cell and the role of such structure in epigenetics have only started to be explored, leaving the physical mechanism behind largely unknown. In this talk, I will present our recent efforts spanning molecular dynamics simulations, single molecule experiments, and live cell visualization of the chromosome. From the molecular level studies, we suggest that polycation-driven electrostatic inter-DNA attraction might play a crucial role in determining the overall condensed structure of DNA. We found that the C5 methyl group of thymines, which methylated cytosines also have, induces sequence-dependent attraction between double stranded DNAs. Such behavior is consistent with the large scale structure of chromosomes from Hi-C measurements and the observed compactness of hyper-methylated chromosomes. Visualization of live chromosome dynamics will further reveal the physical mechanism of regulating chromosome structure and dynamics.

Keywords:
Chromosome, DNA, Polyamine, Epigenetics

Evaluation of Optical Heterodyne Detection System and Phase Control Loop Bandwidth by Introducing External Phase Noise

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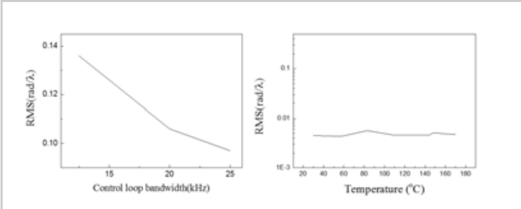
Abstract:



To make a high power laser, Coherent Beam Combining(CBC) technique have been studied. The key point of CBC technique is phase macthing coherently of each channel by phase modulation. Previously, Steven J. Augst evaluated the performance of phase locking system under mechanical noise generated in the phase macthing system. In our research, by applying external phase disturbance into the phase locking system, we evaluated quantitatively the phase control loop bandwidth and estimate the phase locking capability as well as thermal stability.

Keywords:
Laser beam combining, Phase measurement, Heterodyne.

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MgO:PPSLT를 이용한 이터븀 광섬유 레이저의 효율적인 고출력 녹색 레이저 변환

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Abstract:
고출력의 녹색 레이저는 가공, 레이저 디스플레이, 분광기, 군사, 환경 분야 등 다양한 분야에서 사용되고 있다. 녹색 레이저빔을 얻는 방법은 InGaAs 반도체 레이저로부터 직접 얻거나, GaN 다이오드 레이저로 프라세디뮴 도핑 레이저 물질을 펌핑하여 녹색 레이저빔을 발진시키는 것이 가장 쉽지만 저효율, 저출력, 낮은 레이저 손상치 등의 문제가 있다. 현재 가장 많이 이용되는 방법은 비선형 광학 단결정을 이용하여 근적외선레이저빔을 주파수 변환 시켜 얻는 것이다. 일반적으로 주파수 변환 효율은 입사되는 레이저빔의 첨두 출력의 제곱에 비례하는데, 연속 발진 레이저의 경우 낮은 첨두 출력으로 인해 변환 효율이 낮아 고출력 녹색 레이저빔을 얻기 어려운 문제점이 있다. 이를 해결하기 위해 내부공진기 변환 구조, MOPA 구조 등 여러 가지 방법이 사용되고 있는데, 최근 많이 사용되는 방법이 광섬유 레이저와 비선형 광학 계수가 큰 주기반전 비선형 광학 결정을 사용하는 것이다. 특히 광섬유 레이저는 우수한 구조적 특성으로 인해 간단한 구조에서 기존의 고체 레이저의 한계를 훌쩍 뛰어넘는 고출력 연속발진 레이저빔을 생성할 수 있어 단일 패스 주파수 변환 방법에 가장 적합한 방법으로 알려져 있다. 본 발표에서는 Yb 도핑 광섬유 레이저와 MgO:PPSLT를 사용하여 고출력 녹색 레이저빔을 얻은 실험 결과를 보고하고자 한다. Yb 도핑 PM 광섬유를 이득 매질로 사용하고 모든 시스템이 광섬유로 이루어진 1064 nm 발진 고출력 광섬유 MOPA 레이저 시스템을 구축한 다음, 생성된 고출력 편광 레이저빔을 주기 반전 MgO:PPSLT 비선형 광학 단결정에 입사시켰다. 그리고 고출력 레이저빔 입사시 비선형 광학 결정에서 열적 위상 변화로 인한 변환 효율의 감소를 막기 위해 쌍방향 주파수 변환 시스템을 구축하였다. Yb 광섬유 레이저 MOPA 시스템의 출력 특성, 시스템 외부 조건에 따른 녹색 레이저빔의 출력 및 변환 효율과 함께 >5 W급 532 nm 녹색 레이저빔을 생성에 대해 보고할 것이다.

Keywords:
주파수변환, MgO:PPSLT, 녹색레이저, 준위상정합

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Angle-resolved far-field scattering spectra of single Ag nanowire over the entire semi-meridian

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Abstract:
Scattering properties of a plasmonic nanowire have been investigated through dark-field microscopy, back-focal plane imaging and so on. Surface plasmon polaritons (SPPs) supported by the metallic nanowire have a large wavevector and cause strong scattering radiations to the direction of a large angle even beyond the numerical aperture (N.A.) of the microscope objective employed in the conventional methods. To overcome this limitation and obtain the full information of scattering characteristics, we directly measured far-field scattering spectra of a single Ag nanowire over the entire semi-meridian with varying detection angle. SPPs of the nanowire on a coverslip are excited by white-light illumination focused on one end of the nanowire by an objective. The detection part, 0.23 m distant from the nanowire, scans the entire northern semi-meridian with an angular resolution of 2 degrees and collects scattering radiations into an optical fiber attached to a spectrometer. Beyond the N.A. of the focusing objective, purely scattered signal is detected, while, within the N.A., the extinction by the nanowire is observed. The angle-resolved scattering spectra reveal that the far-field scattering pattern of the nanowire carries two features of the near-field: Fabry-Perot resonances of SPPs propagating along the nanowire and phase-matching conditions between SPPs and free-propagating radiation depending on the emission angle and wavelength. The dispersion relation of SPPs can also be precisely retrieved, since the resolved angle corresponds to the wavevector. We believe that the study on the angle-resolved far-field scattering spectra will be useful to understand scattering characteristics of a desired optical nanostructure.

Keywords:
Surface plasmon, nanowire, far-field

CMOS 이미지 센서를 사용한 레이저-플라즈마 가속 양성자빔의 실시간 에너지 측정

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Abstract:
레이저-플라즈마 상호작용에 의해 가속된 양성자빔의 에너지 스펙트럼은 일반적으로 CR-39(Columbia Resin #39) 플라스틱을 사용하여 측정한다. 이는 적은 수의 입자를 보다 정확하게 계수할 수 있다는 장점이 있지만 실험과 별도로 가속된 양성자빔에 노출된 CR-39 플라스틱을 일정시간 식각하고 현미경으로 분석하는 작업이 필요하기 때문에 측정에서 데이터 분석까지 상당한 시간이 소요된다. 본 연구에서는 CMOS(Complementary metal-oxide-semiconductor) 이미지센서 기반 방사선 영상검출기(Teledyne DALSA사의 RadEye1)를 이용하여 레이저-플라즈마 가속 양성자빔의 에너지 스펙트럼을 실시간으로 측정하였다. 기존에 검출기로 사용하였던 CR-39 플라스틱을 이용한 보정작업을 통하여 가속 양성자의 입자개수 대비 이미지센서의 이미지 밝기 보정값을 얻었다. 이미지센서 보정값의 재현성과 정확도에 대한 평가를 통하여 실시간 양성자 에너지 측정기술의 적용범위를 제시하고자 한다.

Keywords:
CMOS 이미지 센서, 레이저-플라즈마 가속, 양성자 가속, 실시간 에너지 측정

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내부 공진기형 파장변환 고출력 녹색 레이저 시스템 개발

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Abstract:
가시광 영역의 고출력 레이저빔은 산업, 디스플레이, 군사, 의료 등 다양한 분야에서 요구되고 있으며 많은 현장에서 이미 사용되고 있다. 이를 얻기 위해 비선형 광학 단결정을 사용하여 근적외선 레이저빔을 파장 변환하는 방식이 가장 많이 알려져 있는데 그 중 내부 공진기형 다이오드 레이저 종 펌핑 고체 레이저 시스템은 파장 변환의 고효율, 시스템 간소성으로 인해 연속 발진 가시광 레이저빔을 얻기 위해 가장 널리 사용되고 있다. 하지만 종 펌핑 고체 레이저 시스템은 고출력 발진시 발생하는 열렌즈 효과로 인해 공진 조건이 불안해져 출력 및 변환 효율의 한계가 있으므로 고출력 레이저빔을 얻기 위해선 이를 반드시 해결해야 한다. 본 연구에서는 내부 공진기형 고체 레이저 시스템에서 고출력 녹색 레이저빔을 얻기 위한 연구를 수행하였다. 레이저 물질로는 Nd:YVO4 레이저 결정, 파장 변환 결정은 LBO를 사용하였고, 펌핑 광원으로 880 nm 다이오드 레이저를 사용하여 열렌즈의 원인인 양자 결함으로 발생하는 열을 줄였다. 또한 다양한 형태의 공진기 시스템을 설계, 테스트하여 공진 한계가 높으면서 비선형 광학 결정의 파장 효율이 극대화된 공진기 시스템을 구축하였다. 그 결과 532 nm 파장에서 >5 W의 녹색 레이저빔을 단일 공진기 레이저 시스템에서 획득하였으며 펌핑 에너지 대비 변환 효율은 26.44% 로 매우 높음을 확인하였다. 본 발표에서는 설계한 다양한 공진기별 실험 결과, 최종 녹색 레이저빔의 빔질 및 안정도 및 향후 출력 증강에 대해 보고할 것이다. 이 논문은 경찰청과 치안과학기술연구개발사업단의 지원을 받아 수행된 치안과학기술연구개발사업임. (PA-B000001)

Keywords:
Second-Harmonic Generation, Frequency-doubling, Intracavity SHG, Green Laser, LBO, Nd:YVO4 Laser

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Boron Nitride Nanostructure Synthesis and Electronic applications

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Abstract:
White graphene (hexagonal boron nitride, h-BN) is an analogue of graphene in which one carbon atom forms sp^2 hybridized bonding with three other carbon atoms. Here, a boron atom forms sp^2 hybridized bonding with three nitrogen atoms, and a nitrogen atom bonds with three boron atoms in the honeycomb structure of h-BN. Its exceptional properties, such as superb oxidation resistance at 800° C, excellent chemical resistance to acid, high thermal conductivity, and superior elastic modulus, are advantageous for a wide range of applications, especially for graphene electric devices, ultraviolet-light emitters, protective coating materials, and composites. Here, the synthetic method (CVD, and annealing) of h-BN on metal catalyst substrates and kinetic study of such method will be presented and discussed including its applications as a support layer for a graphene transistor. Additionally, 1D form of BN, BNNT (boron nitride nanotube) synthesis by high temperature laser and plasma will be introduced including its future applications.

Keywords:
boron nitride, h-BN, BNNT, synthesis, electronic properties

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그래핀 양자점에서 산소 기능기(에폭시기)가 가시 광 방출에 미치는 영향에 대한 연구

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Abstract:
그래핀 양자점은 탄소 한 개 원자층으로 구성된 그래핀의 직경을 나노 스케일로 줄여 제작되며, 그래핀양자점에서 가시 광 방출 현상이 확인되면서 새롭게 조명 받고 있다. 그래핀 양자점의 제작과정에서 표면에 결합 된 산소기능기에 의해, 그래핀 양자점의 발광 효율, 발광 파장 등 다양한 요소들이 큰 영향을 받게 된다. [1, 2] 따라서, 그래핀 양자점의 다양한 응용 및 활용을 위해, 산소 기능기가 그래핀 양자점의 물성에 미치는 영향을 이해하고 조절하는 것이 중요하다. 그러나, 이를 확인하고자 하는 실험적 접근은 여전히 미미한 수준이다. 본 연구에서는 그래핀 양자점에 결합된 대표적인 산소 기능기 중 하나인 에폭시기 (O-C-O)가 가시 광 방출에 미치는 영향을 실험적인 방법을 통해 확인하였다. 에폭시기를 조절하기 위해 올레일아민 (oleylamine)을 낮은 반응 온도에서 선택적으로 결합시키는 방법을 활용하였다. [3] 에폭시기에 올레일아민을 결합시킨 후, 그래핀 양자점의 발광에서 두 가지 변화가 나타나는 것을 확인하였다. 먼저, 260 nm 여기 광에 의해서 방출되는 490 nm의 가시 광을 확인하였다. 또한, 전반적인 발광이 적색 천이가 일어나는 것을 확인 할 수 있었다. 높은 시간 분해능을 가지는 측정을 통해 그래핀 양자점의 재결합 시간을 측정 하였다. 또한 실험적 결과를 이해하고자 시뮬레이션 계산을 적용함으로써 그래핀 양자점에서 나타난 변화 현상을 해석하였다. 이는 440 nm 발광 원인인 에폭시기에 둘러쌓인 sp^2 탄소 도메인의 감소 및 크기 증가에 의한 현상으로 고려 할 수 있다. 그 결과 본 연구에서 확인하고자 하였던 에폭시기의 기능은 그래핀 양자점의 전체 발광에서 청색 발광의 원인인 sp2 탄소 도메인을 형성하는 것임을 확인 할 수 있었다.

Keywords:
그래핀 양자점, 에폭시기, 광 방출, 산소 기능기

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Increased Quantum Yield of Atomically Thin Semiconductors by Silver Nanowires

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Abstract:
Recently, an atomically thin semiconductors are the most promising materials in optoelectronic field. Among them, especially transition metal dichalcogenides (TMDCs) have direct band gap and broad absorption range from ultraviolet to infra-red regions. However, because of its low quantum yield, it is difficult to applicate to optoelectronic devices such as photodetector and light emitting diode (LED). So, many researchers have studied for increasing their quantum yield with doping, free-standing and light-matter coupling by nanostructures of novel metal. In this work, we increased quantum yield of an atomically thin semiconductors which are kind of TMDCs, using silver nanowire networks (Ag NWs). We confirmed strong plasmonic electric field in silver nanowire networks from its dark field scattering. And then, we succeeded to increase more over 100 times intensity of PL and photocurrent using coupling of between exciton of MoS2 and plasmonic resonance of Ag NWs.

Keywords:
Quantum Yield, TMDCs, excition-plasmon couping, AgNWs

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2016.10.19 - 2016.10.21

ZnO-based piezo/triboelectric nanogenerators with surface-modified polydimethylsiloxane for thread-based energy harvester

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Abstract:

Piezoelectric and triboelectric nanogenerators (PENG/TENGs) using a combination of mechanical energy and electrostatic induction has gotten a spotlight among various energy harvesting devices due to its stability, high-efficiency and low cost. While ZnO nanowires shows good piezoelectric properties, we fabricated Li-doped ZnO nanowire-based flexible PENGs. Flexible TENGs was also prepared with metal layer and polydimethylsiloxane (PDMS) layer coated onto elastic PET substrates. Rough PDMS surfaces by coating PDMS layer on top of ZnO nanowires were developed by diluting PDMS base solution for thinning PDMS film on ZnO nanowires. In addition, surface-modified PDMS was obtained by using oxygen plasma treatment. Furthermore, we fabricated a yarn-based flexible NGs to utilize wearable energy harvesting devices and attached them to various parts of human skin such as fingertip, wrist and elbow.

Keywords:

ZnO nanostructures, PDMS, tribo/piezoelectricenergy harvester

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2016.10.19 - 2016.10.21

Nanostructured ZnO frame Synthesis via Aqueous Solution Method for Wearable Energy Harvesting Device

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Abstract:

We present the performance of nanostructured zinc oxide (ZnO)-based energy harvesting devices utilizing hybrid piezoelectric and triboelectric effects as a self-powered system. A hydrothermal routine based on all solution phase synthesis is adapted. Vertically long and well-aligned ZnO nanowires are prepared by adding polymer and polyethyleneimine (PEI) during hydrothermal process. In particular, the density of ZnO nanostructure is intentionally controlled by changing the precursor molecular concentration to form hierarchical branched ZnO nanostructures through removal of polymer and coated-nanoparticles. The piezo-/tribo- electric effect is well identified from the nanogenerators developed by various ZnO nanostructured morphologies. In addition, we develop a hybrid piezoelectric and triboelectric nanogenerator based on thread substrate in order to form wearable devices driven by human motion like stretching, folding, and pressing by using ZnO material properties and their surface-structures.

Keywords:

ZnO nanostructure, Branch, Energy Harvesting, Piezoelectric, Triboelectric

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Effect of Impurities Concentration on the Thermoelectric Properties of GaTe Single Crystals

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Abstract:

Layered semiconductors have always attracted much interests from researchers due to their anisotropic properties, resulting from strong covalent bonding in the layer planes and weak-van- der-Waals-type bonding between them. Gallium telluride (GaTe) is a wide band gap layered chalcogenide semiconductor, which has great potential uses in the optoelectronic devices, radiation detectors, and solar cells, etc. GaTe has a monoclinic layered structure with the C2/m space group symmetry in which only two thirds of the Ga-Ga bonds are perpendicular to the layer planes and the others are in the layer plane. This dissymmetry rises the strong scattering of the charge carriers by optical phonon polarized perpendicular to the layers, so thermal conductivity of GaTe is lower than another chalcogenide compounds. ZT is a strongly internally contradictory transport property, which requires a combination of a large thermoelectric power, low thermal conductivity, and low electrical resistivity. According to the study of S. Pal and D.N. Bose, thermoelectric power of GaTe single crystal was 873 mV/K in the layer and 1233 mV/K in the perpendicular direction at 300 K. This is much higher than many chalcogenide semiconductors. However, most reports are focused on studying the crystal structure, the photoconductivity, photoluminescence characterization, Raman spectra, electrical resistivity, Hall effect and also thermoelectric power. Less information was reported on thermoelectric properties of pure and doped GaTe single crystals. In this work, the effect of impurity concentration on the thermoelectric properties of GaTe single crystals are carried out in the temperature range 20 - 800 K, which will be discussed in more detail.

Keywords:
Gallium telluride, single crystal, thermoelectric, wide band gap, effect of impurities

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$NaYF_4$ upconverting nanoparticles based non-invasive temperature sensor and optical heater

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Abstract:
Temperature is a basic and vital parameter in various fields of medical science, industry and daily life. For this reason, accurate measurement and monitoring of temperature is very important. Up to date, the non-contact optical temperature sensor based on upconversion emission of the rare-earth ions doped luminescent materials using a fluorescence intensity ratio technique has gained considerable interest due its advantages of real-time detection, high sensitivity and high spatial resolution. Although some impressive results have been obtained in optical temperatures, most of them can only be operated in high temperature environment, indicating that the low- and high-temperature measurement can not be synchronously realized in these temperature sensors. To figure out this drawback, searching for a novel optical temperature sensor that can be operated in a wide temperature range is necessary. In this presentation, the rare-earth ions doped $NaYF_4$ upconverting nanoparticles were synthesized via a conventional hydrothermal method. Under 980 nm light excitation, the as-prepared nanoparticles exhibited the characteristic emissions of Er^{3+} ions. The temperature sensing behaviors were systematically studied by analyzing the temperature-dependent upconversion. Ultimately, to confirm the promising application of the $NaYF_4$ based upconverting nanoparticles in optical heater, the internal heating properties induced by the laser excitation power was investigated.

Keywords:
up-conversion, temperature sensor, optical heater

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Current-controlled magnetization using interfacial localizations in complex oxide heterostructure

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Abstract:

An electrical manipulation of magnetism has been an exciting research area due to its better efficiency than control by magnetic field as a promising application for the potential of magnetic data storage, ferromagnetic resonance device and spintronics. For ferromagnetic metal and semiconductors, plenty of approaches are tried to achieve the efficient electrical manipulation of magnetism. Examples include from conventional methods using electric-current induced magnetic fields to external electric field and voltage pulse allowing change in magnetic anisotropy, Curie temperature, and surface charge. Recently, accompanied with fascinating developments of ultra-thin and epitaxial growth techniques, a choice of materials for the magnetic devices has been broader. The complex oxide offers huge changes in magnetism via electrical manipulations since it has strong correlations between spin, charge, orbital degrees of freedoms. There are several interesting examples of electrical control of magnetism; multiferroic materials using magnetoelectric coupling, heterostructure composed of ferromagnetic and ferroelectric layers using interfacial exchange bias, bilayer of piezoelectric and ferromagnetic layer mediated by interfacial strain, and superlattice exhibiting magnetoelectric behavior but sole composed of non-ferroic layers using interfacial charge transfer and lattice distortion. As shown in the above examples, the interface between dissimilar layers is a kind of reservoir containing various and emergent phenomena. For example, a tunnel magnetoresistance (TMR) structure, an insulating layer sandwiched by two ferromagnetic (FM) metallic layers, [$SrRuO_3$/manganite/$SrRuO_3$], exhibited a large coercive field since a charge transport at the interface between FM $SrRuO_3$ and insulating manganite induces a FM behavior in the antiferromagnetic (AFM) manganite layer and a pinning effect in the AFM layer. The strength and direction of the interfacial FM depended on substrate and valence states of buried antiferromagnetic layer. The above mentioned behaviors happen below Curie temperature of ferromagnetic $SrRuO_3$. Further below the Curie temperature, here, we found current-dependent coercivity manipulated by cross weak localization (WL) to weak anti-localization (WAL) behaviors. We propose a new mechanism for interface-based control of magnetism in complex oxides which is based on tuning interfacial localizations by applying a current.

Keywords:
current control, magnetism, weak localization,

Antiferromagnetic Domain Wall Motion Driven by Spin-Orbit Torques

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Abstract:

We theoretically investigate the dynamics of antiferromagnetic domain walls driven by spin-orbit torques in antiferromagnet-heavy-metal bilayers [1]. We show that spin-orbit torques drive antiferromagnetic domain walls much faster than ferromagnetic domain walls. As the domain wall velocity approaches the maximum spin-wave group velocity, the domain wall undergoes Lorentz contraction and emits spin waves in the terahertz frequency range. The interplay between spin-orbit torques and the relativistic dynamics of antiferromagnetic domain walls leads to the efficient manipulation of antiferromagnetic spin textures and paves the way for the generation of high frequency signals from antiferromagnets. [1] T. Shiino et al., Phys. Rev. Lett. 117, 087203 (2016).

Keywords:

Magnetism, Spintronics, Antiferromagnet, Domain wall,Spin-Orbit transfer torque,Spin wave

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Spin-orbit-torque features in W/CoFeB/MgO frames by thermal treatment

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Abstract:

Magnetic switching induced by in-plane current in heavy metal (HM)/ferromagnet (FM) frames has recently been the focus as a novel magnetization switching mechanism due to low power consumption and fast switching speed [1,2]. The Rashba or spin Hall effect were considered for underlying physics to generate SOT [3]. In addition, the recent work by X. Qiu [4] addressed a new mechanism of spin-orbit torque associated with the oxidation states. Here, we examine the current-induced spin orbit torque field in W/CoFeB/MgO frames after various post-annealing temperatures. The SOT features are systematically discussed by various atomic states and distribution, especially oxygen bonding states with Co and Fe upon annealing temperatures.
References Liu, L. Q. et al. Spin-torque switching with the giant spin Hall effect of tantalum. Science 336 (2012) 555-558. Miron, I. M. et al. Perpendicular switching of a single ferromagnetic layer induced by in-plane current injection. Nature 476 (2011) 189-193. Kim, J. et al. Layer thickness dependence of the current-induced effective field vector in Ta/CoFeB/MgO. Nature Mater. 12 (2013) 240-245 Qiu. X. et al. Spin-orbit-torque engineering via oxygen manipulation. Nature nanotech. 10 (2015) 333-338

Keywords:
Spin Orbit Torque; Tungsten; Annealing temperature

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저마늄(Germanium)기판 위에 제작된 $MgO/Co_{40}Fe_{40}B_{20}$ 스핀 터널 컨택의 결정 구조와 스핀 축적간 상관관계에 대한 연구

이수길[1], 김상훈[2], 손장엽[1], 차종인[1], 사친 파닥(Sachin Pathak)[1], 홍종일[*1]
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Abstract:
최근 스핀트로닉스(spintronics)를 기반으로 하는 미래 소자들이 물리학과 공학분야의 연구자들에게 많은 각광을 받고 있다. [1] 제안된 새로운 소자들은 기존의 전자소자들에 비해 고속 동작 특성, 적은 소비 전력, 비 휘발성 등을 달성할 수 있을 것으로 기대되는데, 그 이유는 전자의 전하만을 이용했던 기존 소자와 다르게 전자의 "스핀"을 이용하는 것을 기본으로 하기 때문이다. 페르미 준위(Fermi level)에서 스핀 분극(spin polarization)이 존재하는 강자성체(ferromagnet)로부터 비강자성체로 전자의 스핀을 주입해서 발생시킨 "스핀 전류"는 이러한 소자들을 작동시키는 핵심 개념이다. 따라서 상기 언급한 소자들의 개발을 위해서는 높은 스핀 분극을 갖는 효율적인 스핀 주입기를 연구하는 것이 선행되어야 한다. [2] 본 연구에서는 스핀 분극율이 큰 것으로 알려진 $MgO/Co_{40}Fe_{40}B_{20}$ (CFB) 스핀 터널 컨택(혹은 스핀 주입기)을 이용해서 표면이 (001)면인 n형 Ge 기판으로 스핀 주입효율을 향상시키는 연구를 진행했다. 시편은 5×10^{-9} Torr의 기본진공(base pressure)을 갖는 초고진공 스퍼터링 시스템을 이용해 증착했으며 three-terminal Hanle (TTH) 측정을 위한 소자는 포토리소그래피와 Ar 이온 밀링법을 이용해서 리프트 오프(lift-off)법으로 제작했다. 준비된 스핀주입기의 결정성을 분석하기 위해 엑스선 회절기(X-ray diffractometer)와 투과전자현미경(transmission electron microscope)을 이용한 실험을 진행했다. 상기 제작된 소자에서 스핀 주입 실험은 TTH 측정법을 통해 관찰 했으며 이를 관찰하기 위해 연구실에서 제작한 저온 전자기 측정기와 physical property measurement system (PPMS)을 이용했다. 이론적으로 거의 반금속(half-metal)에 가까운 스핀분극율이 얻어진다고 알려진 MgO(001)[110]/체심입방(body-centered cubic) 강자성체 (001)[100] 구조[3]를 제작하기 위해 MgO와 CFB의 결정성을 다양한 방법으로 조절했다. 먼저 6Å의 두께를 갖는 얇은 Mg 박막을 n형 Ge(001)기판과 MgO사이에 삽입해서 MgO 터널배리어의 (001) 텍스처(texture)를 증가시켰다. 그 위에 스퍼터링으로 증착된 비정질 CFB을 후속 열처리함에 따라 타나나는 에피 성장(epitaxial growth) 역시 투과 전자 현미경을 이용해 관찰했다. 이를 통해 밝혀낸 두 인접한 박막사이의 에피 관계(epitaxial relationship)는 MgO(001)[110]/CFB(001)[100]로써 이는 상기 언급한 높은 스핀분극율을 가진다고 밝혀진 구조와 정확히 일치한다. 상기 박막들을 이용해 제작된 모든 소자들에서 스핀주입신호가 성공적으로 검출되었다. Mg 층의 삽입여부와 열처리 온도에 따라 여러 결정성을 갖는 소자들, 즉 스핀분극율이 다를 것으로 예측되는 소자들을 이용해서 그것이 스핀주입신호에 미치는 변화를 조사했다. 그 결과 Mg층을 삽입해서 만들어진 최고의 스핀분극율을 가질 것으로 예상되는 소자의 스핀주입신호가 Mg를 삽입하지 않은 소자에서 얻어진 값에 비해 2.7배가량 증가함을 알아냈다. 이러한 모든 결과들을 종합해 볼 때 MgO/CFB 스핀 주입기의 스핀분극율 증가를 통해 n형 Ge으로의 스핀주입효율을 향상시키는 것이 가능하다고 판단된다. [4,5] 이 결론은 본 연구에서 이용된 n형 Ge기판이나 MgO/CFB스핀 터널 컨택 같은 특정 재료에 국한되지 않고 다른 스핀주입 제어실험에도 동일하게 적용될 수 있을 것이라 사료된다. [1] S. Wolf, D. Awschalom, R. Buhrman, J. Daughton, S. Von Molnar, M. Roukes, A. Y. Chtchelkanova and D. Treger, Science 294, 1488 (2001) [2] R. Jansen, S. P. Dash, S. Sharma and B. C. Min, Semicon. Science and Tech. 27, 083001 (2012) [3] W. Butler, X.-G. Zhang, T. Schulthess and J. MacLaren, Phys. Rev. B 63, 054416 (2001) [4] S. Lee, S. Kim, J. Son, S.-h. C. Baek, S.-H. Lee and J. Hong, Appl. Phys. Express 9, 043005 (2016) [5] S. Lee, S. Kim, J. Son, S. Pathak, and J. Hong, Jpn. J. Appl. Phys. 55, 090303 (2016)

Keywords:
spin injection, tunnel-spin polarization, epitaxial growth

Layer-number-dependent atomic scale imaging of black phosphorus and its structural transformation

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Abstract:

Black phosphorus (BP) has recently emerged as an alternative two-dimensional semiconductor owing to its fascinating electronic properties such as tunable bandgap (2.2 eV for monolayer phosphorene and 0.3 eV for bulk BP) and high charge carrier mobility. The structural investigation of few-layer black phosphorus, such as identification of layer thickness and atomic-scale edge structure, is of great importance to fully understand its electronic and optical properties. Here we report atomic-scale analysis of few-layered BP performed by aberration corrected transmission electron microscopy (TEM). We establish the layer-number-dependent atomic resolution imaging of few-layer BP via TEM imaging and image simulations. Moreover, in the range of 3~9 layer thickness of BP flakes, we find that the optical transmittance reduces 3.3% per layer. The structural modification induced by the electron beam leads to revelation of crystalline edge and formation of BP nanoribbons and nano-chain. Our study on the precise identification of BP thickness and atomic-resolution imaging of edge structures will lay the groundwork for investigation of few-layer BP, especially BP in nanostructured forms. -We acknowledge support from Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2014R1A1A2058178).

Keywords:

Black phosphorus, phosphorene, Nanoribbon, edge structure, Transmission electron microscopy

Substrate-dependent degradation of black phosphorus

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Abstract:

Black phosphorus (BP) is an emerging two-dimensional layered material owing to its fascinating properties such as highly tunable bandgap and high charge carrier mobility. One of the major issues for BP application is its degradation under ambient exposure. In this research we systematically study the substrate effects on BP degradation. Optical microscopy, atomic force microscopy, Raman spectroscopy and electrical characterizations using field-effect transistors consistently show that the degradation of BP accelerates on the hydrophobic substrates compared to hydrophilic substrates. Our study shed light on main degradation mechanisms of BP under ambient exposure. We acknowledge support from Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2014R1A1A2058178).

Keywords:
Black phosphorus, Degradation

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Power Dissipation and related Cooling in Black Phosphorus Field Effect Transistor

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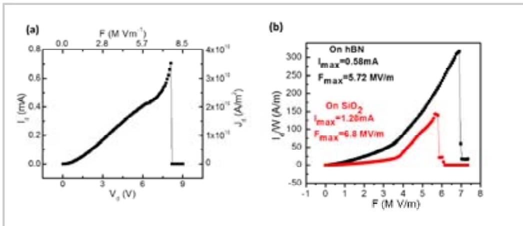

Abstract:
Recently, 2-dimensional (2D) materials have garnered enormous attention from researchers due to their auspicious properties.[1-6] Similarly, recently rediscovered semiconducting 2D black Phosphorus (BP) is considered as a potential candidate for solid state device applications, since it exhibits thickness dependent sizeable band gap, high carrier mobility and in plane anisotropy.[4-6] The most of the scope of the previous studies on BP is concentrated towards low electric field measurements, whereas the high field transport and its related power dissipation issue is rarely studied.[4-6] Therefore, we employed high field breakdown thermometry and investigated the thermal spreading problems in BP device. Surprisingly, few layer BP device exhibits one order higher current density ~3.5×10^{10} A/m^2 than multilayer MoS_2 as shown in Fig.(a) . Furthermore, we observe that breakdown power scales linearly with channel foot-print area and this trend indicates Joule heating as a likely responsible breakdown mechanism inside the channel. Based on this, we propose a simple size dependent analytical model to extract BP-SiO_2 interfacial thermal conductance and it span 1~10 M W/m^2·K. Additionally, we found that most of the heat is dissipated towards Si substrate via thermal resistive SiO_2, and this motivates towards dielectric engineering. Therefore, we replace SiO_2 with hBN as a dielectric material for BP device and realize effective power density in BP due to clean interface and higher thermal conductivity of hBN as shown in Fig.(b). This study will be helpful to fabricate energy efficient circuits and systems based on novel 2D materials. References [1] H.M.Li et al., Nat. Commun., 6, 6564 (2014) [2] M.S.Choi et al. Nat. Commun., 4, 1624 (2013). [3] F.Ahmed et al., Nanoscale, 7, 9222 (2015) [4] H.Liu et al. ACS Nano, 6, 8563 (2014). [5] M.Engel, M., et al., Nat. Lett., 15, 6785 (2015). [6] D. Yue et al., Nanoscale, 8, 12773 (2016).

Keywords:
Power dissipation; Black phosphorus; h-BN; Current density

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Interlayer Sliding in Bilayer Molybdenum Disulfide

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Abstract:
We report experimental evidence for interlayer sliding in bilayer molybdenum disulfide under uniaxial strain. The effects of strain on the vibrational modes (shear, breathing, E_{2g}^1, and A_{1g} modes) are systematically investigated by using polarized Raman spectroscopy. Both the in-plane Raman modes, intralayer E_{2g}^1 and interlayer shear modes, are split into two peaks under uniaxial strain because the degeneracy of the in-plane vibrational modes is lifted. For the E_{2g}^1 modes, both of the split peaks are redshifted and the vibration along the strain direction has a lower energy. However, unlike the ordinary response of intralayer Raman modes on the uniaxial strain, the shear mode splits into hard and soft modes and the vibration along the strain direction has a higher energy. We found that the origin of this anomalous splitting of the shear mode is attributed to the interlayer sliding induced by uniaxial strain. Furthermore, the unexplored components of the compliance tensor could be obtained by analyzing the splitting of the interlayer shear mode.

Keywords:
MoS_2, Molybdenum disulfide, Raman spectrosocpy, Interlayer sliding, strain

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2016.10.19 - 2016.10.21

Tunneling transport of mono- and few-layers magnetic van der Waals MnPS3

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Abstract:

We have investigated the tunneling transport of mono- and few-layers of MnPS3 by using conductive atomic force microscopy. Due to the band alignment of indium tin oxide/MnPS3/Pt-Ir tip junction, the key features of both Schottky junction and Fowler-Nordheim tunneling (FNT) were observed for all the samples with varying thickness. Using the FNT model and assuming the effective electron mass (0.5 me) of MnPS3, we estimate the tunneling barrier height to be 1.31 eV and the dielectric breakdown strength as 5.41 MV/cm.

Keywords:
Magnetic van der Waals materialMnPS3Tunneling transportTransition metal phosphorus trichalcogenidesConductive atomic force microscopy

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H5.06*
2016.10.19 - 2016.10.21

Trap-assisted electronic transport properties of pentacene/MoS_2 heterostructure p-n junction devices

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Abstract:

Transition metal dichalcogenide (TMDC) materials have emerged as semiconductors for future nanoelectronic devices due to their ultrathin nature and favourable electronic properties. TMDCs have pristine surfaces free of dangling bonds due to van der Waals bonding between the layers of the TMDCs, which enables vertical staking of other materials that do not have similar lattice constants to those of TMDCs. In this study, we fabricated the heterostructure devices made with n-type molybdenum disulphide (MoS_2) and p-type organic pentacene and investigated their electrical properties at different gate voltages and different temperatures. We observed that the the pentacene/MoS_2 p-n heterostructure devices were gate-tunable and were strongly affected by trap-assisted tunnelling through the van der Waals gap at the heterojunction interfaces between MoS_2 and pentacene. The pentacene/MoS_2 p-n heterojunction diodes had gate-tunable high ideality factor, which resulted from trap-mediated conduction nature of devices. From the temperature-variable current-voltage characterization, the gate-tunable electrical characteristics of the devices were explained by a space-charge-limited conduction and a variable range hopping conduction at a low temperature. This study helps in the understanding of the role of traps and the electrical properties of organic/2-dimensional material van der Waals heterojunction devices.

Keywords:

van der Waals heterostructurep-n junction, trap,MoS_2, pentacene

Pulse laser deposition assisted grown continuous monolayer $MoSe_2$ film

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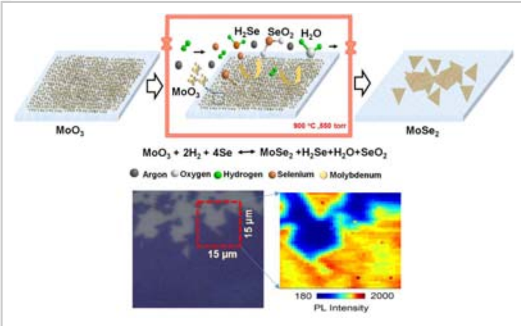
Abstract:



The lower reactivity of selenium makes even more difficult the growth of uniform continuous monolayer 2D selenides materials, such as $MoSe_2$ and WSe_2, required for practical devices. Here, we employed pulse laser deposition assisted selenization method for the synthesis of good quality continuous monolayer $MoSe_2$ film on SiO_2/Si and sapphire substrates. The laser energy was carefully varied to optimize the growth of highly uniform continuous monolayer film. The morphological characterizations including optical microscope, field emission scanning electron microscope and atomic force microscope results clearly demonstrate that the synthesized film is monolayer, continuous and homogeneous. The Raman and photoluminescence maps of the continuous film exhibit uniform brightness indicating the uniform and homogeneous nature of the film. Moreover, The full width half maximum values of A_{1g} and A exciton peaks were found to be 3.7 cm^{-1} and 24 nm, respectively, which show the excellent optical quality of the grown film. These results imply the potential use of grown film and the synthetic approach in device fabrication.

Keywords:
pulsed laser deposition. Selenization, contionus MoSe2monolayer

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2016.10.19 - 2016.10.21

Selective deformation of monolayer MoS_2 by illuminating laser

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Abstract:

2-dimensional transition metal dichalcogenide (TMDC) materials such as MoS_2 have attracted much research interest for future electronics and optoelectronics due to their unique properties. In this presentation, we report, for monolayer MoS_2, one can selectively deform the part of monolayer by laser irradiation. We argue the difference in the thermal expansion between the substrate and MoS_2 can result in the mechanical deformation. In addition, we bring attention to the periodic modulation of the structure generated in the monolayer by the laser irradiation. The strain engineering might provide a useful tool with enhancing the performance of electronic and optoelectronic devices.

Keywords:

MoS2,Illuminating Laser, Deformation, Strain engineering

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H5.09
2016.10.19 - 2016.10.21

Low-frequency noise characteristics in monolayer tungsten disulfide field-effect transistors

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Abstract:
Among numerous kinds of layered 2D materials, a monolayer tungsten disulfide (WS_2) field-effect transistor (FET) has recently gained great interests as a new electronic device because of its high thermal stability, high on- and off-current ratio with in-plane field-effect mobility, low subthreshold swing, and large thickness-dependent direct bandgap. However, those intrinsic properties are easily hampered by the extrinsic environment factors such as substrate doping, surface roughness, and metal-semiconductor contact resistance. In particular, the largely distributed interfacial Coulomb impurities lead to the severe carrier fluctuation, limiting a signal-to-noise ratio. Here, we report the low-frequency (LF) noise characteristics of monolayer WS_2 FETs with respect to temperature. In order to minimize the contact resistance effects and possess a better interface quality, a nitrogen annealing process was carried out. Both the temperature dependence LF noise and 4-probe measured field-effect mobility analysis can further lead to conclude that its electronic transport can be strongly dominated by the enhanced Coulomb scattering sources located in WS_2 with carrier trapping/de-trapping processes into the oxide traps.

Keywords:
Tungsten disulfide, Low-frequency noise, field-effect transistor, Coulomb scattering

Ferroelectricity in ultrathin $BaTiO_3$ films grown on $SrTiO_3$-buffered silicon

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Abstract:

Since the successful epitaxial growth of perovskite $SrTiO_3$ (STO) on silicon by molecular beam epitaxy (MBE) about two decades ago, multifunctional complex oxides on silicon have been a promising platform for novel nanoelectronics to innovate current metal-oxide-semiconductor (MOS) technology. Especially, ferroelectric oxides on silicon have attracted tremendous attention due to their applications as ferroelectric field-effect transistors (FETs) for non-volatile memories and logic devices. $BaTiO_3$ (BTO) is a most fascinating candidate for the ferroelectric FETs, as it is a prototypical ferroelectric oxide with perovskite structure. Recently, reversible switching of the c-axis polarization was reported in 8- to 40-nm-thick BTO films on STO-buffered silicon. However, the critical thickness for BTO on STO-buffered silicon has been less investigated. In this talk, I will present my recent research results on ferroelectricity in ultrathin BTO films grown in STO-buffered silicon. The thickness of BTO films range from 4 - 10 monolayers (MLs). The measurements of the advanced scanning probe microscopies (SPMs), including band excitation piezoresponse force microscopy (BE-PFM) and contact Kelvin probe force microscopy (cKPFM) show the systematic change of ferroelectricity in these ultrathin BTO films with the film thickness. I will discuss this evolution of ferroelectricity in terms of mixed ferroelectric-electrochemical states and the critical thickness of this system.

Keywords:
ferroelectricity, $BaTiO_3$, silicon, scanning probe microscopy, critical thickness

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2016.10.19 - 2016.10.21

Inhomogeneous Tunneling Conductance in Ultrathin Ferroelectric Films and Fundamental Barrier Thickness Limits of Ferroelectric Tunnel Junctions

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Abstract:

Followed with the rapid advancements in heteroepitaxy growth techniques, ultrathin (a few nanometers thick) ferroelectric (FE) films have attracted considerable research interests recently. On one hand, reduced dimension in such ferroelectric systems offers a variety of intriguing phenomena such as ferroelectric dead layer, polar nanoregions induced ferroelectricity, and continuous polarization switching.[1] Moreover, as the film thickness decreases to few nanometers, quantum mechanical tunneling through the FE barrier becomes possible. In the so called ferroelectric tunnel junctions (FTJ), tunneling current can be effectively tuned by several orders of magnitude by ferroelectric polarization, producing the tunneling electroresistance (TER) effect. This device is considered to be a promising candidate for next-generation nonvolatile memories, because it combines the advantages of both ferroelectric random-access-memory and resistive-switching memory.[2] In this work, we fabricated high quality $BaTiO_3/SrRuO_3/SrTiO_3(001)$ epitaxial ultrathin films and controlled the film thickness in unit-cell scale. First, with the help of advanced scanning probe microscopy technique, we systematically investigate the local tunneling behavior in this prototypical system. We found that the tunneling current at the one-unit-cell-height terrace edges is significantly enhanced when the film thickness is less than 5 unit-cells. The dense grid current-voltage mappings further indicate that the tunneling barrier thickness at the terrace edge decreases substantially. Such an inhomogeneous tunneling behavior is related to the local carrier doping at the terrace edge, which may caused by the chemical environment change of Ti^{4+} cations. Second, we fabricated FTJ devices with these ultrathin $BaTiO_3$ films and characterized the barrier thickness dependent device performances. We found that the TER is limited by two fundamental barrier thickness limits: i) pronounced leakage current for ultrathin barriers and ii) extremely small tunneling current (below detection limit) for thick barriers. Last, we investigate the device performance of FTJs with $BaTiO_3/SrTiO_3$ composite barriers. In this system, the extra $SrTiO_3$ barrier provides an additional degree of freedom to modulate the barrier potential and tunneling behavior. The resultant high tunability can be utilized to overcome the barrier thickness limits and enhance the overall performances beyond those of single barrier FTJ devices.[3] [1] M. Dawber, et al. Rev. Mod. Phys. 77, 1083 (2005); [2] V. Garcia and M. Bibes, Nat. Commun. 5, 4289 (2015); [3] L. Wang, et al, Nano Lett. 16, 3911 (2016).

Keywords:

Ultrathin ferroelectric films, tunneling conductance, ferroelectric tunnel junction

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2016.10.19 - 2016.10.21

Modulation of Surface and Interface of Complex Oxide Thin Film Heterostructures

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Abstract:

Surfaces and interfaces have been investigated intensively due to their significance and some exotic phenomena in condensed matter physics, especially, oxide electronics. Two-dimensional electron gas that some oxide thin film heterostructures have and topologically protected edge states proposed for some strongly correlated oxide heterostructures are representative examples of well-known interfacial properties. In this talk, using $LaAlO_3/SrTiO_3$ as model system, it will be discussed how surface and interfacial structures can be changed with the modulation of their transport properties as there are external perturbations such as polar molecular adsorption, temperature/pressure change, and application of electric fields. Synchrotron surface x-ray diffraction shows that polar adsorbate-induced interfacial metallicity reduces polar displacements in the $LaAlO_3$ layer. First-principles density functional theory calculations show that surface dipoles introduced by polar adsorbates lead to additional charge transfer and the reduction of the ionic displacements in the $LaAlO_3$ layer supporting the experimental observations. Polar molecular adsorption can also act as a chemical switch to turn on and off the interfacial conductivity. In addition, polar surface undergoes atomic reconstruction on the surface region in nature and under a certain condition of film growth due to its polarity. However, it can be converted into an ideal interface without atomic reconstruction with the deposition of other materials making a conducting layer. In the end, the role of surface oxygen vacancies for the two-dimensional conducting interface will be revisited.

Keywords:

two-dimensional electron gas, polar interface, surface oxygen vacancy

Polar Metals by Geometric Design

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Abstract:

Gauss's law dictates that the electric field inside a conductor in electrostatic equilibrium is zero; free carriers within a metal eliminate internal dipoles that may arise owing to asymmetric charge distributions. Quantum physics supports this view, demonstrating that delocalized electrons make a static macroscopic polarization, an ill-defined quantity in metals: It is exceedingly unusual to find a polar metal that exhibits long range ordered dipoles owing to cooperative atomic displacements aligned from dipolar interactions as in insulating phases. Here we describe quantum mechanical design and experimental realization of new room temperature polar metals in thin film $ANiO_3$ perovskite nickelates using a strategy based on atomic scale control of inversion preserving (centric) displacements. We predict with ab-initio calculations that cooperative polar A cation displacements can be geometrically stabilized with a non-equilibrium amplitude and tilt pattern of the corner-connected NiO_6 octahedra - the structural signatures of perovskites - owing to geometric constraints imposed by the underlying substrate. Heteroepitaxial thin films grown on $LaAlO_3$ (111) substrates fulfill the design principles. We achieve both a conducting polar monoclinic oxide that is inaccessible in compositionally identical films grown on (001) substrates, and observe a hidden, previously unreported, non-equilibrium structure in thin film geometries. We expect that our approach of geometrical stabilization will provide avenues to the development of new multifunctional materials with unusual coexisting properties.

Keywords:
ferroelectric, thin films, perovskite, (111) geometry

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H6.05
2016.10.19 - 2016.10.21

Direct nanoscale analysis on temperature-resolved growth behaviors of ultrathin perovskites on $SrTiO_3$

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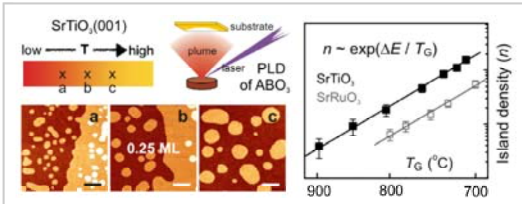

Abstract:
We introduce an application of in-situ scanning tunneling microscopy and atomic force microscopy to the growth dynamics in homo (SrTiO3)- and hetero (SrRuO3)-epitaxies on SrTiO3 (001). Direct comparison of temperature dependent surface structures of SrRuO3 with SrTiO3 films suggests that the peculiar growth mode switching from the 'layer-by-layer' to the 'step-flow' types in a SrRuO3 film arises from a reduction of the surface migration barrier, caused by the change in the chemical configuration of the interface between the topmost and its underlying layers. Island densities in perovskite epitaxies show a clear linear inverse growth temperature dependence. A prototypical study on island nucleation stage of SrTiO3 homoepitaxy reveals that the classical diffusion model is valid in the perovskite growths. [NRF-2014R1A1A1002868, IBS-R009-D1] (Y. J. Chang and S.-H. Phark, ACS Nano 10, 5383 (2016))

Keywords:
STM, $SrTiO_3$, $SrRuO_3$, PLD

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2016.10.19 - 2016.10.21

Peierls distortion in carbynes and carbon rings: quantum Monte Carlo study

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Abstract:
Based on quantum Monte Carlo (QMC) calculations of their energetics, we study Peierls distortion in carbynes and the competition between Peierls distortion and Hückel's rule in carbon rings. Carbynes, linear chains of carbon atoms, can exist in two forms depending on the bond order; polyyne with alternating single and triple bonds and cumulene with only double bonds. Polyyne is understood to be more stable than cumulene as a result of π-electrons localization by Peierls distortion. However, the energy difference between them was estimated to be too small in density functional theory (DFT) calculations, only 0.014 eV/atom at the PBE level, to assure polyyne's stability against cumulene. Our QMC calculations show that the energy of polyyne is lower by 0.088 eV/atom than that of cumulene. This demonstrates unambiguously that polyyne is truly the ground-state structure for linear carbon chains. In addition, our study of ideal carbon rings has revealed that electrons described by the DFT-PBE functional tend to be delocalized even in the regime where the dimerization effects should be large. On the other hand, our QMC calculations turn out to provide an accurate picture that a Peierls insulator is realized over a delocalized state governed by the Hückel's rule as the size of carbon ring increases.

Keywords:
QMC, DFT, carbyne, carbon ring

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H7.02*
2016.10.19 - 2016.10.21

The origin of 1T' phase of WTe_2: A first-principles study

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Abstract:

Among transition metal dichalcogenides (TMDCs), group VIB element TMDCs (MoS_2, $MoSe_2$, $MoTe_2$, WS_2, WSe_2 and WTe_2) have several phases such as semiconducting hexagonal phase (H), metallic octahedral phase (T), and semimetallic distorted T phase (T'). For most group VIB TMDCs, the energetically stable structure is known to be H phase except for WTe_2, which is 1T'. The 1T' phase of WTe_2 have recently received a considerable attention for their rich physics such as the Weyl fermions and the topological property etc. However, until now, the origin of 1T' phase of WTe_2 is unknown. Here, we study the electronic structures of group VIB element TMDCs using first-principles calculations to find the origin of 1T' phase of WTe_2 and external control parameters.

Keywords:
Transition metal dichalcogenides, WTe_2, First-principles calculations

Atomistics of Carbon Nanotube-Polyacrylonitrile Interfaces for Next-Generation Carbon Fibers: A Multiscale Computational Study

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Abstract:
Atomistic understanding of the carbon nanotube (CNT)-polyacrlyonitrile (PAN) interfaces is a critical missing element for the development of next-generation carbon fibers [1]. In this presentation, we provide the systematic atomic-scale analyses of the CNT-PAN interfaces based on a multiscale computational approach combining density-functional theory (DFT) and force-fields molecular dynamics (FFMD) simulations. Based on DFT calculations, not only the several configurations of CNT-PAN complex are discussed, but we also elucidate the electronic origin of the CNT-PAN binding. Via FFMD simulations, we confirmed that the interfacial CNT-PAN atomic configurations faithfully reflect the geometric motives identified in DFT calculations. Moreover, application of our finding in the context of development of carbon fibers is discussed using reliable CNT-PAN interface model. 1. Chae, H.G. and S. Kumar, Making Strong Fibers. Science, 2008. 319(5865): p. 908-909.

Keywords:
Carbon nanotube, Polyacrylonitrile, Carbon fiber, Density functional theory, Molecular dynamics

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2016.10.19 - 2016.10.21

Strain Engineered Spin-dependent Schottky Barrier in MoS_2-VS_2 Lateral Heterostructure

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Abstract:
It has been known that Schottky barrier (SB) formed at metal-semiconductor junction is one of the very important key parameters determining modern electronic device performance and efficiency. Recently, two-dimensional (2D) transition metal dichalcogenides (TMD) have emerged among the hottest classes of materials owing to their promising properties for future applications. Furthermore, it has been reported that 2D TMD can sustain much higher elastic strain up to 10 % than typical bulk materials. Here, using density functional calculations, we find that the SB height (formed at the interface consisting of semiconducting MoS_2 and ferromagnetic metal VS_2) is spin dependent and tunable by about 0.1 eV due to the uniaxial strain. In particular, we first find that the spin up SB height abruptly decreases and goes to zero near the 8% strain while the spin down SB height remains constant, which means that there exists a critical strain in MoS_2-VS_2 lateral heterostructure. We expect these strain engineered lateral heterostructures can be promising 2D-based rectifying devices for future spintronics.

Keywords:
Spin-dependent Schottky barrier, Strain engineering, First-principles calculations, MoS_2, VS_2, Lateral heterostructure

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2016.10.19 - 2016.10.21

Multiferroic coupling between magnetism, in-plane structural order, and out-of-plane polarization in heterogeneous bilayer of transition-metal dichalcogenides

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Abstract:
We suggest a cleverly selected pair of heterogeneous bilayers of transition-metal dichalcogenides (TMDCs) can resulted in a balanced interlayer charge transfer, which induces a delicate coupling between the out-of-plane electric polarization and the in-plane structural and magnetic degrees of freedom. We performed first-principles density functional theory calculations for the model system of Li-intercalated bilayer of VS_2 and ZrO_2. Two stabile phases was identified in a narrow energy window: the nonmagnetic state with a large out-of-plane polarization and the ferromagnetic state with a small reversed polarization. For the former state, the donated electrons from Li intercalant occupy mostly VS_2, inducing 1T phase in the ZrO_2. For the latter, the electron can be shared by both VS_2 and ZrO_2 layer, preserving the magnetism and stabilizing the 2H phase of ZrO_2.

Keywords:
Transition-metal dichalcogenides, DFT

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2016.10.19 - 2016.10.21

Second-order ferroelectric phase transition in two-dimensional puckered group-V materials

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Abstract:

Two-dimensional orthorhombic group-V (P, As, Sb, and Bi) materials have puckered honeycomb structure formed by covalent bonding of one-dimensional zigzag chains. The degree of buckling in these zigzag chains is negligible in P and As and significant in Sb and Bi. The structural difference between orthorhombic P(As) and Sb(Bi) is affected by two factors: i) the degree of s-character in lone pair and ii) the degree of softening of B_{1u} mode leading to the second-order phase transition from flat structure to buckled one. In the process of phase transition, despite of the homogeneity in these systems, the spontaneous polarization is induced by the inversion symmetry breaking. Our calculations show that the strain and doping effect can effectively modify the degree of buckling. Interestingly, we found that the coexistence of ferroelectric and topological non-trivial phase in tensile-strained orthorhombic Bi.

Keywords:

Topological insulator, Ferroelectric

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2016.10.19 - 2016.10.21

Correlation between polaron hopping barrier and Sn doping in Hematite

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Abstract:
α-Fe_2O_3 has been known as a promising photo-anode material due to its efficient visible light absorption as well as appropriate band edges and strong stability in aqueous electrolyte. However, its solar to hydrogen conversion efficiency is strongly limited by slow charge transport governed by the polaron hopping conduction. Here, using density functional theory calculations, we find that the polaron hopping barrier in Sn-doped α-Fe_2O_3 is reduced by about 0.2 eV compared to that in bare α-Fe_2O_3 with oxygen vacancy, which corresponds to around 3000 times enhancement in electrical conductivity at room temperature. Such a remarkable effect with preserving properly positioned band edges is achieved by only 2% Sn substitution and clearly confirmed by the 4-probe measurement. We thus expect that our combined study can provide essential information for developing novel α-Fe_2O_3-based photoelectrochemical cell capable of converting sunlight into chemical fuels at high rate and with high efficiency.

Keywords:
α-Fe_2O_3, Photoelectrochemical cell, Sn doping, Eletrical conductivity, Polaron, Hopping barrier

Novel metallic state in orbitally ordered phase of FeSe revealed by optical spectroscopy

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Abstract:
For most iron-based superconductors, the superconducting phase emerges in the vicinity of the antiferromagnetic-orthorhombic (AFO) phase. However, FeSe exhibits the tetragonal-to-orthorhombic structural phase transition at $T_s \sim 90$ K without accompanying the magnetic phase transition. Below T_s, the orbital ordering was observed, suggesting the electronic origin of the structural transition. Although the change in the band structure across T_s has been intensively studied, the effect of the orbital ordering on the charge dynamics remains unclear. In this work, we performed optical spectroscopy on the FeSe thin film on CaF_2 substrates grown by the pulsed laser deposition method. We extracted the optical properties of FeSe by fitting the reflectivity spectrum of the film. Remarkably, no abrupt spectral change was observed across $T_s \sim 90$ K, in contrast with the case of iron pnictides showing the AFO phase, in which a clear gap feature is observed. Below T_s, the weight of a coherent Drude component decreases with decreasing temperature, indicative of a gradual suppression of the coherent carrier density. This highlights a peculiar metallic state in FeSe that the Fermi surface gradually modified with temperature. We also found the anomalous behavior of the optical phonon mode involving displacements of Fe and Se atoms. The temperature dependence of the phonon frequency below T_s is distinct from that above T_s. This indicates the intimate relation between lattice and orbital degrees of freedom and thus the orbital origin of the structural transition.

Keywords:
Novel metallic state in orbitally ordered phase of FeSe revealed by optical spectroscopy

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2016.10.19 - 2016.10.21

Ultrafast quasiparticle dynamics of optimally doped $Bi_{2.1}Sr_{1.9}CaCu_2O_{8+\delta}$ via time-resolved optical spectroscopy

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Abstract:

We use time-resolved optical spectroscopy to measure quasiparticle relaxation dynamics in optimally doped $Bi_{2.1}Sr_{1.9}CaCu_2O_{8+\delta}$, In agreement with previous reports, we found that at least two different relaxation processes are involved, which is manifested by a second maxium of the pump induced reflectivity change. However, investigation over a broad range of the fluence reveals that the delay time of the second maximum shows a non-monotonic behavior as the pump fluence increases. We compare our data with other ultrafast spectroscopic data and discuss two different regimes can be understood in terms of the conventional behavior of Cooper pairs and their competition with pesudogap.

Keywords:

Cuprate,Superconductivity, Pseudogap, Time-resolved spectroscopy

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2016.10.19 - 2016.10.21

Enhancement of superconductivity by interfacial phonons in perovskite-clad FeAs monolayers

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Abstract:
The physics at the interface between monolayer iron-based superconductor (FeSC) and perovskite substrate has received considerable attention due to the unusually high T_c of ~100 K found recently in monolayer FeSe on $SrTiO_3$ substrate. It has been suggested that forward-scattering interfacial phonons coupled with the Fe-layer electrons can enhance superconductivity from almost any kind of pre-existing electron-based pairing, initiating the quest for perovskite-clad FeSC monolayer and its bulk heterostructure with higher coupling efficiency with interfacial phonons. Here we report a spectroscopic imaging scanning tunneling microscopy (SI-STM) study on a parent-compound superconductor Sr_2VO_3FeAs, the only currently known self-assembled bulk example of FeSC monolayers on perovskite layers with substantially high T_c ~ 37 K. It shows clear signatures of forward-scattering phonons with unprecedentedly strong coupling gph2/Ωph2 close to 1 probably due to doubled interfaces per FeSC monolayer. Our masked quasiparticle interference (QPI) analysis based on the superconducting gap(Δ) map and the V-Fe hybridization strength(Γ) map shows clear positive correlations between all pairs of Δ, Γ and g_{ph} gphwhich is the hallmark of pairing enhancement due to electron-phonon coupling with interfacial phonons. With the possibility of massive number of parallel superconducting layers and the stronger electron-phonon coupling achieved, perovskite-clad FeSC monolayers may become an essential building block of the next generation Fe-based high-T_c superconductors with significantly enhanced T_c and current carrying capacity.

Keywords:
STM, superconductivity, interfacial phonon

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2016.10.19 - 2016.10.21

Evidence of nodeless multigap superconductivity in 2H-Pd_xTaSe_2 from thermal transport

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Abstract:

2H-$TaSe_2$ is one of unique transition metal dichalcogenides which exhibits an incommensurate charge density wave (ICDW) state at ≈ 122 K followed by a commensurate charge density wave (CCDW) state at ≈ 90 K and superconductivity at T_C ~ 0.14 K. Recently, it was found that upon systematic intercalation of Pd ions into 2H-$TaSe_2$, the CCDW order is destabilized more rapidly than ICDW to indicate a hidden quantum phase transition point at x ~ 0.09-0.10. Moreover, T_C shows a dramatic enhancement up to 3.3 K at x = 0.08, ~24 times of T_C in 2H-$TaSe_2$ [1]. In this work, we measured the in-plane thermal conductivity (k) of a 2H-Pd_xTaSe_2 single crystals with T_c ~ 3.13 K down to 100 mK. In zero magnetic field, the absence of the residual linear term in κ_0/T at T → 0, supports the nodeless superconducting gap feature. Moreover, magnetic field dependence of the normalized residual linear term ($\kappa_0(H)/T)/(\kappa_N/T)$) exhibits similar behavior as observed in the multiband superconductor like $NbSe_2$ [2]. These results strongly support the presence of multiple nodeless superconducting gaps in 2H-Pd_xTaSe_2. This work has been supported by Creative Research Intiatives by KRF (**) References : [1] D. Bhoi et al., Scientific Reports 6, 24068 (2016) [2] E. Boaknin et al., Physical Review Letters 90, 117003 (2003)

Keywords:

MultibandSuperconductivity, Thermal conductivity, Transition metal chalcogenides, Charge density waves

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Superconductivity in doped 3D Dirac semimetal with lattice distortion

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Abstract:
Motivated by recent observation of unconventional superconductivity in 3D Dirac semimetals under pressure, we have theoretically studied the effects of generic lattice distortion on the superconductivity. We started with the minimal Dirac semimetal model which has both time-reversal and inversion symmetries and is protected by the four-fold rotational symmetry so that this minimal model is known to describe real Dirac semimetal such as Cd_3As_2 and Au_2Pb. Using group theoretical method, we classified the generic lattice distortions and possible superconducting phases. We found that there can be nodal superconducting phases which are protected by a certain topological winding number. The non-triviality of winding number depends on the time-reversal, inversion, chiral, and mirror symmetries of the system. Therefore, at the mirror-symmetry preserving planes, we found the existence of flat Andreev bound states. For various classified superconducting pairings, we calculated the superconducting critical temperature and, hence, obtained phase map. We found that as the lattice distortion increases the superconducting critical temperature increases due to the enhancement of density of states at Fermi surface, which is consistent with the recent experiment. We also found that unconventional superconductivity can emerge when the lattice distortion is large enough because the spin orbital texture allows unconventional spin triplet pairing even when the spin-orbital coupling exists in this system.

Keywords:
Dirac semimetal, unconventional superconductivity, nodal superconductor, lattice distortion

Ferromagnetism controlled by electric field in tilted phosphorene nanoribbon

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Abstract:

Study on phosphorene nanoribbon was mostly focused on zigzag and armchair structures and no ferromagnetic ground state was observed in these systems. Here, we investigated the magnetic property of tilted black phosphorene nanoribbons (TPNRs) affected by an external electric field. We also studied the edge passivation effect on the magnetism and thermal stability of the nanoribbons. The pure TPNR displayed an edge magnetic state, but it disappeared in the edge reconstructed TPNR due to the self-passivation. In addition, we found that the bare TPNR was mechanically unstable because an imaginary vibration mode was obtained. However, the imaginary vibration mode disappeared in the edge passivated TPNRs. No edge magnetism was observed in hydrogen and fluorine passivated TPRNs. In contrast, the oxygen passivated TPNR was more stable than the pure TPNR and the edge-to-edge antiferromagntic (AFM) ground state was obtained. We found that the magnetic ground state could be tuned by the electric field from antiferromagnetic (AFM) to ferromagnetic (FM) ground state. Interestingly, the oxygen passivated TPNR displayed a half-metallic state at a proper electric field in both FM and AFM states. This finding may provoke an intriguing issue for potential spintronics application using the phosphorene nanoribbons. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and future planning (2016R1A2B4006406)

Keywords:
first-principles calculation, phosphorene nanoribbon,

Circular photon drag effect in a Bi_2Se_3 thin film investigated by terahertz emission spectroscopy

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Abstract:
We investigate photocarrier dynamics in a Bi_2Se_3 film by exploiting terahertz (THz) emission spectroscopy which is implemented for unbiased sample without electric contact, so that it provides us useful information about the intrinsic internal bias near the sample surface such as surface band bending, asymmetric scattering, and so on. We monitored the THz electric fields emitted from the Bi_2Se_3 film under variations of the polarization of incident light and the sample azimuth, and observed (i) photon-helicity-dependent modulations in both amplitude and phase of the emitted THz wave and (ii) three-fold periodic azimuth dependence of such circular anisotropy. Based on the symmetry analysis for the nonlinear photocurrent generation process, we reveal that the observed helicity-dependent THz responses mainly originate from the circular photon drag effect, that is, linear and angular momentum transfer from photons to photocarriers.

Keywords:
topological insualtor, photon drag effect, photogalvanic effect, circular, photocurrent

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Edge State of Boundary-Functionalized 2D Topological Insulator

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Abstract:

We investigate the effects of the boundary modification on the edge state of two-dimensional topological insulator based on Kane-Mele model. The edge states of the Kane-Mele model show different localization properties depending on its boundary types, such as zigzag- and armchair-edge. The edge state of the zigzag-edge is more localized on the edge and less sensitive on the staggered potential than that of the armchair-edge. In this work, we modify the boundary condition of the edge and study the changes of the edge states in the Kane-Mele model. We first calculate the localization length of the edge state in a size-effect-free half-infinite lattice with various boundary conditions on zigzag- and armchair-edge. The results are also compared with the finite sized nano-ribbon system with additional atomic sites on the edge which change the boundary condition of the edges. The gap of the edge state is also affected by the edge functionalization in the nano-ribbon system. This work was supported by the NRF of Korea (Grant No. 2011-0018306).

Keywords:

Kane-Mele model, edge state, 2D topological insulator

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2016.10.19 - 2016.10.21

Raman scattering studies of strain effect of suspended molybdenum disulfide (MoS_2) on periodic structured substrate

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Abstract:

Large amount of research has been conducted over two-dimensional materials including transition metal dichalcogenide monolayers (TMDCs) such as MoS_2, WS_2, $MoSe_2$, WSe_2, and $MoTe_2$ since production of the single- and the multi-layered graphene. These materials exhibit interesting 2-dimensional physics and, in principle, can be utilized for electronic and optoelectronic devices. For example, MoS_2 can be used for photovoltaic devices from its electrical conductivity and light emitting property. Also, the field-effect transistor (FET) made of MoS_2 shows the mobility over 100 $cm^2V^{-1}S^{-1}$ and it is stable in both acidic and basic conditions, which make TMDCs even more attractive for applications. In addition, strained TMDCs can change the band gap with mobility and effective mass of electrons which can improve device performances. In this study, we used MoS_2 samples made by exfoliation and by CVD method that were transferred on Si substrates with a 300 nm SiO_2 layer and Ag grating with 200 nm period. For measuring basic characteristics such as lattice properties and information regarding the electronic band structures of the samples, we performed Raman scattering spectroscopy by using five different excitation energies of 457.9 nm (2.71 eV), 488 nm (2.54 eV), 514.5 nm (2.41 eV), 532 nm (2.33 eV), and 632.8 nm (1.96 eV). We report anomalous phonon behavior that depends on the thickness of layers and underlying strain effect of periodic structured substrate.

Keywords:
2-Dimensional material, Strain, Periodic substrate

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Crystallinity and Electrical Resistivity of TiZrNi Quasicrystals by Adding Hydrogen

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Abstract:

TiZrNi quasicrystals show metal behavior in electrical resistivity at ambient temperature higher than 20 K.[1] The specific resistance value of $Ti_{50}Zr_{30}Ni_{20}$ quasicrystal is known to 520 $\mu\Omega\cdot$cm at room temperature.[2] In this presentation, the structure and its electrical resistance values of TiZrNi quasicrystals by absorption of hydrogen were analyzed. The $Ti_{53}Zr_{27}Ni_{20}$ alloys were prepared by using an arc-melting method followed by a rapid quenching. To study the structure and electrical resistance values of the samples as a function of hydrogen, $Ti_{53}Zr_{27}Ni_{20}$ alloys were partially and fully hydrogenated as increasing the H/M (the ratio of the number of absorbed hydrogen atoms per number of host metal atoms) values from 0 to 1.33. The rapidly quenched $Ti_{53}Zr_{27}Ni_{20}$ alloys showed quasicrystal structure. After hydrogen absorption, the quasi-coherence length was increased from 130 to 284 Å. The increment of coherence length demonstrates that quasi-crystallinity of sample was improved. Specific electrical resistance values of sample were decreased from 421.2 to 275.0 $\mu\Omega\cdot$cm as increasing the H/M value from 0 to 1.33. Consequently, the electrical resistance values of $Ti_{53}Zr_{27}Ni_{20}$ quasicrystals were decreased by increment of quasi crystallinity of samples. Reference 1. V. Azhazha, V. Khadzhay, G. Malikhin, Phys. Lett. A 319, 539 (2003). 2. Y. K. Kuo, N. Kaurav, W. K. Syu, K. M. Sivakumar, U. T. Shan, S. T. Lin, Q. Wang and C. Dong, J. Appl. Phys. 104, 063705 (2008).

Keywords:
Quasicrystal, Electrical resistivity, Hydrogen

Graphene bubbles and their effects on the charge transport behaviors

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Abstract:

We investigated the formation of graphene bubbles and their effects on the charge transport behaviors of the graphene/h-BN heterostructures as a function of bubble coverage formed at the interface of graphene and h-BN insulator. From the experimental data and quantum transport,simulation, we concluded that a few percent of bubble coverage seems to be enough to vary fundamental electrical properties of graphene by forming local p-doped regions on graphene surface, which lead to a significant electron-hole asymmetric feature. Additionally, we found that the valley symmetry of graphene is broken near the bubbled region as it is supported by quantum transport measurements in the quantum Hall regime.

Keywords:

Graphenbe, Hexagonal Boronnitride, Bubble

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Magnetic properties of transition metal Mn, Fe and Co dimers on monolayer phosphorene

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Abstract:

We studied the geometries, electronic structure and magnetic properties of substitutional doping and adsorption of transition metal (Mn, Fe and Co) dimers on phosphorene monolayer. The electronic band structures and magnetic properties were dependent on the doping type and dopant materials. For Mn and Fe substitutional and adsorption dimer, we obtained semiconducting band structures with spin polarization. However, we found a half-metallic feature in Co substitutional dimer while the Co adsorption dimer showed a semiconducting behavior without any spin polarization. The hybridization between TM and phosphorene sheet contributed to suppressing the magnetic moment of TM dimers. For instance, the total magnetic moments of −2.0, 4.24 and 1.28 μ_B/cell for Mn, Fe and Co substitutional dimer were obtained while the Mn and Fe adsorption dimers showed magnetic moments of −1.69 and 0.46 μ_B/cell. We observed that the Mn and Fe substitutional dimers showed an out-of-plane magnetization with magnetocrystalline anisotropy energies (MAEs) of 0.57 and 0.89 meV/cell while an in-plane magnetization with a MAE of 0.58 meV/cell was obtained in Co substitutional dimer. The Mn adsorption dimer still displayed a perpendicular magnetization with a MAE of 0.50 meV/cell. In contrast, the Fe adsorption dimer had an in-plane magnetization with a MAE of 0.11 meV/cell. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and future planning (2016R1A2B4006406)

Keywords:
first-principles calculation, transition metal doping, magnetic anisotropy

Ultra-compact high-resolution space telescope for earth and astronomical observations

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Abstract:
The recent progress and huge potential application of micro-satellites require the development of telescopes for both Earth and astronomical observations to be not only extremely high resolution and field of view (FOV) but ultra-compact size. From the technical point of view, thermal stability in optics system, and mass and volume would be critical limitations which should be taken into account from design to fabrication. For the development of several such systems, we have introduced analysis of possibilities of COTS-based and specially developed optics. We develop a telescope directly applicable to 16U CubeSat, as characterized by 3° flat FOV, resolution better than 0.9 arcsec, F/# 3.5, 241 mm equivalent aperture, 230*230*330 mm in size, 6kg in mass, and operational temperature of -50 to +50 ° C. This resolution corresponds to GSD of 2.5m with 25km wide Earth images from 600km orbit, or 14 star magnitude with 2.5x2.5° FOV for astronomical observation. This telescope has been successfully manufactured and is being under various tests for space qualification. It is noticed that we employ Catadioptric spherical design in entire optics consisting of a Mangin primary mirror, a secondary mirror, one front corrector lens, and two field corrector lenses. We made also a special opto-mechanical design to provide high precision alignment accuracy of 5um, and guarantee a stability at 100° temperature range, various modes of vibrations and 40G shock. The design of optics and opto-mechanics, results of modelling tolerances, mechanical and thermal deformation, and the results of ongoing tests will be presented, together with future approaches and plans.

Keywords:
Micro-satellite,CubeSat, Catadioptric

Pre-Launch Status of the Silicon Charge Detector for the ISS-CREAM experiment

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Abstract:
The ISS-CREAM experiment will carry out the direct measurement of energy and composition of energetic cosmic rays at the International Space Station, and it will be launched to and installed at the Space Station in April 2017. The Silicon Charge Detector (SCD) is one of two main instruments of the ISS-CREAM payload. The SCD consists of 4 layers with total 10752 silicon pixels and associate electronics and it is capable of precision measurement of elemental constitution of cosmic rays. After the successful completion of all space environment tests, the ISS-CREAM payload was delivered to the launch place, Kennedy Space Center, in September 2015. The final checkup of the ISS-CREAM payload before the launch will be carried out in September 2016. We will present the performance of the SCD including the response to cosmic-ray muons during the final checkup.

Keywords:
International Space Station, ISS-CREAM, SCD

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2016.10.19 - 2016.10.21

Electron Physics Simulation Study for Top and Bottom Counting Detectors of ISS-CREAM Experiment

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Abstract:
The Cosmic Ray Energetics and Mass (CREAM) experiment at the International Space Station (ISS) is developed for studying the origin, acceleration and propagation mechanism of high-energy cosmic rays. The ISS-CREAM instrument is being scheduled to be launched in 2017 to the ISS. The Top and Bottom Counting Detectors (T/BCD) are developed for studying electron/gamma-ray physics. The T/BCD separate electrons from protons by comparing the number of hits and shower distributions between electrons and protons. We have studied the T/BCD performance and optimal parameters for the e/p separation in various energy ranges by using a set of GEANT3 simulation data. In this presentation, we are going to present on the status of a simulation study for the electron physics.

Keywords:
e/p separation, cosmic-ray, ISS-CREAM, Top/Bottom Counting Detector

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Problem of Multipoles in BOSS DR12 results

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Abstract:

Intrinsically, the observed galaxy power spectrum is anisotropic in the redshift space due to the its peculiar velocity. Both the so-called "Finger-of-God" effct and the redshift space distortions induce these anisotries at small and large scales, respectively. One can predict the multipoles such as monopole, quadrupole, hexadecapole, and etc. The sloan digital sky survey (SDSS) III's Baryon Oscillation Spectroscopic Survey (BOSS) releases their data on those multipoles based on the quasi-linear model. We show the results are inconsistent with our prediction at both large and small scale. We will discuss the possible reasons for this discrepancies.

Keywords:
Large Scale Structure (LSS), Redshift space power spectrum

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A new estimator of the deceleration parameter from galaxy rotation curves

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Abstract:

In de Sitter space, the vacuum assumes a low energy scale defined by the cosmological horizon, that gives rise to a dynanmic dark energy with relatively steep dq(z)/dz at z=0. This may be probed in the regime of weak gravity. We present a novel relation q(z) = 1 - (4pia_0/cH)^2, enabling a determination of q(z) by measuring Milgrom's parameter a_0(z) in galaxy rotation curves, equivalent to the coefficient A in teh Tully-Fisher relation V_c^4 = AM_b between rotation velocity V_c and baryonic mass M_b. We infer that dark matter should be extremely light with clustering limited to the size of galaxy clusters.

Keywords:
de Sitter space, dark energy, spiral galaxies

Eccentric compact binary inspirals and GW parameter estimation

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Abstract:
In September 2015, gravitational waves (GWs) from massive black hole mergers were detected. The advanced LIGO, advanced Virgo, and KAGRA will be able to detect more GW signals from different heavenly bodies, most likely coalescences between black holes and/or neutron stars. More realistic GW waveform model will allow us to increase precision of GW parameter estimation. Moreover, a better waveform model will be useful to detect exotic systems such as significantly eccentric binary coalescences. We present an eccentric compact binary inspiral waveform model based on post-Newtonian formalism. Using th model, we examine statistical and systematic error in parameter estimation.

Keywords:
Compact binary coalescence, GW data analysis, post-Newtonian waveform, Black hole

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2016.10.19 - 2016.10.21

Initial Data Construction for Lattice Universe with Rotating Black Holes

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Abstract:

We have investigated an initial data of a locally inhomogeneous universe model which consists of cubic lattice of identical rotating black holes. It is a numerical solution of the vacuum Einstein constraint equations. By imposing periodic boundary conditions at the surfaces of the cubic cell, we constructed a numerical universe model where identical rotating black holes are uniformly distributed. Our numerical solutions are three parameter families of solutions characterized by the Arnowitt-Deser-Misner (ADM) mass, the Bowen-York spin parameter, and the coordinate size of its cubic domain. We introduced some methodologies to analyse numerical solutions in the framework of flat homogeneous universe model (Kasner universe). In our methodology, the presence of rotation makes the Kasner exponents unequal, revealing the cosmic anisotropy. In the limit of large separation between adjacent black holes, the numerical solutions appear to become the Einstein de Sitter universe.

Keywords:

cosmologynumerical relativity

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2016.10.19 - 2016.10.21

A study of light reflection near a black hole

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Abstract:

We explain the bending of light in the gravitational field by the refraction of light in the field with the help of Snell's law. Assuming the distribution of the gravitational field makes the difference of the properties of the medium, we can get the same refracted angle as calculated in the general relativity. We also consider the reflection of the light in the gravitational field through the wave-nature of light and find the possibility of total reflection at the Schwarzschild radius. With this reflection effect, we explain the odd phenomenon that the black hole absorbs material splits them into plasma by their tidal force, and finally the light and particles are scattered out from the black hole because of its wave property.

Keywords:

black hole, Schwarzschild radius, general relativity, tidal force

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Light on a plane gravitational wave background

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Abstract:
We consider a light propagating on a curved background spacetime of plane gravitational waves. Assuming that the gravitational wave is not so strong, the Maxwell equations are systematically expanded around the flat Minkowski background. In this perturbed scheme the gravitational wave plays like a source term, learly coupled to the light unperturbed. By solving this set of equations we investigate deformations of the light, e.g., how the wave length changes. The results are also compared to those obtained in the geometric optics approximation.

Keywords:
Gravitational waves, Light propagation

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H12.01
2016.10.19 - 2016.10.21

KSTAR 플라즈마의 난류 시뮬레이션 및 진단 연구 현황 소개

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Abstract:
플라즈마 난류의 이해와 제어는 토카막 장치를 사용한 성공적 핵융합 반응 유도를 위해 필수적이다. 토카막과 같이 강한 외부자기장에 의해서 감금된 플라즈마의 경우 외부 자장에 의한 이온 자기 선회 주파수보다 느린 시간 척도를 갖는 난류들이 발생한다. 그리고 이와 같은 난류들이 핵융합 반응을 일으키기 위해 외부에서 공급된 에너지와 입자들을 빠르게 수송시키는 원인으로 지목되고 있다. Gyrokinetic 모델은 이런 현상을 수치적으로 시뮬레이션 하는 가장 정교한 방법의 하나로 지난 20여년간 지속적으로 연구되어오고 있으며, 특히 최근 들어 플라즈마 난류의 진단 기술 발전과 슈퍼컴퓨터의 발전에 힘입어 보다 정교한 시뮬레이션과 실험 비교 연구가 활발히 진행되고 있다. 본 발표에서는 KSTAR에서 수행되고 있는 gyrokinetic 시뮬레이션 연구와 난류 진단 연구를 소개하고자 한다. 현재 개발중인 gyrokinetic 코드에 대한 소개와 함께, ECEI, MIR 등을 사용한 KSTAR 플라즈마 난류 진단 결과들도 함께 소개한다. 그리고 시뮬레이션과 실험 결과의 비교 연구에 대한 최근 연구결과와 함께 앞으로의 계획도 논의하고자 한다.

Keywords:
tokamak, plasma turbulence, gyrokinetic simulation, turbulence diagnostics

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2016.10.19 - 2016.10.21

Current profile measurements under non-inductive current drive at KSTAR

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Abstract:
The current profile evolutions have been measured from the plasma discharges with various non-inductive current drives for the Korea Superconducting Tokamak Advanced Research (KSTAR) for the first time. This measurement has been possible by the newly-installed motional Stark effect (MSE) diagnostic system that utilizes the polarized Balmer-alpha emission from the energetic neutral deuterium atoms induced by the Stark effect under the Lorentz electric field. The 25-channel KSTAR MSE diagnostic is based on the conventional photoelastic modulator (PEM) approach with the spatial and temporal resolutions of 〈 2 cm (for the most of the channels except 2 to 3 channels inside the magnetic axis) and about 10 msec, respectively. The strong Faraday rotation imposed on the optical elements in the diagnostic system is calibrated out from a separate and well-designed polarization measurement procedure using an in-vessel reference polarizer during the toroidal-field ramp-up phase before the plasma experiment starts. The evolution of the pitch angle along with the modulated injection of the 170 GHz ECCD implies that the modulation frequency in the electron cyclotron wave injection is fast compared with the current relaxation time (about 1 sec) at the KSTAR plasmas. According to the magnetic pitch angle profiles, it is conjectured that the wave energy is transported to the plasma with the time scale comparable to that of the modulation (about 0.1 sec). The current density profile that can be inferred from the spatial gradient of the tokamak pitch angle is not drastically changed and instead, a significant shift of the whole profile including the location of the magnetic axis is clearly seen as a result of the energy transport. The measured pitch angle data can be used to constrain iterative equilibrium calculations in order to obtain current density and safety factor profiles consistent with the magnetic flux surfaces.

Keywords:
motional Stark effect, non-inductive current drive, KSTAR

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H12.03
2016.10.19 - 2016.10.21

Ion-scale turbulence study in KSTAR L-mode plasmas

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Abstract:

Ion gyroscale density fluctuations with the poloidal wavenumber $k_\Theta \sim 3\ \mathrm{cm}^{-1}$ have been observed in neutral beam injected L-mode discharges on KSTAR. The poloidal wavenumbers of the observed fluctuations were deduced from the fluctuation frequencies and poloidal rotation velocities in the laboratory frame, obtained using the multichannel (4 radial and 16 poloidal) microwave imaging reflectometer (MIR) system. Linear and nonlinear gyrokinetic simulations performed with the GYRO and GTS code, respectively, support the measurements by demonstrating that the dominant turbulence is most unstable at $k_\Theta \sim 3\ \mathrm{cm}^{-1}$ (or $k_\Theta \rho_s \sim 0.4$) in the L-mode plasmas. Temporal and spatial characteristic scales of the measured turbuelnce evaluated with a cross correlation anaysis were compared with parameters relevant to the ion-scale turbulence. *Work supported by the NRF of Korea under contract no. 2014M1A7A1A03029865 and Korean Ministry of Science, ICT, and Future Planning under the KSTAR project contract.

Keywords:
turbulence, poloidal wavenumber, microwave imaging reflectometer

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2016.10.19 - 2016.10.21

Evolution of locked mode under the existence of non-axisymmetric fields in KSTAR

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Abstract:
A synergistic effect of mixed non-axisymmetric (NA) field applications has been investigated in KSTAR plasmas. While the application of the n=1 NA field alone brings field penetration, locking, and then minor disruption, the addition of n=2 NA field appeared to have moved up the onset of n=1 EF penetration and locking, but to have either delayed or avoided the minor disruption. The magnetic diagnostics suggests that the n=2 NA field started to hinder the growth of n=1 locked mode, when the mode amplitude reached a certain level, which appears to be correlated with the n=2 NA field strength. Nonetheless, a fast mode growth resumes, just prior to a minor disruption. It seems that there exists 2nd threshold of EF penetration related to the disruption phenomena, similar to a locking threshold (i.e. 1st threshold). In comparison, the pure n=1 NA field case without n=2 field does not show any noticeable change of growth rate after locking, gradually increasing the locked mode amplitude towards minor disruption.

Keywords:
Nuclear Fusion, Tokamak, MHD stability

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H12.05
2016.10.19 - 2016.10.21

Rotation and its Shear Studies by the Effect of Non-axisymmetric Magnetic Fields in KSTAR*

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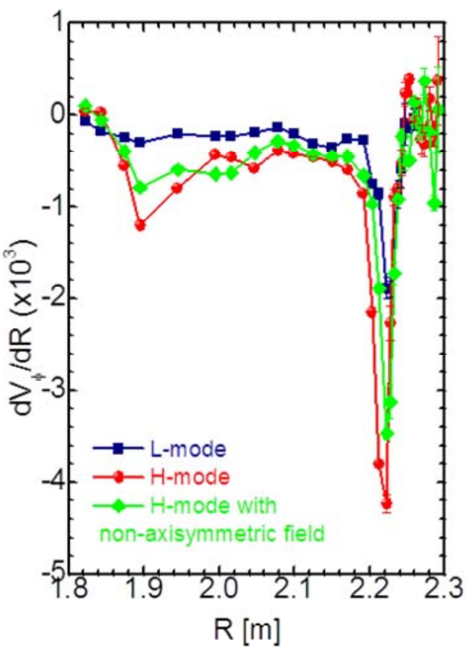

Abstract:

The recent tokamak research has been emphasizing that the plasma rotation plays an essential role in determining transport which is related in rotation shear and stability which is affected by increased rotation [1]. Charge exchange spectroscopy (CES) is one of the important diagnostics on the Korea Superconducting Tokamak Advanced Research (KSTAR) to get ion temperature and toroidal rotation velocity [1-2]. The measurement of poloidal rotation velocity profiles with the high spatial resolution plays an important role in understanding the behavior of plasma especially for the edge transport barrier region. The poloidal and toroidal rotation and ion temperature profiles of the carbon impurity line are measured by charge exchange spectroscopy and it enables to understand the behavior of plasma especially for the non-axisymmetric fields in KSTAR [2, 3]. The non-axisymmetric fields make not only ELM suppression but also reduction of rotation in the KSTAR H-mode plasma. The effect of the non-axisymmetric fields appears on rotation, its shear, density, and temperature profiles for different collisionality in KSTAR. Especially, rotation gradually decreases from edge to core region by the non-axisymmetric fields and it is opposite direction for mechanism of making H-mode pedestal. The LH transition threshold power also increase as the current of the non-axisymmetric fields increases and the ongoing study focusses on H-mode threshold power and pedestal transport with controlled non-axisymmetric fields. *This work was supported by the Korean Ministry of Science, ICT and Future Planning of Republic of Korea.

Keywords:
Non-axisymmetric Magnetic Fields , Rotation, threshold power, rotation shear

Computing and Software Development in DUNE

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Abstract:

The DUNE experiment will operate on several massive scales: the size of the detector, the length of the proposed run, the size of the data set, and the number of participating physicists in the international collaboration are all very large. The design and prototyping efforts are the current focus of intensive work. In order to support the current and planned work, a strong software and computing effort is needed, resource requirements need to be specified, and the means to meet these requirements must be identified. Software for simulating the far detector, the near detector, the beamline, and the ProtoDUNE detectors is under active development. Many of the tools currently in use by the DUNE collaboration are shared with other experiments, from a common code base for liquid argon TPC simulation and reconstruction, to batch processing and storage tools that were developed for collider experiments and other intensity frontier experiments. Much work remains to be done. I will outline the current status and plans of DUNE's software and computing effort, and list areas where new collaborators can contribute.

Keywords:

ProtoDUNE, LAr TPC simulation and reconstruction

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H13.02
2016.10.19 - 2016.10.21

The role of data center in data intensive research era in Korea.

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Abstract:
Global Science experimental Data hub Center(GSDC) is the unique infrastructure for data intensive science in Korea. GSDC has been supporting for international and domestic research collaborations including ALICE, CMS, Belle, LIGO and RENO since 2010, providing data analysis computing environment and data repository service. As data-driven science is emerging to the new paradigm in scientific discovery, the role of GSDC is continuously growing and being expected to contribute more to scientific community. In addition, OECD Global Science Forum recently highlighted Open Science which focuses on openness in access, collaboration and data. Such a circumstance requires GSDC to build new strategy and direction for scientific community and national agenda as a national data center in Korea. In this talk, we will share recent achievements, concerns and new direction of GSDC as a unique nationwide data center for basic science.

Keywords:
GSDC. Data Center. Data Intensive Research

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H13.03
2016.10.19 - 2016.10.21

Neutrino-induced Reactions and Neutrio Scttering with Nuclei

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Abstract:

In this talk, we briefly review neutrino-induced reactions and neutrino scattering with finite nuclei which are used as targets for neutrino detection. Theoretical frameworks for these calculations, for example, shell model, QRPA and DWBA models are also explained with recent results compared to experimental data available up to now. Physical implications in nuclear, particle, astrophysics as well as neutrino physics will be addressed with some recent topics.

Keywords:
Neutrino Interactions, neutrino scattering, QRPA, shell model, DWBA

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H13.04
2016.10.19 - 2016.10.21

Prospect of DUNE Korea

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Abstract:
Korea has become a member country in Deep Underground Neutrino Experiment (DUNE) in 2016, which is a global project being pursued by physicists and scientists from about 28 countries. Parallel to domestic neutrino experiments with medium- or short-baseline oscillation, it will make a good combination to pursue such an ultimate long-baseline neutrino experiment within international collaboration. The goals of neutrino physics cannot be reached until the outcomes of various types of experiments are integrated. We check motivation, progress, human resources and infra condition of potential Korean Group. It is also necessary to estimate the balance between contribution and scientific benefit of Korean group in DUNE Collaboration.

Keywords:
DUNE, neutrino oscillation

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.01
2016.10.19 - 2016.10.21

Light-front quark model analysis of the P(π, η, η') $\gamma^*\gamma$ transition form factors

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Abstract:
In the present work, we investigated the P$\gamma^*\gamma$ (P=π, η, η') transition form factors (TFF) in the light-front quark model(LFQM) based on the QCD motivated effective LF Hamiltonian. In the previous work, we discussed the link between the chiral symmetry of QCD and the numerical results of the LFQM, analyzing both the two-point and three-point functions of a pseudo scalar meson from the perspective of the vacuum fluctuation consistent with the chiral symmetry of QCD. In this work, we start from the covariant Bethe-Saltpeter (BS) model used in the previous works to pin down the zero mode for the P -> ₩gamma^* ₩gamma TFFs and find that the meson-photon TFF is immune to the zero mode. We confirm the self-consistent correspondence relation between the covariant BS model and the LFQM that allow the substitution of the radial and spin-orbit wave functions of the exactly solvable model by the more phenomenologically accessible model wave functions that can be provided by the LFQM analysis of meson mass spectra. Furthermore, we show not only timelike but also spacelike TFF using the analytic continuation method of changing Q^2-> -Q^2 in the form factor. The ₩eta-₩eta' mixing scheme is analyzed to obtain the optimum values of the ₩eta(₩eta')-₩gamma TFFs and compared with the current available experimental data. The present work rejuvenates our earlier analysis of the P -> ₩gamma^* ₩gamma process solely based on the standard LF approach of the LFQM, in which we have shown a good agreement with the low- and intermediate Q^2 data ($0 < Q^2 < 10\,GeV^2$) measured decades ago from the CELLO and CLEO Collaborations.

Keywords:
quark model, Light-front, BaBar, Belle, transition form factor

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.02
2016.10.19 - 2016.10.21

Interference effects in K+ K- p photoproduction

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Abstract:

In this talk, we present our recent research on the interefence effects in gamma p --> K+ K- p reaction process. The interference pattern appears from the overlap of phi(1020) and Lambda(1520) in the Dalitz plot. We suggest that this intereference can explain the bump-like structure, which has been observed in dsig/dt for the phi(1020) photoproduction as a function of photon energy. From the numerical calculations, a bump caused by the interference is observed. We also discuss some inconsistency betweeen the old experimental data for the phi(1020) and provide possible explanations on this issue.

Keywords:
Photoproduction, phi(1020), Lambda(1520), Interference, Dalitz process.

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2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.03
2016.10.19 - 2016.10.21

Photoproduction of $\Lambda(1405)$ with an Effective Lagrangian approach

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Abstract:
We investigate $K\Lambda(1405)$ photoproduction off the proton combining an effective Lagrangian method with a Regge model. We consider K and K* Reggeon exchanges in the t-channel, nucleon in the s-channel, and hyperons in the u-channel. We also take into account higher nucleon resonances near 1.9 GeV. It turns out that some resonances are essential for describing the recent CLAS data.

Keywords:
photoproduction, nucleon resonances, effective Lagrangians

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.04*
2016.10.19 - 2016.10.21

Radiative weak decay of pion, $\pi + \rightarrow e+ \nu \gamma$, from the instanton vacuum

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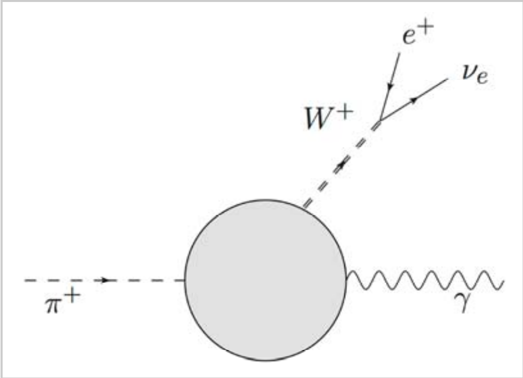
Abstract:
We investigate the vector and axial-vector form factor of the pion radiative weak decay, $\pi + \rightarrow e+ \nu \gamma$, based on the non-local chiral quark model from the instanton vacuum. We compare our results with the corresponding experimental data and other theoretical works such as NJL model and chiral perturbation theory. we also consider the tensor channel of this process which may provide a clue for beyond the Standard Model.



Keywords:
pion, instanton, form factor

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.05*
2016.10.19 - 2016.10.21

Pairing correlation effects in neutron star

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Abstract:
Symmetry energy is one of important quantities for understanding the equation of state of nuclear matter. Neutron star is considered as a typical nuclear matter one may observe in the cosmos. On the other hand, pairing interaction is known to play important roles in the nuclear structure of finite nuclei. In this work, we discussed the correlation between the pairing effects and the equation of state of neutron stars. First, we exploit Skyrme effective potential as the interaction in nuclear matter and calculate the equation of state. Second, we studied the equation of state by including the pairing effects within the HFB (Hartree Fock Bogoliubov) approache, which has been used to describe the nuclear structure. The equation of state obtained such a way is applied to describe various properties of neutrons stars.

Keywords:
Pairing, Neutron star, Symmetry energy

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.06*
2016.10.19 - 2016.10.21

Constraint of the spin assignments to the excited states in ^{23}Mg through a ^{24}Mg(p,d)^{23}Mg reaction

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Abstract:

The energy levels in ^{23}Mg have been studied through the ^{24}Mg(p,d)^{23}Mg transfer reaction by using a 41 MeV proton beam and an isotopically enriched ^{24}Mg solid target. Recoiling deuterons were detected by a large area silicon strip detector array. Excitateion energies of nine energy levels in ^{23}Mg were extracted, and angular distributions of the differential cross section for each level could be obtained. Spins and parities of three energy levels were constrained for the first time by comparing the experimentally obtained angular distributions with distorted wave Born approximation calculations.

Keywords:
^{24}Mg(p,d)^{23}Mg, Transfer Reaction, Level Structure, Excitation Energy, Differential Cross Section, DWBA Calculation,Spin-Parity Assignment

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H14.07*
2016.10.19 - 2016.10.21

Big bang nucleosynthesis with a non-Maxwellian distribution

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Abstract:

Non-Maxwellian distribution functions derived from the Tsallis' non-extensive statistics, are used to calculate the thermal nuclear reaction rates that contribute to the big bang nucleosynthesis (BBN). The primordial abundances of elements in the BBN are consequently affected by this non-Maxwellian statistics. In the present work, we determine, from the comparison with the observed abundances, the non-extensive parameter q by which the non-Maxwellian distributions are characterized.

Keywords:
Big bang nucleosynthesis, non-Maxwellian distribution, non-extensive statistics

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2016.10.19 - 2016.10.21

Performance Test of a Prototype Neutron Detector Array using 65-MeV and 392-MeV Neutrons at RCNP

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Abstract:
Neutron array detector is a part of LAMPS(Large Acceptance Multipurpose Spectrometer) that will be installed at the rare-isotope beam facility, RAON, in Korea. we performed neutron beam test at N0 beam line of RCNP cyclotron facility in Osaka University. We used quasi-monoenergetic neutron beam produced by the lithium target with 392MeV, 65 MeV proton beam. In this experiment, we set up 3 stations with 11 plastic scintillators(BC408) and took data with FADC. We will show test results about energy resolution, position resolution and basic study for finding multi-neutron.

Keywords:
neutron detectorFADC RCNP

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 H15.02
2016.10.19 - 2016.10.21

The present status of 10 kW target fabrication for ISOL in RISP

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Abstract:
Rare Isotope Science Project (RISP) is developing Isotope Separation On-line (ISOL) system to provide various rare isotope beams for the researches in basic science and application. Rare isotopes are produced in target grain (uranium carbide, UCx) by 70 MeV-10 kW proton beam via the proton-induced fission reaction. The 10 kW target system is designed to operate a temperature near 2,000 ° C taking into account the production rate, thermal analysis, and release efficiency. One of the main issues for the ISOL target is to develop an appropriate target material in terms of porosity and nano-structure for high release efficiency. Due to the difficulties in handling radioactive material, as a first step, we are performing the development of the lanthanum-carbide (LaC_2) disks with similar chemical properties to the uranium carbide. The LaC_2 disks with the diameter of up to 50 mm are synthesized by using suspension grinding and wet-mixing with multi-walled carbon nanotubes (MWCNTs) to have nano-structure. In this presentation, the present status of ISOL target fabrication will be reported.

Keywords:
RISP, ISOL, target, UCx, LaC2

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2016.10.19 - 2016.10.21

Development of HypTPC Software for the J-PARC E42 Experiment

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Abstract:

The J-PARC E42 experiment aims at searching for the H-dibaryon composed of six quarks(uuddss) using (K-,K+) reaction. A time projection chamber, called HypTPC, is a central tracking device of the E42 spectrometer, which reconstructs decay products from the H-dibaryon such as $\Lambda\Lambda$ or $\Lambda p\pi-$. The superconducting Helmholtz-type dipole magnet which surrounds HypTPC is also developed to apply the uniform magnetic field in its drift volume. The signal of drift electrons is amplified by triple GEM foils and read out by GET system via 5768 concentric pads around the target. This talk will cover recent development of a full simulation software for hit clustering and track reconstruction in the HypTPC. Performance of decoder and analyzer codes for a full readout system of the HypTPC will also be presented.

Keywords:
J-PARC, E42, TPC

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2016.10.19 - 2016.10.21

Low temperature measurement setup of simultaneous heat and light detection for 1 cm^3 crystals

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Abstract:
We have developed low-temperature measurement setup of heat (phonon) and light detection system based on MMC sensors for 111 cm^3 scintillation crystals. Using a scintillating crystal as a target material in particular, an extremely high energy resolution can be obtained with the phonon signals of the crystal. The MMCs are a kind of ultrasensitive thermometer used in cryogenic particle detection. A Ge wafer in 1.51.50.05 cm^3 is employed as the absorber of the scintillation light. By using the MMC sensors, we can simultaneously detect heat and light with the phonons of the crystal and the wafer. We present the principle and design concern of the simultaneous heat and light detection system and also introduce recent results and improvements.

Keywords:
Cryogenic, Crystal, Scintillation, MMC

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2016.10.19 - 2016.10.21

Growth and Characterization of Na_2O-MoO_3 content Crystals

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Abstract:
The AMoRE (Advanced Mo Based Rare Process Experiment) phase-I is going to use Molybdenum based $^{40}Ca^{100}MoO_4$ crystals to search for neutrino less double beta decay of ^{100}Mo. It is also looking for a new Mo content crystal for the AMoRE phase-II. We have developed two new crystals from Na_2O-MoO_3 phase by a Czochralski technique. We are going to present the detail procedure and difficulties of the growing process. Luminescence properties of the crystals were studied at room and low temperature by exciting samples with a laser source (266nm). Both of the crystals have very low light yield at room temperature. However, at 10 K, the light yield increases significantly. At 10 K, the light yields of both crystals were normalized to the $CaMoO_4$ crystal and found that $Na_2Mo_2O_7$ is higher while $Na_6Mo_{11}O_{36}$ is lower than the $CaMoO_4$ crystal. Decay times of both crystals were measured from 300 K to 10 K and are found to be long at 10 K in the range of ms. The $Na_2Mo_2O_7$ crystal might be a promising candidate of the Mo contained crystal for searching $0\nu\beta\beta$ decay due to its high light yield at low temperature and the fact that the purification techniques are well known for both Na_2CO_3 and MoO_3.

Keywords:
Czochralski technique, $Na_2Mo_2O_7$ crystal, $Na_6Mo_{11}O_{36}$ crystal, Light yield

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2016.10.19 - 2016.10.21

Simulations of cross section measurements for radiative-capture reaction using KoBRA

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Abstract:
The capture reaction of proton or alpha on proton-rich unstable nuclei is one of the most important topics in nuclear astrophysics. Because of the short life-times of proton-rich unstable nuclides, the direct measurement of the cross section of radiative-capture reaction requires inverse kinematics method using RI beams. In the measurement, the number of beam particles is about 10^{13} – 10^{15} higher than that of recoil particles since the cross section of radiative-capture reaction is extremely small. Particle detectors cannot identify beam and recoil particles with such high beam intensity, which means the spectrometer with high beam rejection capability is strongly required for the measurement. The Monte-Carlo simulations for the cross section measurements of the radiative-capture reactions were performed using current design of the KoBRA (KOrea Broad acceptance Recoil spectrometer and Apparatus) in order to examine the beam rejection capability. Details of the simulations will be presented with brief overview of the KoBRA facility.

Keywords:
Simulation, Radiative-capture reaction, RI beam, Recoil spectrometer, KoBRA

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Performance results for a PPAC for use with the KOBRA spectrometer

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Abstract:
We have fabricated two prototype delay type parallel plate avalanche counters (PPACs) intended for future use with the KOBRA spectrometer. A desire for precise position measurements at high count rates ($>10^5$ pps) motivated our design. Our prototype consists of a single biased electrode plane (10x10 cm^2) located between two strip segmented grounded electrode planes, allowing for both X and Y position measurements. Using 4.5 Torr of C_3F_8 gas we measured a position resolution of 0.85 mm and a time resolution of 420 ps FWHM, from an ^{241}Am alpha source.

Keywords:
PPAC, proportional counter, avalanche, detector, KOBRA spectrometer, IF separator, RAON

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Angular Distributions of Bremsstrahlung X-ray Emission from ECR Plasma

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Abstract:

High energy X-ray emission beyond a critical energy from ECR heating has long attracted much attention and its nature has yet been unsolved.We have measured bremsstrahlung X-rays from the 28-GHz ECR ion source at Busan Center of KBSI. The gamma-ray detection system consists of three NaI(Tl) scintillation detectors placed 62 cm radially from the beam axis at the extraction port, and a NaI(Tl) scintillation detector for monitoring X-ray intensity at the beam axis.Bremsstrahlung X-ray energy spectra were measured at 9 azimuthal angular regions at RF power of 1kW. We also measured bremsstrahlung X-rays by exchanging detector positions for studying systematic uncertainties.Detection efficiency and shielding effect are taken into account for extracting real X-ray energy spectra from measured ones, based on Geant4 simulation results. Preliminary results on the azimuthal angular distributions of bremsstrahlung X-rays with respect to energy region will be presented.

Keywords:

ECRIS, NaI(TI), RF power, X-ray, Axial, Radial.

포스터발표논문

Poster session abstracts

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Synthesis and characterization of SnO & SnO2 nanowires by thermal CVD under hydrogen atomsphere

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Abstract:

We report the characteristics of individual ultra-long SnO_2 nanowires(NWs) grown on sapphire(0001) substrates using a vapor transport method. NWs, with typical lengths of 〉400 mm, grew in NW bundles under a H_2 reducing atmosphere, without metal catalysts. Individual NWs were examined using high-resolution X-ray diffraction, transmission electron microscopy, and micro-Raman spectroscopy. The results revealed that the SnO_2 NWs grew as high-quality, tetragonal-rutile-phase single crystals with mosaic distributions of 0.02° and 0.026° in the (101) and (110) planes, respectively.

Keywords:
SnO_2; Nanowires; Vapor transport method; hydrogen reducing atmosphere; X-ray techniques; Raman.

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Screw-Dislocation-Driven Growth of ZnO Nanotubes Seeded by Self-Perpetuating Spirals during Hydrothermal Processing

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Abstract:

We report the effects of precursor concentration on the characteristics of ZnO nanostructures during hydrothermal processing. Self-perpetuating surface spirals are fabricated at concentrations of 0.25 and 0.5 M, with samples grown at concentrations of 0.05 and 0.125 M exhibiting ZnO nanorods. This can be explained by a change in the growth mode from an initial columnar growth to a screw-dislocation-driven growth with decreased supersaturation. The screw dislocations nucleate at the V-shaped valleys of the columnar boundaries during the intermediate stage. We demonstrate that continuous screw-dislocation-driven growth leads to the formation of ZnO nanotubes having Burger's vectors of 1.45 nm.

Keywords:
ZnO, Screw-dislocation-driven growth, Self-perpetuating spirals, Hydrothermal growth, Nanotubes

Chemical doping for Low Contact Resistance and De-Pinning at the Interface of Molybdenum Based Chalcogenides and Metals

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Abstract:

MoS_2 and $MoTe_2$ are the promising two dimensional materials, having sizable band gap that is suitable for future semiconductor applications. However, large Schottky barrier is induced along these materials and contact metals interface due to strong Fermi level pinning. Also, the high contact resistance (>10 kΩ μm) due to the high Schottky barrier sets off small source-drain current, so that it limits the usage of novel semiconductor device.[1)] In this work, we investigate the interfacial Schottky barrier formed between mono- or bi-layer MoS_2, $MoTe_2$ and Ti, Cr, Au, Pd. By varying temperature in the range from 200 to 500 K, we obtained their current - voltage and hysteresis characteristics so as to determine accurate Schottky barrier heights and their relative pinning factors. The interface trap density and charge neutral levels are calculated from the measured pinning factors. They show that the defect density affects the degree of pinning and we can predict the location of the pinned energy levels from it. Benzyl viologen and gold chloride are the effective n- or p-type doping solutions for MoS_2 and $MoTe_2$. Using these chemical dopants, we can achieve a reduced contact resistance < 3 kΩ μm and de-pinned interfaces. These results are found to be crucial to resolve the Fermi level pinning and high contact resistance issues of two dimensional materials, which can be used to develop highly efficient, flexible devices based on two dimensional materials. References 1. D. Jena, K. Banerjee and G. H. Xing, Nature Mat., Vol 13, (2014).

Keywords:

Fermi level pinning; Chemical doping; Two dimensional material; Depinning; Schottky barrier

Defect density reduction at Ge interface by oxidation through a capping layer

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Abstract:

Ge is a promising candidate to replace Si in MOSFET because of its superior carrier mobility, particular that of the hole. However Ge oxide is thermodynamically unstable. At elevated temperature, GeO is formed at the interface of Ge and GeO2, and its formation increases the interface defect density, degrading its device performance. In search for a method to surmount the problem, we investigated Ge oxidation through an inert capped oxide layer. For this work, we prepared low doped n-type Ge (100) wafer by removing native oxide, oxidizing in a furnace and depositing a capping layer, and show that GeO2 interface can be successfully recovered through the capping layer by additional thermal oxidation in a furnace. The thickness and quality of thus grown GeO2 interface was examined by ellipsometry and XPS along with I-V and C-V measurements performed at 100 K to 300 K. We will present the result of our investigation, and provide the discussion on hysteresis, interface state density and electrical characteristics in comparison with other studies using the direct oxidation method.

Keywords:
MOSCAP, Germanium, GeO2, Ge oxidation, C-V measurement

Electric transport properties of thin monoclinic $MoTe_2$ fabricated by laser thinning

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Abstract:

Two-dimensional layered transition metal dichalcogenides (TMDs) have attracted academic interests by their diverse lattice structures, producing novel electrical, physical, and mechanical properties. In particular, thickness control of TMD materials has recently appeared as a promising way to manipulate electronic properties of the TMDs, but conventional chemical and physical fabrication methods produced only non-homogeneous and arbitrary thickness distributions in the TMD applications. Here, we report local heating and thickness-dependent electric properties of $MoTe_2$, including metal-semiconductor transition. We fabricated few-layered monoclinic $MoTe_2$ channel devices without additional chemical lithography or etching steps and derived carrier concentration in the thinned channel. Importantly, semiconducting behavior in laser-thinned few-layered monoclinic $MoTe_2$ device has been observed. We believe that the optical method to fabricate thin TMDs would be a technical breakthrough for future electronics.

Keywords:
$MoTe_2$,2-dimension device, TMDs, 2d materials, hall effect, nano device

Asymmetric Nanoporous Ta_2O_{5-x} Memristor for Neuromorphic System

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Abstract:

Memristor composing of a simple metal-oxide layer sandwiched between two conducing electrodes is being envisioned as a technical platform to imitate the principal of biological synapse system due to its nonlinear and dynamic electrical characteristics depending on the history of applied electrical pulse [1,2]. Here we introduce asymmetric nanoporous (NP) Ta_2O_{5-x} memristor device using anodic treatment in a room-temperature process and utilized it as a synaptic device. The device exhibits a self-embedded highly nonlinear I-V switching behavior with asymmetric morphing rectifier feature depending on the voltage polarity and sweep direction, which can effectively prevent a sneak current in a densely integrated array structure. From the reversible modulation of oxygen vacancy and contact transformation of NP Ta_2O_{5-x} memristor depending on the electrical pulse, the synaptic functions such as long and short-term potentiation (or depression) and synaptic learning rule (Spike timing dependent plasticity, STDP) will be presented. [1] Wang, G.; Lee, J. H.; Yang, Y.; Ruan, G.; Kim, N. D.; Ji, Y.; Tour, J. M. Nano Lett. 2015, 15, 6009-6014. [2] Volos, C. K.; Kyrpianidis, I. M.; Stouboulos, I. N.; Tlelo-Cuautle, E.; Vaidyanathan, S. J. Engin. Sci. Tech. Rev. 2015, 8, 157-173

Keywords:
Nanoporous, tantalum oxide, memristor, neuromorphic system, synaptic device

Photodetector device of the transferred large area synthesized few layers $MoSe_2$ on arbitrary substrate

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Abstract:

Transition metal dichalcogenides (TMDCs) has been studied for promising optoelectronic device because they are direct band gap and sub nanometer thickness. We studied molecular beam epitaxy (MBE) method for large area $MoSe_2$ facilitating a direct exfoliation-less device fabrication. We evaporated Mo element by e-beam and Se element by Knudsen cell. We investigated the chemical composition of the few layers film by high resolution X-ray photoelectron spectroscopy (HRXPS) and confirmed the optical band gap by photoluminescence (PL). Atomic force microscopy (AFM) and Raman spectroscopy was examined to confirm the film thickness and synthesis. In addition, PL and Raman mapping were examined to show the uniform large area $MoSe_2$ film. In order to measure scanning transmission electron microscopy (STEM), we transferred the $MoSe_2$ films on TEM grid with polystyrene/toluene solution. We confirmed the films with top view and veretical view, resulting in the formation of high quality film. Finally the $MoSe_2$ films was transferred on arbitrary substrate. E-beam lithography was conducted to pattern photo device on the transferred film. We examined photoreponse characteristics with 532 nm laser, showing the photo-dector device. This study would provide potential application of large area synthesis method, macroscopic device fabri-cation and optoelectronic devce.

Keywords:

$MoSe_2$, Molecular beam epitaxy, Photoluminescence, Raman spectroscopy, Scanning transmission electron microscopy, Photodector

Single nanoporous structure-based silicon oxide memory

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Abstract:

Oxide-based resistive memory has had meteoric rise as one of strong candidates for sustaining the explosive growth of the nonvolatile memory industry due to its nanoscale footprint, fast switching speed, and low power consumption [1]. Previously, we reported the multiple nanoporous (NP)-structure based SiO_x memory fabricated by anodizing process which enables unipolar switching feature through its several vertical-nanogap [2]. In this study, we fabricated a well-defined single nanopore structure (diameter ~20-30 nm) in a deposited SiO_2 on a substrate using a nanopore technique which is driven by thermally assisted metal evaporation and oxide migration and was recently invented as a nanometric tool [3]. This single nanopore can allow a fabricated memory device to limit the size of switching filament and lead to the enhancement of switching operational stability. After the formation of nanopore structure, Au was deposited on the NP structure and utilized as top electrode. The single NP structure-based SiO_x memory cell was completed after the electromigration process of the deposited Au wire. We will mainly present the fabrication method of single NP structure-based SiO_x memory and its switching characteristics. [1] Rainer Waser, Masakazu Aono, Nat Mater., 2007, 6, 833. [2] G. Wang, Yang, Yang, Lee, Jae-Hwang, Abramova, Vera, Fei, Huilong, Ruan, Gedeng, Thomas, Edwin L., Tour, James M., Nano Lett., 2014, 14, 4694. [3] Lennart J. de Vreede, Albert van den Berg, and Jan C. T. Eijkel, Nano Lett., 2015, 15, 727.

Keywords:

Nanoporous, silicon oxide, nonvolatile, memory, resistive, switching

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Room-temperature detection of vapor-phase hydrogen peroxide using Pt-decorated carbon nanotube networks

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Abstract:
The Pt-decorated single-walled carbon nanotube (SWCNT) network films are demonstrated and utilized as sensor transducers for determination of vapor-phase hydrogen peroxide at room temperature. The Pt-decorated SWCNT films are coated on a SiO_2/Si substrate by spray deposition and then incubation in the H_2PtCl_6 solution under UV radiation with wavelength of 254 nm for 1 min. After heat treatment at moderate temperature, the Pt nanoparticles are aggregated on the SWCNT surfaces. Furthermore, the nanoparticle size could be modulated by controlling the mole concentration of H_2PtCl_6 solution. By forming interdigitated electrodes on the Pt-decorated SWCNT films, the sensor transducers are fabricated for the determination of vapor-phase hydrogen peroxide and showed a sensitive detection down to 50 ppm.

Keywords:
Carbon nanotube; Pt nanoparticles; Vapor-phase hydrogen peroxide

Enhanced MoS_2 characteristic in 2D material junction structure based on MoS_2

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Abstract:
Recent Rapid progress in basic property and applications of MoS_2 has been accompanied by an explosion of interest in other 2D material instead of graphene. $TMPS_3$(TM=Fe, Ni, Mn, etc.), which still has a lot of unopened properties, is also have attracted much attention in 2D material area. Here, graphene/$FePS_3$/MoS_2 structure on SiO_2 substrate by transfer shows advanced mobility of MoS_2 of ~49.6 cm^2/Vs. It leads more interest and possibility that improved electrical characteristic of MoS_2 can be verified, especially transferred on the $FePS_3$. Furthermore thickness of $FePS_3$ can effect to electrical characteristic of MoS_2 as a channel in above structure. Additionally, we study that junction of MoS_2 and $FePS_3$ exhibits an attractive effect.

Keywords:
2D material, MoS_2, $TMPS_3$, junction

Nanoporous Anodic Aluminum Oxide의 고효율/친환경 제작 및 응용성 연구

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Abstract:

Nanoporous Anodic Aluminum Oxide (AAO)는 다양한 분야의 연구와 산업에 널리 활용되고 있다. 그러나 AAO의 제작과 관련된 기존의 기술은 Aluminum(Al)의 낮은 재활용성, 인체 및 환경에 유해한 독성물질의 사용, 긴 공정시간에 기인한 낮은 수득률 등의 단점을 지닌다. 본 연구에서는 Simultaneous Multi-Surfaces Anodization (SMSA)과 Stair-like Reverse Biases(SRBs)를 이용한 AAO 분리 기술을 결합하여 기존의 문제점을 극복할 수 있는 방안을 제시한다. 본 기술의 장점은 Al의 다중표면에서 동시에 AAO를 제작하기 때문에 기존의 Anodizing 조건에서도 수득률을 500% 이상 증가시킬 수 있다는 점이다. 그리고 Mercury Chloride나 Copper Chloride 또는 Bromine 등과 같은 독성물질로 Al을 용해하여 AAO를 얻는 기존의 방볍과 달리, SRBs을 이용하면 Anodizing에 사용된 Acidic Electrolyte에서 AAO를 Al으로부터 직접 분리할 수 있다. 또한, AAO가 분리된 Al은 재사용이 가능하므로 자원활용의 효율성을 높인다. 이렇게 얻어진 AAO를 이용하여 Gold 및 π-Conjugated Polymer를 Nanowire 및 Nanotube의 형태로 각각 합성하였으며, Nanoporous Template로의 응용성을 확인하였다. Nanoporous AAO의 Barrier Oxide Layer 위에 Interdigitate Electrodes를 형성하여 Capacitive Humidity Sensor를 제작하였으며, 상대적으로 낮은 Relative Humidity 구간에서 Capacitance가 Linear하게 변화함을 확인하였다.

Keywords:

Keywords: Anodic Aluminum Oxide, Simultaneous Multi-Surfaces Anodization, Stair-like Reverse Biases, Nanowire, Nanotube, Capacitive Humidity Sensor

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Resistance change of ion beam irradiated graphene

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Abstract:
Amount of defects in graphene can be controlled by ion beam irradiation. Moreover, it is reported that the defective graphene has higher adsorption energy than a pristine graphene, indicating that the resistance change of the defective graphene is more dramatic than a pristine graphene at different atmosphere. We discuss that the ion beam irradiated graphene can be used as a sensitive gas sensor.

Keywords:
Graphene, Ion beam irradiation, Defect

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An optimization of composition for supercapacitors using experimental design with mixture components

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Abstract:
Supercapacitors, also being called ultracapacitors, electrochemical supercapacitors(ECs) have recruited substantial research attentions due to their advantages such as fast charge/discharge rates, long cycle life, high power density. Recently, it is well known that the optimum composition is closely related to the performance of these devices. However, there are few studies on systematic approach to find the optimum mixing proportion of the components. Thus, we suggest a statistically systematic way to find the optimum mixing rates of three components that are reduced graphene oxide (rGO), acetylene black (AB), and polyvinylidene fluoride (PVDF) by using the extreme vertices design for the purpose of attaining the maximum specific capacitance. We found that the best mixing proportion (rGO : AB : PVDF = 0.95 : 0.00 : 0.05). That is, among three components, acetylene black had a little effect on our response, specific capacitance. We also present our study results searching for the reason of the performance improvements through the electrochemical measurements, scanning electron microscopy analyses.

Keywords:
Supercapacitor, Graphene oxides, Mixture design, extreme vertices design

Observations of Au nanoparticles within the well structure using scanning electron microscope through reduced or non-reduced graphene oxide layers

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Abstract:

Graphene is very strong, flexible and very thin of a single-atom thickness material. Because of its thinness, graphene can pass through the electron beam of the microscopes without a significant dispersion. From various development of nanotechnologies, the need to protect delicate structures on the surface while preserving microscope-observation capability is arising. To protect the surface of the sample while maintaining electron-microscope-observation capability, covering the surface with reduced or non-reduced graphene oxides may be implemented. Herein, we have studied the effects of covering the surface coated with Au nanoparticles with reduced or non-reduced graphene oxide with and without a polymer support layer. These layers were transferred on to the Au particle coated micro-well structure. Our observation indicated that scanning electron microscope images of the particles were not significantly distorted while the distribution of the nanoparticles was preserved from a harsh surface treatment of water-submerged ultrasonication. Such protection was observed even inside of the concave structure of micro-wells. Our results may promote the protected observation of the various nanostructures (e.g. DNA-like material) utilizing graphene-derived layers.

Keywords:

Graphene oxides, Graphene oxides windows, scanning electron microscope, Au nanoparticle

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Investigation of the performance change of the graphene-based supercapacitors after a proton irradiation

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Abstract:
Graphene, a two-dimensional (2D) allotrope of carbon where carbon atoms are arranged in a hexagonal structure, has been the subject of many fascinating studies since its discovery. Its unexpected stability, combined with nearly massless behavior of its charge carriers, and large specific surface area make it a unique choice for the supercapacitor application. Due to its durability and light weight, supercapacitors can be a potential device for the space applications. However, the durability of graphene-based supercapacitors in the space environment should be investigate for such possibility. Herein, a proton irradiation is used for the purpose of investigating on the radiation stability the graphene-based supercapacitor electrodes. The irradiation simulates the cosmic radiation in outer space. Our results indicate that the proton irradiation did not have any decisive effect on the supercapacitor electrodes. Furthermore, Raman spectroscopy, XPS, and AFM measurements were used to analyze the property change of the graphene layer after the proton irradiation.

Keywords:
Supercapacitor, Proton irradiation, Graphene oxides, Graphene

Fabrication of bilayer VO_2 films

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Abstract:

Vanadium dioxide (VO_2) exhibits metal-to-insulator (MI) transition when heated to its transition temperature (T_{MI}) of 68℃. The VO_2 is an monoclinic insulator below T_{MI}, and the tetragonal metal above T_{MI}. This phase transition makes VO_2 a promising candidate for a non-volatile resistive random access memory (ReRAM), which typically require a high density integration. A non-volatile multi-level memory is being desired for next generation memory. In this study, we fabricated a bilayer VO_2 films each of which possesses different T_{MI} to be used as a multi-level ReRAM device. The VO_2 films were deposited on TiO_2 (001) substrates using pulsed laser deposition (PLD). We analyzed layer-by-layer crystallinity of VO_2 film, of which a deposition oxygen pressure is 20 mTorr and 40 mTorr, respectively. The top electrode is composed of 50 nm thick Ti and 100 nm-thick Au. We will present metal-insulator transition behaviors of bilayer VO_2 films depending on the temperature and an external electric field.

Keywords:
Metal-insulator transition, vanadium dioxide, oxygen pressure, pulsed laser deposition, multi-level device

Magnetization switching driven by spin-orbit torque in exchange-biased magnetic tunnel junctions

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Abstract:

The magnetization switching by spin-orbit torque provides an alternative route to operate magnetoresistive random access memory (MRAM) devices [1]. The key elements of this approach are the transverse spin current generated by in-plane charge current in ferromagnet/ heavy metal structures and the magnetization switching driven by the spin current. The switching of the magnetic layer is, in many cases, proved by the anomalous Hall effect while the magnetization switching in full magnetic tunnel junction (MTJ) structure is scarcely reported because of the difficulties in the fabrication process [2]. Here we report the spin-orbit-torque driven switching of in-plane magnetic layer in exchange-biased MTJs. The MTJ layer stack consists of Ta/ CoFeB/ MgO/ CoFeB/ Ru/ CoFe/ IrMn/ Ta/ Ru. The stack is patterned into nano-scale MTJs having three-terminal geometry, and the junction size is 200 nm × 80 nm. By flowing current in the bottom Ta layer, it is possible to switch the bottom CoFeB free layer while the top CoFeB layer is pinned by the synthetic antiferromagnetic structure. The magnetization switching is monitored by measuring tunnel magnetoresistance of the MTJ. We have analyzed the relation between the critical switching current and external magnetic field by measuring magnetoresistance switching curves with varying in-plane current and external magnetic fields. It is shown that the CoFeB free layer is switched by an in-plane current of 2.0 mA even without external magnetic fields. This experimental result obtained with the exchange-biased MTJ raises prospect for the spin-orbit-torque MRAM devices. [1] Liu et al, Science 336, 555 (2012). [2] S. V. Aradhya et al, Nano Letters 6b01443 (2016).

Keywords:

spin-orbit torque, MRAM, spin current, magnetic tunnel junction (MTJ)

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CO oxidation of Palladium Nanoparticles on Different Carbon Supports: Nanodiamond and Onion-like carbon

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Abstract:

Recent study showed that CO oxidation of palladium nanoparticles on Nanodiamond (Pd NPs @ND) occured at much lower temperature than palladium nanoparticles on Onion-like carbon (Pd NPs @OLC), exhibiting enchanced catalytic activity of Pd NPs @ND in CO oxidation [1]. It is estimated that modified electronic structure of Pd NPs on these carbon supports altered the bonding interaction between Pd NPs and CO. In this study, we conducted in situ CO oxidation of Pd NPs @ND and Pd NPs @OLC substrates using ambient pressure X-ray photoemission spectroscopy (AP-XPS) to monitor the chemical states of Pd NPs during the reaction. Powdered samples (Pd NPs @ND and Pd NPs @OLC) were prepared in ethanol solution and dropped onto the gold coated silicon wafer. Graphitic layers on the samples were removed by hydrogen annealing pretreatment. Then, under the pressure of 20 mTorr of CO and 100 mTorr of O_2 gas, temperature was gradually increased until CO oxidation reaction start. With in situ mass spectrometer attached to AP-XPS chamber, enabling real-time monitoring CO oxidation reaction time and temperature, Pd NPs @ND showed the enhancement of CO oxidation at 408 K while Pd NPs @OLC at 454 K, confirming lower energy barrier of Pd NPs @ND during CO oxidation process. The measured XPS data of high resolution Pd 3d spectra immediately after CO oxidation displayed three components, i.e. surface Pd oxide, bulk Pd oxide, and Pd-carbide. It showed that the intensity of oxide peak in Pd NPs increases during CO oxidation, implying Pd oxide play a critical role in CO oxidation process. References [1] L. Zhang, et al., Angew. Chem. Int. Ed., 2015, 54, 15823-15826.

Keywords:
Nanodimond, Onion-like carbon, CO oxidation, Palladium nanoparticle, Ambient pressure X-ray photoemission spectroscopy, AP-XPS

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Excitonic resonance Raman effects of thin film WS_2

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Abstract:

We investigated Raman spectra of thin film WS_2 using seven different excitation energies in the range of 1.96 to 3.81 eV. Because of complicated excitonic band structures, transition metal dichalcogenides show anomalous resonant Raman behaviors. Some peaks, including some second-order peaks, are enhanced when the excitation energy matches with exciton states. Also, in the low frequency region (<80 cm^{-1}), several new peaks appeared in addition to the breathing and shear modes. We observed a broad central peak and new peaks at 28 cm^{-1} and 46 cm^{-1} when the excitation energy matches the A and B exciton states. Also, additional breathing-like peaks were observed below 20 cm^{-1} at resonance with the A exciton. Furthermore, we observed selective enhancement of each Raman mode with different exciton states. Because the E_{2g}^1 mode peak overlaps with the 2LA signal, we used polarized Raman measurements to resolve the E_{2g}^1 mode peak. We found that the A_{1g} and 2LA modes are enhanced near resonance with the A, B and C exciton states whereas the E_{2g}^1 mode is enhanced only near the C exciton state. Also, shear and breathing modes are strongly enhanced near the C exciton state.

Keywords:
Resonant Raman spectroscopy, Tungsten disulfide, Exciton, TMDs

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First-order Raman modes in few-layer WSe_2

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Abstract:

We present a Raman analysis with eight different lasers ranged from 325 to 784.8 nm to investigate the resonance effects in few-layer and bulk WSe_2. The E_{2g}^1 and A_{1g} modes near 250 cm^{-1} appear as a single peak in a unpolarized Raman spectrum but can be resolved by using circularly polarized Raman spectroscopy. The resonance behaviors of the E_{2g}^1 and A_{1g} modes were examined. Firstly, both the E_{2g}^1 and A_{1g} modes were strongly enhanced at ~2.4 and ~2.8 eV. For the E_{2g}^1 mode, the resonance at ~2.8 eV was most prominent. The E_{1g} (at ~176 cm^{-1}) and A_{2u} (at ~308 cm^{-1}) modes appeared only in spectra taken with specific lasers. For example, the E_{1g} mode was only visible for 2.71 and 2.81 eV lasers. The A_{2u} mode was visible for 2.33 to 3.81 eV with a weak resonance for 2.54 eV. The first-order Raman modes exhibit Davydov splitting for layer number larger than 2. In few layer WSe_2, the A_{1g} mode has a strong dependence on the number of layers and the excitation energy so that the intensity ratio between the split peaks A(1) and A(2) drastically changes upon the two parameters.

Keywords:

WSe_2, Tungsten Diselenide, Raman spectroscopy, Davidov splitting

Resistive switching in epitaxial brownmillerite oxide thin films by touching a probe tip to an active layer

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Abstract:

Metal-Insulator-Metal (MIM) structures are the most promising configuration for next generation memory storage, due to their simple structure and fabrication-friendly design. The MIM structures associated with filamentary-like conduction have attracted significant attention in the last years because of their potential relevance in resistive random access memory (RRAM). The formation and rupture of conducting filaments in these devices results in existence of two metastable resistance states: the high resistance state (HRS) and low resistance state (LRS), which can be represented as the logic values '0' and '1', respectively. Recently, we have discovered that epitaxial brownmillerite oxides like $SrCoO_x$ and $SrFeO_x$ thin films are strong candidate for RRAM application due to their ability to form perpendicular and uniform conducting filaments, which was explained to be due to existence of alternating octahedral and tetrahedral layer inherent in brownmillerite structure. In this work, we studied the resistive switching parameters in these materials by placing the Au plated probe tip directly on the $SrCoO_x$ and $SrFeO_x$ surfaces, instead of using large area top electrodes grown on top of the brownmillerite oxides. The switching behaviors for the SrCoOx device without top electrode was found to be much better than that for the SrCoOx device with top electrode. In addition, the LRS and HRS of SrCoOx device without top electrode was more stable with time than those of SrCoOx with top electrode. We also did the similar measurements for the device based on $SrFeO_x$. Reference O. T. Tambunan, K. J. Parwanta, S. K. Acharya, B. W. Lee, C. U. Jung, Y. S. Kim, B. H. Park, H. Jeong, J. Park, M. R. Cho, Y. D. Park, W. S. Choi, D. Kim, H. Jin, S. Lee, S. J. Song, S. Kang, M. Kim, C. S. Hwang, Appl. Phys. Lett. 2014, 105, 063507. S. K. Acharya, R.V.Nallagatla, O. T. Tambunan, B.W. Lee, C. Liu, C. U. Jung, B. H. Park, J. Park, Y. Cho, D. W. Kim, D. H. Kwon, M .Y . Kim, C. S. Hwang, and S.C.Chae, ACS Applied Materials & Interfaces 2016 8 (12), 7902-7911.

Keywords:
Brownmillerite structure,RRAM,without top electrode

Scalable Production of Sensor Arrays based on High Mobility Hybrid Graphene Field Effect Transistors

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Abstract:
We have developed a scalable fabrication process for production of DNA biosensors based on gold nanoparticle-decorated graphene field effect transistors (AuNP-Gr-FETs), where monodisperse AuNPs are created through physical vapor deposition followed by thermal annealing. The FETs are created in a four-probe configuration, using an optimized bilayer photolithography process that yields chemically clean devices, as confirmed by XPS and AFM, with high carrier mobility (3590 ± 710 cm2/V-s) and low unintended doping (Dirac voltages of 9.4 ± 2.7 V). The AuNP-Gr-FETs were readily functionalized with thiolated probe DNA to yield DNA biosensors with a detection limit of 1 nM and high specificity against non-complementary DNA. Our work provides a pathway toward the scalable fabrication of high-performance AuNP-Gr-FET devices for label-free nucleic acid testing in a realistic clinical setting.

Keywords:
Graphene gold nanoparticle DNA sensing

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Electrical Characterizations and Anisotropic Properties of GeSe Nanoflakes

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Abstract:
GeSe is an orthorhombic layered structure and its electrical and optical properties strongly depend on the number of layers and crystal directions. We study the basic properties of GeSe nanoflakes, especially focusing on the anisotropic optical transmittance and Raman spectroscopy as well as electrical characterizations. GeSe field effect transistors exhibit decent charge carrier mobility as well as high photo-response. The layer-number-dependent properties of GeSe flakes will be also briefly discussed.

Keywords:
GeSe,Orthorhombic layered structure,Anisotropic, 2D material, Photo-response

코어-셀 양자점을 포함한 polyvinylpyrrolidone 나노복합체를 기반으로 제작한 비휘발성 메모리 소자의 전기적 특성과 동작 메커니즘

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Abstract:
나노 입자를 포함한 유기물/무기물 나노복합 소재를 기반으로 한 비휘발성 메모리 소자에 대한연구는 나노복합체의 물성적인 연구와 차세대 플렉서블 기기에 응용 가능성 때문에 관심을 받고 있다. 금속입자를 포함한 유기물층을 활성층으로 사용한 비휘발성 메모리 소자에 대한 제작과 전기적 특성에 대한 연구는 많이 진행되었으나 코어-셀 양자점을 포함한 폴리머를 활성층으로 사용한 비휘발성 메모리 소자에 대한 전기적 특성과 동작 메커니즘에 대한 연구는 상대적으로 적게 진행되었다. 본 연구에서는 코어-셀 양자점을 포함한 polyvinylpyrrolidone (PVP) 층을 스핀 코팅 방법을 사용하여 비휘발성 메모리 소자를 인듐 주석 산화물이 코팅된 유리 기판 위에 제작하였다. 알루미늄/코어 셀 양자점을 포함한 PVP 층/인듐주석산화물/유리 소자의 전류-전압 특성은 전기적 쌍안정 특성을 보여주었다. 동일 전압에서 높은 전도도 상태와 낮은 전도도 상태의 전류비율이 10^4으로 관측되었다. 소자의 내구성과 안정성을 관측하였다. 관측된 전기적 특성과 에너지 밴드 개략도를 기반으로 코어-셀 양자점을 포함한 PVP 층으로 형성한 나노복합체를 사용한 소자의 전기적 특성과 동작 메커니즘을 규명하였다. Acknowledgement This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2016R1A2A1A05005502).

Keywords:
나노입자, 비휘발성 메모리 소자, 코어-셀, 전기적 쌍안정 특성, 나노복합체

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Improved Photosensitivity of MoS_2 Field Effect Transistors by Surface Treatment with Copper Phthalocyanine

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Abstract:

Recently, transition metal dichalcogenide (TMD) two-dimensional (2D) materials have gained a considerable interest as a candidate for next generation nanoelectronic devices. Among the various TMD materials, molybdenum disulfide (MoS_2) has been widely researched as 2D field-effect transistors (FETs) and exhibited outstanding electrical properties [1]. In contrast to graphene which lacks an energy band gap, MoS_2 has a direct band gap of 1.8 eV as a single layer and an indirect band gap of 1.2 eV as a multilayer MoS_2. Becuase of these band gap properties of MoS_2, the photodetectors made with MoS_2 have exhibited excellent photoreponse properties. Beyound the structure of MoS_2 FET alone, it has been demonstrated the MoS_2-based heterostructure through stacking other p-type materials results in higher photoreponsivity [2]. Organic materials can be a good choice to form vertical p-n hybrid heterostructure, because p-type organic semiconductor layers have been extensively studied and can be easily stacked on 2D films by spin-coating or deposition systems, and the thickness of the organic layer on 2D films can be accurately controlled.
In this study, I report the photoresponsive properties of MoS_2 FET-based photodetectors by stacking copper phthalocyanine (CuPc) layers on the MoS_2 surface [3, 4]. We characterized and compared the photodetection ability and photoresponse times (rise and decay times) of MoS_2 devices prior to and after the devices were stacked with p-type organic semiconductor (CuPc) layers on the MoS_2 surface. Consequentially, we could improve the photoresponsivity of devices throughout the wavelength ranges and under different intensity. This study suggests that the MoS_2 hybrid structure with organic material can be promising as efficient photoswitching devices and optoelectronic circuits.
References [1] B. Radisavljevic, A. Radenovic, J. Brivio, V. Giacometti and A. Kis, Nature Nanotechnology, 6, 147 (2011). [2] D. Kufer, I. Nikitskiy, T. Lasanta, G. Navickaite, F.H.L. koppens, and G. Konstantaos, Adv. Mater. 27, 176 (2015). [3] Jinsu Pak, Jingon Jang, Kyungjune Cho, Tae-Young Kim, Jae-Keun Kim, Younggul Song, Woong-Ki Hong, Misook Min, Hyoyoung Lee, and Takhee Lee, Nanoscale, 7, 18780 (2015). [4] Jinsu Pak, Misook Min, Kyungjune Cho, Der-Hsien Lien, Geun Ho Ahn, Jingon Jang, Daekyoung Yoo, Seungjun Chung, Ali Javey, and Takhee Lee, submitted (2016).

Keywords:
Transition metal dichalcogenide, MoS2, photodetector

Generation and transport of photo-generated carriers in P3HT/Si nanopillar arrays

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Abstract:

In spite of numerous merits of organic materials, the extremely short exciton diffusion lengths in organic semiconductors (~20 nm) limit the photovoltaic performance of the organic solar cells. Thus, organic/Si hybrid (OSH) nanostructured devices have been proposed to improve the carrier collection efficiency, taking advantages of high carrier mobility of Si and the enlarged junction area. In this study, we fabricated Si nanopillar (NP) arrays coated with poly(3-hexylthiophene-2,5-diyl) (P3HT) organic semiconductor layers. Optical reflection spectra and simulated results showed that Mie resonance significantly increased the scattering cross-sections of the NPs and concentrated incident light in the NPs. To investigate the local behaviors of the carriers, we studied the surface photovoltage (SPV) characteristics of the OSH nanostructures using the Kelvin probe force microscopy technique. Under red light, SPV values at the NP top was much larger than planar sample. Such SPV behavior directly revealed that the concentrated light produced numerous charge carriers in the NPs. This suggested that the optical resonance in OSH nanostructures benefits not only broad-band light trapping but also efficient carrier collection.

Keywords:

Hybrid nanostructure, P3HT, Si, surface photovoltage, Mie resonance

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Synthesis and Characterizations of Copper Phosphide-Graphene Heterostructure

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Abstract:
Graphene-semiconductor junctions have great potential in various electronics, such as photodetector, photovoltaics, gas sensor, and vertical transistor. Here we fabricate vertical heterostructures composed of copper phosphide (Cu_3P) on graphene. The stacking relation between Cu_3P crystals and graphene is investigated using transmission electron microscopy (TEM). We also explore the possibility of using Cu_3P-graphene device for vertical transistor as well as photodetector applications.

Keywords:
graphene, copper phosphide, heterostructure, synthesis

Electrical transport of single layer reduced graphene oxide

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Abstract:
We investigate transport properties on a single layer reduced graphene oxide (RGO). The sample is prepared by bubble deposition method and thermal reduction. The temperature dependent charge transport data reveal that charge conduction in the RGO is governed by Efros-Shlovskii variable range hopping between localized state. A coulomb gap is suppressed at high carrier density. We also observed field driven hopping transport at low temperature and high electric field regime.

Keywords:
graphene oxide, transport, variable range hopping

Apparent Power Law Scaling in Single Carbonized Polymer Nanofibers

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Abstract:

We induce dramatic changes in the structure of conducting polymer nanofibers by carbonization at 800 ^{o}C and compare charge transport properties between carbonized and pristine single nanofibers. Despite the profound structural differences, both types of systems display power law dependence of current with voltage and temperature, and all measurements can be scaled into a single universal curve. We analyze our experimental data in the framework of variable range hopping and argue that this mechanism can explain transport properties of pristine polymer nanofibers as well.

Keywords:
Polymer nanofibers, Polyacetylene, Polyaniline, Carbonization, Pyrolysis, Variable range hopping, Non-linear transport, One dimensional transport

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Efficient optimization for ultrathin metamaterial perfect absorbers at VHF and THz bands

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Abstract:
We design and realize an ultrathin metamaterial perfect absorber (MPA) for VHF band (30-300 MHz). By the proper optimization, the perfect absorption is achieved at 250 MHz and the thickness (t) of MPA with respect to working wavelength (λ) is efficiently minimized to be $t/\lambda=1/240$. The proposed MPA exhibits the polarization-independent behavior and can maintain the absorption over 90% up to 45^{o} for incident angles of electromagnetic wave. To evaluate the preeminent advantage of the proposed MPA, a thermo-tunable THz MPA, based on a ferroelectric material (STO), is also investigated by scaling down the initial design. It was found that the perfect absorber works at room temperature (300 K) with an ultrathin thickness of $t/\lambda=1/300$. Particularly, a fractional frequency shift of 49% is reached (while the absorption is still over 90%) by controlling the temperature of STO from 150 to 400 K. Our work is expected to contribute to the development of future devices working from the radio to the THz ranges. This work was supported by the ICT R&D Program of MSIP/IITP, Korea (13-911-01-101).

Keywords:
Metamaterials, Perfect absorption, Low frequency, Tunable.

Observation of a water droplet motion by using oxide nanowire transistors covered by a nanofiber mesh

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Abstract:
The dropping height and flow speed of a water droplet could be monitored by using oxide nanowire transistors covered with a polyurethane nanofiber mesh. The main role of the polyurethane nanofiber mesh, allowing the passage of water vapor while blocking liquid water, was to restrict the direct contact between the water droplet and the oxide nanowire semiconducting channel and electrodes, which could cause abnormal transistor characteristics. During the motion of a water droplet, the representative transistor characteristics, especially the threshold voltage and the on-current, were changed because the adsorbed water molecules acted as electron donors on the surface of the oxide nanowire. The proposed monitoring method of the dropping height and flow speed of a water droplet is expected to apply in different usage environments with providing a stable sensing performance.

Keywords:
Nanofiber mesh, Nanowire transistor, Selective filter, Water droplet, Hydrophobicity

Detection of chemical substances in water by using oxide nanowire transistors covered by a three dimensional graphene

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Abstract:
The chemical substances in water could be monitored by using oxide nanowire transistors covered with a three dimensional graphene structure as a chemical selective filter. The three dimensional graphene structure coated by the trichlorosilane self-assembled monolayer allowed chemical to pass through and block water because of its hydrophobic characteristics. The block of water into the semiconducting sensing region is required in order to avoid the abnormal transistor characteristics. The concentration of chemical agents in water could be evaluated by measuring the threshold voltage shifts and on-current changes of the oxide nanowire transistors covered by the three dimensional graphene structure. The proposed monitoring method is expected to offer means for application in different usage environments with providing stable sensing performance.

Keywords:
SnO_2 nanowire transistor, three dimensional graphene, self-assembled monolayer, selective filter, detector

Flexible, Transparent, and High-Performance Microsupercapacitors Based onc as Waterproof Energy Storage Devices

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Abstract:
We report a successful fabrication of high performance transparent on-chip microsupercapacitors (MSCs) on a flexible poly-ethylene terephthalate (PET) substrate as water-proof energy storage devices. The facile and rapid laser printing technology was utilized for in-plane microsupercapacitor circuit due to its low cost and high throughput. The as-fabricated flexible MSCs exhibited a superior specific capacitance of 33 mF cm^{-2}, which is far better than that of polyaniline based MSCs reported in the literature. The initial capacitance value was retained 70% after 1,000 cycles indicating its excellent cyclic stability. Owing to its hydrophobic property and encapsulated structure, the MSCs is washable and waterproof. This innovative approach can open up a new strategy for facile and scalable fabrication of flexible and waterproof on-chip energy storage devices.

Keywords:
in-planemicrosupercapacitor, flexible, waterproof, washable, Crosslinked Polyaniline

Electromagnetically-induced transparency-like effect in a bending resonators

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Abstract:

The electromagnetically-induced transparency (EIT)-like effect in metamaterials (MMs) is presented by the interference among the plasmonic unit cells, and the simple tuning can be realized by varying the geometry. The EIT-like effect in MMs has been increasingly of interest, because this effect enables us to have promising applications in optical devices, multifunctional MMs and novel sensors. Recently, the EIT-like effect using non-planar substrates has received much attention due to new flexible applications. In this work, we studied the EIT-like effect using bright- and dark-mode resonators in a bending system. Two types of resonators were fabricated at the top (bar resonator) and the bottom (ring resonator) of FR4 substrate. This allows us to have the classical analogue of EIT-like effect due to the phase coupling between bar and ring resonators, which results in the enhanced transmission at 5.26 GHz. We have also studied the bending effect in an EIT MMs operating at GHz frequencies. The EIT-like feature could be controlled by adjusting the bending parameter of sample. It is demonstrated that the interference excited by the dark and the bright resonators can be controlled by the bending parameter. This tuning response by bending sample would be useful for not only active filters but also applications involving switching sensors for controlling electromagnetic waves. This work was supported by the ICT R&D program of MSIP/IITP, Korea (13-911-01-101).

Keywords:
Metamaterials, Electromagnetically-induced transparency, Bending effect

위상마이크를 이용한 음파간섭무늬의 시각화 연구

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Abstract:
강당이나 콘서트 장에서는 여러 곳에 설치된 스피커로 인해 음파의 간섭현상이 일어나 잘 들리는 곳과 잘 들리지 않는 곳이 존재한다. 이처럼 음파의 간섭현상을 최소화 하지 않으면, 아무리 좋은 음향 시설이 있어도 좋은 공연을 듣기 어렵다. 따라서 음파의 간섭현상에 대한 이해는 매우 중요하다. 본 연구에서는 음파 위상 측정 장치인 위상마이크를 제작하여 음파의 위상신호를 측정하고, 파장을 구하였다. 위상마이크는 콘덴서 마이크 앞에 음원과 동일한 진동수의 AC전압이 인가된 도체 판을 설치하여 제작하였다. 위상신호는 위상마이크와 스피커 사이의 거리에 따라 신호의 세기가 극대와 극소를 반복하는 주기적 형태를 보였으며, 측정신호의 파장은 이론으로 구한 파장과 동일하였다. 위상마이크로 음파의 위상을 측정하는 것이 가능하므로, 위상마이크를 이용해 음파간섭무늬의 시각화 실험을 진행한다. 이를 위해 위상마이크와 스피커 사이에 이중 슬릿을 설치하고, 슬릿을 통과한 음파의 위상신호를 분석하여 2차원 간섭무늬로 시각화 한다.

Keywords:
간섭무늬, 음파, 파장, 위상, 위상마이크, 시각화

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Flexible perfect absorber, utilizing layered-structure metamaterial

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Abstract:
Metamaterials (MMs) are artificially-designed structures to have particular electromagnetic (EM) responses. MMs have wide range of potential applications, such as cloaking, stealth aircraft, and perfect absorber. Change in the geometric parameters of “meta-atom” allows us to arbitrarily tailor the EM properties of the designated medium. To overcome the restricted applications due to the rigidness of MMs, great efforts have been made to adopt flexible substrates. In this work, we study a flexible MM absorber based on a simple layered structure. This structure is comprised of sandwiched layers in which the top layer is the metallic resonators separated from the bottom metallic ground plane by a dielectric layer. Generally, the conventional MMs are fabricated on FR-4. Our MM absorber, however, consists of three metallic layers separated by flexible PET layers. The top and the middle metallic layers are composed of rectangular and circular meta-atoms, respectively, and the bottom layer is a continuous metal plane. The simulation reveals that the proposed MM-absorber structure has six absorption peaks of resonance are observed at 11.22, 11.76, 12.39, 13.24, 14.77 and 17.11 GHz, with nearly perfect absorption at these frequencies, ranging from 90% to 99% of absorption. The characteristics of each absorption band are elucidated though the adequate simulation, and further analyzed by comparing with the experimental ones. This work was supported by the ICT R&D program of MSIP/IITP, Korea (13-911-01-101).

Keywords:
Metamaterials, Flexible, Layered structure

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Triple-band metamaterial absorber based on the toothed-wheel structure

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Abstract:

The effective electric permittivity and the effective magnetic permeability of metamaterials can be tailored by designing the appropriate structure and its geometric parameters. Electromagnetic absorbers can be useful in many application fields. The conventional metamaterial absorbers are made of a metallic pattern on one side and a continuous metallic plane on the other side separated by a dielectric layer. The patterned metallic layer is to suppress the reflection by the impedance matching with the free space, and the continuous metallic plane prevents the transmission. In this work, we numerically and experimentally investigated a strategy for the property enhancement of the conventional metamaterial absorber which includes periodic toothed-wheel-type resonators. Not only the fundamental- and the third-magnetic resonances, which were reported in previous research, but also the second-magnetic resonance of the meta-atom was exploited to yield the perfect absorption due to satisfaction of the resonance conditions by manipulating the structural parameters. The metamaterial absorber was also achieved in the mid-infrared and the visible regions of electromagnetic wave.
This work was supported by the ICT R&D program of MSIP/IITP, Korea (13-911-01-101).

Keywords:
Perfect absorption, Metamaterial, Microwave applications

Non-volatile resistive memory array using aluminum oxide on a flexible tape substrate

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Abstract:

Nowadays, electronic devices such as transistors and memories become flexible, transparent, or stretchable. Si which has been the most commonly used substrate for electronic devices barely has these properties. To overcome the limitation of Si for flexible electronic devices, researchers have been looking for flexible substrates. Many kinds of materials such as plastic films, fiber papers, or tapes were used as flexible substrates. Among these, scotch tape can be a good flexible substrate with good flexibility, attach-ability, and low price. These properties make the scotch tape to be used as disposable substrate for various flexible devices such as an electronic wrapping paper, electronic memory stamp, or a sticker bus card. Here, we fabricated 8 x 8 arrays of non-volatile resistive memory devices on a commercially available tape as the flexible substrate. The memory device structure was Au/AlO_x/Au/AlO_x/Al/tape. The fabrication process to make memory devices was dry and low temperature process. Therefore, the tape substrate did not suffer from any damage during the fabrication. The fabricated memory devices showed typical unipolar non-volatile resistive memory property. Our memory devices were turned to ON-state at ~3.5 V and turned to OFF-state at ~10 V, showing a negative differential region after ~5 V. The memory devices exhibited high ON/OFF ratio, good reproducibility, good stability, and high yield. Specifically, the ON/OFF ratio was high as ~10^4, and the devices endured over 200 cycles of reading/writing process. The retention time of the devices was longer than ~10^4 s. We observed that ~68 % of the total fabricated memory cells were well-operated. More importantly, our devices showed stable electrical properties under various bending conditions.

Keywords:
resistive memory,flexible, Non-volatile, unipolar

열음극의 전류밀도 측정과 관련 파라미터 계산

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Abstract:
열음극은 마이크로전자파 발생장치의 전자방출원으로 사용된다. 열음극의 가장 중요한 성능인 전류밀도를 측정하기 위한 장치를 꾸미고 전류밀도를 측정하였다. 측정결과를 열전자 방출과 관련된 법칙들(Child-Langmuir's law, Richardson's law)로 계산하여 측정장치의 마이크로퍼비언스, 열음극의 일함수와 같은 파라미터를 계산하였다.

Keywords:
열음극, 전류밀도 측정, 일함수

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브레이크 캘리퍼 내부 검사를 위한 비전시스템 개발

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Abstract:

비파괴검사의 일종인 비전 시스템의 개발은 기계부품을 완제품에 도입하기 전에 불량여부를 미리 판별하는데 유용하게 사용될 수 있다. 자동차는 수 만개의 기계부품을 포함하고 있으며, 자동차의 성능을 최대로 끌어올리기 위해서는 각 기계부품의 품질검사가 매우 중요하다. 특히 자동차 부품의 결함여부를 미리 판단하기 위하여 부품 제조사는 다양한 검사를 수행하고 있는데, 그 중에서도 비파괴 검사기술이 빠르게 적용되고 있다. 본 연구에서는 다양한 자동차 부품 중에서 안전과 직결되는 브레이크 구성 부품 중 하나인 브레이크 캘리퍼 내부 검사를 위한 비전 시스템을 개발하였다. 브레이크 캘리퍼는 유압으로 피스톤이 작동하여 브레이크 디스크에 마찰력을 가해 자동차의 제동력을 생성하는 장치이다. 캘리퍼 내부에는 오일이 새지 않도록 오일씰이 위치하는 그루브(홈)이 존재하며 비전 시스템을 통해 이 그루브 내부에 존재하는 이물질의 존재여부를 판정하는 비전검사 시스템을 구현하였다. GigE 카메라와 캘리퍼 내부를 한번에 확인할 수 있는 360도 렌즈와 전용 조명시스템을 구성하여 이물질 검출이 가능하도록 하였다. 검출 가능한 이물질의 최소 사이즈는 0.1mm 였으며, 다양한 사이즈의 캘리퍼의 이물질을 검출하는 테스트를 통해 이물질이 잘 검출되는 것을 확인하였으며, 본 시스템을 캘리퍼 생산 산업현장에 적용할 수 있음을 확인하였다.

Keywords:
비전, 비파괴검사

반사판을 이용한 해상용 LED등명기의 광학 설계

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Abstract:
선박 항해 및 운항의 안전을 위하여 각종 항로표지가 사용되고 있으며, 특히 우리나라 서해안과 남해안은 작은 섬들과 해안선이 복잡하여 항로 표지는 매우 중요한 실정이다. LED 해상용 등명기는 2003년 개발되어, 초기에는 200 mm 등명기를 대체하는 용도로 등부표에 주로 이용되었으나 현재는 교량등으로도 널리 이용되고 있다. 사용 대수도 2003년 최초 개발 시에 241대가 검사신청 되었던 것에 비해 2008년에는 1135대로 증가 하였으며, 2014년에는 1900대로 증가하였다. 하지만 이러한 LED 등명기는 소형등명기에만 집중되어 있어 실질적으로 소비 전력이 큰 중대형 등명기의 개발은 미미한 실정이다. 20 NM 급의 항로표지용 400 mm급 등명기를 설계하기 위하여 국외 중형급 LED등명기 제품의 광도 및 소비전력등을 분석하고 국내 해상용 등명기 표준규격서를 참고하여 부동광도 및 발산각을 설정하였다. LED 칩은 CREE사의 XHP 35 HI의 Ray 데이터를 사용하여 광학 설계 프로그램인 Lighttools를 이용하여 시뮬레이션 하였다. LED광을 수평으로 발산하게 하기 위하여 렌즈 대신 포물선 반사판을 이용하였고 광효율을 올리기 위해 LED칩의 각도를 달리하여 광학 설계를 하였다.

Keywords:
해상용 LED 등명기반사판광학설계

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Local Heating Effect on Few-Layer $MoTe_2$ Flake Transistor

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Abstract:
We have fabricated the transition-metal-dichalcogenide field-effect transistor consisting of an exfoliated few-layer $MoTe_2$ flake. To study the effect of local-heat treatment, an exfoliated graphite heater was attached on the central channel area of $MoTe_2$ transistor, where the Joule heating of graphite flake induced the change of local property of $MoTe_2$ transistor. We analyzed the effect of local heating in terms of the thermal annealing on the channel part and that on the contact area. The contact between $MoTe_2$ and graphite seemed to be strongly influenced by the local heating of graphite flake, which mainly attributed to the direct contact between $MoTe_2$ and graphite flake. Detailed analysis on the effect of local heating in the few-layer exfoliated $MoTe_2$ transistor would be presented.

Keywords:
MoTe2, MoTe2 transistor, Graphene joule heating

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Improvement of voltage linearity of capacitors through stacked structure and annealing process

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Abstract:

An important issue regarding capacitor performances required for accurate analog-to-digital converters (ADC) is small quadratic voltage coefficient of capacitance (VCC-α). Yttrium oxide (Y_2O_3) is widely investigated as a high-k material. We fabricated Ta/Y_2O_3/Pt thin film capacitors using the RF magnetron sputter and the conventional furnace. To obtain low VCC-α, a stacked structure was made of Y_2O_3 with the positive VCC-α and SiO_2 with the negative VCC-α. The VCC-α for single Y_2O_3 and stacked Y_2O_3/SiO_2 is obtained as 41.4 ppm/V^2 and −8.65 ppm/V^2, respectively. Furthermore, as annealing time of Y_2O_3 is increased to 0 h, 1 h and 5 h, the VCC-α is measured as 96.4 ppm/V^2, 90.3 ppm/V^2 and 77.2 ppm/V^2, respectively. Leakage current and X-ray Photoelectron Spectroscopy (XPS) measurement are effective methods for elucidating relationship of the VCC-α and defect density. In this work, we obtain the low VCC-α through stacked structure and annealing process in vacuum.

Keywords:

Dielectric, High-k, Capacitor, VCC-α, Voltage linearity

Influence of post annealing on the response/recovery time of photodetectors based on polycrystalline MoS_2.

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Abstract:

Recently, molybdenum disulfide (MoS_2) has attracted much attention because various devices based on mono- or few-layer MoS_2 show great performance, Especially the optoelectronic device because MoS_2 can absorb relatively a broad range of wavelength due to its band gap of 1.2 ~ 1.8 eV depending on the number of layers. We fabricated the polycrystalline MoS_2 thin film on the Si wafer by using chemical vapor deposition method. In order to facilitate the efficient collection of photo-carriers, we prepared interdigital electrode patterns by using photo-lithography process. Response and recovery time are important factors for photodetector to determine device performance. These factors can be degraded by surface defects. Therefore we study on the effect of post annealing depending on thickness of MoS_2 thin film.

Keywords:

MoS_2, Photodetector

LiF:Mg,Cu,Si와 LiF:Mg,Cu,P의 방사선 및 열자극 발광의 측정 및 분석

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Abstract:

방사선 조사에 의해 물질에서 즉시 빛이 방출되는 방사선발광(radioluminescence: RL)은 방사선자극에 의해 전자와 홀이 쌍생성되어 트랩준위와 재결합준위로 이동하고, 다시 트랩의 전자가 재결합준위로 이동하면서 발광이 일어난다. 열자극에 의해 빛이 방출되는 열자극발광(thermoluminescence: TL)은 내부에 다수의 트랩과 재결합중심을 가진 물질이 온도를 증가시키는 열적 자극에 의해 빛이 방출되는 현상으로 트랩준위의 전자가 열자극에 의하여 트랩내의 전자가 재결합 준위로 이동하여 발광이 일어나게 된다. 각각 실시간 방사선량측정과 누적방사선량 측정의 용도로 이용되고 있다. 발광특성을 측정하기 위해 실험실에서 자체 제작한 X-선원(Moxtek사, 50kV, 0.2mA, Pd 표적)이 부착된 RL/TL/OSL 측정장치를 이용하였다. 측정에 사용된 장치는 방사선을 노출하기 위한 X-선 발생장치와 열자극을 위한 발열체가 시료대의 역할을 하며, 광자극을 위한 고휘도 청색 LED로 구성되어 있다. 이들은 시료를 향하고 있어 시료의 위치를 변화시키지 않고 일관된 환경에서 다양한 자극을 가하며 측정을 할 수 있다. 또한 동일한 환경에서 측정된 결과는 RL/TL/OSL 분석프로그램을 활용하기에 편리한 장점을 가지게 된다. 측정 및 분석은 선량분석에 많이 활용되고 있는 LiF:Mg,Cu,Si와 LiF:Mg,Cu,P에 대하여 다양한 조건으로 RL/TL을 측정하였다. 한편, TL 측정 후 트랩에 남은 전자들은 자외선에 의하여 트랩들에 재배치를 하게 되어, 새롭게 열자극을 가하면 발광현상이 나타난다. 이는 phototransferred thermoluminescence(PTTL)이며, 깊은 트랩에 대한 정보를 확인할 수 있다. 각각 시료의 재결합준위를 정보를 얻기 위하여 분광계를 활용하여 RL 및 TL 스펙트럼을 300 ~ 700 nm 영역에서 측정하였다. 이러한 다양한 측정을 통하여 LiF:Mg,Cu,Si와 LiF:Mg,Cu,P의 발광곡선을 분석하여 발광메커니즘을 규명하였다.

Keywords:
RL, TL, PTTL, LiF:Mg,Cu,Si, LiF:Mg,Cu,P

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Al_2O_3:C의 방사선 및 열, 빛의 자극 발광특성

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Abstract:

Al_2O_3:C는 Al_2O_3의 결정성장 과정에서 미량 주입한 탄소가 결정구조의 산소를 부분적으로 결핍시켜서 점결함의 결정체를 이룬다. 산소가 있던 자리에 대치해서 들어간 하나 혹은 두 개의 전자는 발광의 중심역할(F+-cneter, F-center)을 하여 이에 의한 발광을 방사선량 측정에 이용하고 있다. 일반적으로 방사선에 의해 이동한 이들 전자는 금지대에 위치한 전자의 불순물준위에 포획되어서 안정된 상태를 유지하다가 다른 빛의 자극으로 다시 빛을 내는 광자극발광(optically stimulated luminescence: OSL)은 이전의 방사선 노출 정도에 대한 정보를 정교하게 읽어내게 한다. OSL은 선량평가에 대한 넓은 다이나믹 레인지, 재판독성, 신속성 등의 장점을 가지고 있어서 기존의 열자극발광(thermally stimulated luminescence: TL)에 의한 선량측정을 점차 대치하고 있다. 특히 Al_2O_3:C은 OSL의 발광감도가 높고, 물질이 열적으로 안정적이어서 Landauer사에서 이를 선량물질로 개발하여 상업화한 이후 집중적으로 연구되고 또한 이용되고 있다. 광섬유 끝단에 Al_2O_3:C를 부착하여 방사선치료에서 환부에 노출된 선량을 정교하게 모니터하는 의료장비에서의 활용하고 있다. 또한 방사선 유출사고 후 피폭선량을 복원하는 선량소급분석(retrospective dosimetry)에서 주로 이용하는 전자소자의 함유물질로 Al_2O_3의 발광특성으로 이용한다. 따라서 Al_2O_3나 Al_2O_3:C의 발광과정을 정교하게 이해하는 것이 중요하다. 이를 위해서 Landauer사의 Al_2O_3:C에 대하여 방사선(radioluminescence: RL)과 열(TL), 빛(OSL)의 자극이 혼재된 환경에서의 발광을 측정하였다. 방사선원은 Pd 표적의 Moxtek사의 X-선 발생장치로 최대 50kV, 0.2mA이고, 열자극은 상온에서 400° C까지, 광자극은 532nm의 녹색 레이저와 475nm의 LED를 이용하였다. 이들 세 종류의 자극은 실험실에서 자체 제작한 통합측정장치를 이용한다. X-선 노출시 대체로 완만하게 증가하는 형태의 전형적인 RL특성을 보이고 있으며, 상온에서의 OSL은 세 개의 지수적으로 감소하는 발광곡선이 중첩된 것으로 보여 세 종류의 전자트랩이 관여하는 것으로 보이고, 또한 TL의 경우, 180° C, 320° C 등 몇 개의 피크를 가진 전형적인 TL 발광곡선의 특성을 가지고 있었다. 한편 이의 발광스펙트럼은 뚜렷한 420nm의 피크가 있어서 F-center에서의 발광이 주된 것으로 확인되었다.

Keywords:
RL, TL, OSL, Al_2O_3:C, Dosimetry

Al_2O_3:C의 방사선 및 열, 빛의 자극발광의 발광과정 해석

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Abstract:

방사선량 측정에 널리 이용되고 있는 Al_2O_3:C의 방사선 발광(radioluminescence: RL)과 열 자극 발광(thermally stimulated luminescence: TL), 광자극 발광(optically stimulated luminescence: OSL)의 발광 곡선과 발광스펙트럼 데이터를 이용하여 Al_2O_3:C의 발광 메커니즘을 정교하게 규명하였다. 이에는 본 연구진이 개발한 다트랩 다재결합 중심모형(multi-trap multi-recombination center model: MTMR)을 이용하였다. MTMR은 결정의 에너지띠 모형에서 전자가 포획되는 트랩(electron trap)의 종류가 여럿이고, 또한 전자가 양공(hole)과 재결합하는 재결합중심(recombination center: RC)도 여럿이며, 이들 트랩의 전자나 재결합중심의 양공이 각각 전도대나 가전자대를 통하여 서로 넘나들 수 있는 것을 허용한 모형으로 전자나 양공의 흐름에 대한 제일원리에 입각하고 있어서 물리적인 실체에 더욱 가깝다. 이 알고리즘을 통하여 분석하는 실험 데이터는 모두 본 실험실에서 자체 제작한 통합측정장치로 측정한 것으로, 이 장치는 방사선과 열/빛의 자극이 혼재된 환경에서 발광곡선과 발광스펙트럼을 측정하는 것이 가능하다. Al_2O_3:C는 미국 Landauer사에서 제작한 것이다. 이의 발광특성은 지금까지 보고된 전형적인 형태로서 세 개의 감소하는 곡선을 가진 CW-OSL, 180° C의 주된 피크를 가진 TL, 그리고 일정한 방사선 자극일 때 점진적으로 발광이 증가하는 RL의 특성을 보였다. 이를 자체적으로 C#으로 코딩한 MTMR 알고리즘의 해석프로그램으로 분석한 결과 전도대 아래의 얕은 트랩(shallow trap), 중간 깊이의 발광관여 트랩, 그리고 깊은 트랩(deep trap)이 각각 몇 종류 있고, 또한 F-center가 발광의 중심 역할을 하는 것으로 분석되었다. 즉 방사선에 의해 쌍생성된 전자와 양공 중에서 전자는 여러 종류의 전자트랩에 포획되고, 양공은 F-center에 포획되어 안정된 상태를 유지한다. 이제 열이나 빛의 자극에 의해 전자트랩의 전자가 전도대로 전이하여 다시 F-center의 한 전자가 빈 상태에 결합하고, 다시 이의 바닥상태로 떨어지는 과정에서 빛을 내는 모형으로 분석되었다. 발광곡선을 맞춰내는 방법으로 각 트랩이나 재결합중심의 에너지 준위, 광이온화단면적 등 발광에 관여하는 파라미터들을 세부적으로 확정할 수 있었다.

Keywords:
RL, TL, OSL, Al_2O_3:C, dosimetry

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Electroforming 방법을 이용한 WO_x 전극의 스마트 슈퍼캐패시터 특성 향상

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Abstract:
본 연구에서는 스마트 슈퍼캐패시터의 전극물질로 WO_x를 RF magnetron sputtering system을 이용하여 ITO 기판 위에 성장하였다. Eletroforming을 이용하여 전극에 나노 필라멘트 채널을 형성하였으며, 이에 따라 전극의 전도성을 향상시켰다. 전기화학적 특성을 측정하기 위하여 1 M $LiClO_4$ + PC 전해질에서 Cyclic Voltammetry (CV)를 측정한 결과, 나노 필라멘트 채널이 형성된 WO_x의 경우 캐패시터 용량이 최대 60% 향상되었고, 2000 cycles 이후의 캐패시터 용량값도 안정적인 것을 확인 할 수 있었다. 또한, 스마트 슈퍼캐패시터 특성 확인을 위해 Chronocoulometry (CC)를 측정한 결과coloration efficiency 특성도 많이 개선되는 것을 확인 하였다. 이에 WO_x 전극에 나노 필라멘트 채널이 형성된 경우 개선된 전도성을 기반으로, 향상된electrochromic 특성과 전기화학적 에너지 저장 특성을 보이며 높은 신뢰성을 유지하는 것을 확인하였다.

Keywords:
Supercapacitor, Tungsten oxide

열처리 온도에 따른 ITO/Ag-Pd-Cu/ITO 박막의 특성변화 연구

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Abstract:

OLED의 구현 방식은 크게 전면발광구조와 배면발광구조로 나눌 수 있다. 이중 전면발광구조는 빛이 TFT를 거치지 않고 바로 출력되기 때문에 배면발광구조에 비해 더 높은 밝기를 가지는 장점이 있다. 이러한 전면발광구조의 OLED에서 양극은 높은 반사율과 낮은 저항특성을 동시에 가져야 하는데 반사금속으로 사용되는 재료 중 Ag는 높은 반사율과 낮은 저항을 가지나 쉽게 산화되고 열에 의해 반사율이 저하되는 단점이 있다. 본 연구에서는 Ag대신 산화에 강하고 내열성이 좋은 APC(Ag-Pd-Cu) 합금을 사용하여 glass 기판 위에 ITO/APC/ITO 박막을 제작하였고 열처리 온도에 따른 기판 특성을 분석하였다. ITO/APC/ITO 박막은 상온, 100℃, 200℃, 300℃, 400℃에서 각각 30분간 열처리하였으며, UV-visible spectrophotometer를 사용하여 반사율 변화를 측정하였다. 또한 AFM (Atomic force microscope)과 면저항기(four point probe)를 사용하여 열처리에 의한 표면 거칠기 변화 및 저항특성 변화를 파악하였다. 그리고 상부의 ITO 두께를 최적화하기 위해 ITO두께에 따른 반사율을 시뮬레이션하였다.

Keywords:
OLED, 전면발광구조, Ag-Pd-Cu alloy, ITO

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Nanogenerators consisting direct-grown $Pb(Zr,Ti)O_3$ nanoparticles on multi-walled carbon nanotubes for energy harvesting

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Abstract:

Nanogenerators that harvest energy from mechanical vibration are an attractive area of nanotechnology fields. Recently, composite-type nanogenerator consisting of piezoelectric nanostructures and multi-walled carbon nanotubes (mwCNTs) is one of the excellent candidates for the future energy harvesting because they can apply the great electrical and mechanical properties of mwCNTs. The researches on the mwCNT based piezoelectric nanogenerators (PNGs) have been focused on understanding the role of the mwCNT and improving their output power. We reported here composite-type nanogenerator based on PZT-atomically-interconnected mwCNT. The detail atomic scale-crystal growth of PZT nanoparticles (NPs) on the mwCNT was confirmed by field emission transmission electron microscopy (FETEM) analysis, and the crystal orientation of PZT NPs was controlled by reaction times between PZT and mwCNT. We confirmed that the growth of the PZT NPs with a perovskite (001) orientation on mwCNT is effected to the density of defect on mwCNT. In addition, the direct growth of PZT NPs on the mwCNT, formed by stirring and heating method of the PZT-mwCNT mixture solution, resulted in the various positive effects by adding flexoelectricity to the piezoelectricity, resulted in the enhancement of output voltage by external mechanical force. Significantly, PZT-mwCNT-based nanogenerators generate the voltage output of 3.6 V and current output of 47 nA at force of 34 N, which is higher than those of PZT and mwCNT simply mixed nanogenerator. These results present a significant step towards the application of nanogenerators using composite-type piezoelectric.

Keywords:
Nanogenerators, Multi-walled carbon nanotubes, Energy harvesting

Synthesis of Highly Crystalline Hexagonal Boron Nitride for Graphene Transistors

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Abstract:

In this work, we used a polymeric precursor for the synthesis of highly crystalline h-BN films on metal catalyst for the first time. A borazine oligomer precursor has advantage over others in that it can be easily coated on a variety of catalytic substrates with controlled thickness, and it also does not evaporate from the substrate in contrast with ammonia borane. By associating catalyst below or on top of borazine oligomer film, we were able to acquire highly crystalline and large areal h-BN films with the stoichiometric B/N ratio close to 1 at ~1000 °C. The graphene field effect transistor (GFET) characterization has also proved the high quality synthesis of h-BN films, showing the shift of neutrality point and the increase of the mobility. Since the catalyst deposited on top of borazine oligomer films can be easily removed, we can coat various surfaces with high quality h-BN films for the desired purpose. The method developed here is facile and cost-effective to synthesize h-BN films for a variety of applications.

Keywords:
h-BN, borazine oligomer, graphene field effect transistor

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Hydrogen storage with Li-intercalated graphene oxide.

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Abstract:

Hydrogen storage is an important issue in hydrogen-powered fuel cell car industry. Since the present hydrogen storage method uses high pressure storage techniques, there exists a safety issue. Thus, the development of hydrogen storage materials which absorb hydrogen gas under relatively low pressure has attracted a great interest in the energy material science field. Recently, a study for intercalated graphene oxide(GO) was reported. The study revealed experimentally and theoretically that K-intercalated GO showed high hydrogen storage performance compared with other storage materials. In the present study, we used Li instead of K for the intercalation into the GO system. Through the theoretical study of the Li-intercalated GO system using the density functional theory(DFT), we have found that the Li-intercalated GO also has high hydrogen storage capability. By comparing with the K intercalated GO system, we present advantages and disadvantages of the system.

Keywords:
graphene, graphene oxide, hydrogen storage, energy material, lithium, density functional theory

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이종 핵종 이원자 분자 초미세 구조 분석 연구

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Abstract:

초냉각된 이종 핵종 이원자 분자의 기저준위로의 밀도 이전을 위해 단일항과 삼중항이 상호 강하게 섭동하고 있는 중간단계의 전자상태의 에너지 및 초미세 구조 연구는 필수적이다. 본 연구에서는 초음속 분자 빔 실험으로 얻어진 분광 데이터를 이용하여 강하게 섭동된 중간 전자 상태의 양자 진동수를 광연합에 얻어진 초미세 구조의 특성을 이용하여 지정하였다. 또한, 이러한 초미세 구조 분석을 다양한 각운동량 결합 방식에 따라 변화하는 초미세 구조의 특성 분석을 통해 얻어진 초미세 구조의 Hund 경우를 분석하여 실험으로 얻어진 분광선의 에너지 위치와 분광선 세기를 분석하였다.

Keywords:
이종핵종 이원자 분자, 초미세구조, Hund cases

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Multi-sublevel effect on the second-order correlation of a single-atom-cavity system

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Abstract:

Second-order correlation is a well-studied subject in quantum optics. By using the second-order correlation, non-classical effect in cavity QED has been extensively investigated [1,2]. Moreover, it is one of the key indicators for single photon generation [3,4]. In particular, polarization dependence of the second-order correlation function has been studied [5-7]. Analytic solution for a two-level atom in a cavity is obtained [8]. However when Zeeman sub-levels of the atom are considered, the system can be studied only numerically or experimentally. Beside the complexity of calculation due to many levels, the entanglement between Zeeman sub-levels of the atom and the polarization of cavity photons make the situation more complicated but plays an important role in correlation functions. We theoretically investigate several intriguing properties of the second-order correlation functions of a single-atom-cavity system originated from such entanglement. First, a mixture of bunched light beams can have anti-bunching property. Second, sub-Poissonian light can be filtered from mixture of super-Poissonian lights. At last, a classical bound of the second-order correlation function between two orthogonal modes is calculated, and its violation is showed numerically. [1] G. Rempe, R. J. Thompson, R. J. Brecha, W. D. Lee, and H. J. Kimble, Phys. Rev. Lett. 67, 1727 (1991). [2] L. Mielke, G. T. Foster, and L. A. Orozco, Phys. Rev.Lett. 80, 3948 (1998). [3] P. Michler et al., Science 290, 2282 (2000). [4] C. Kurtsiefer, S. Mayer, P. Zarda, and H. Weinfurter, Phys.Rev. Lett. 85, 290 (2000). [5] F. Rohde et al., J. Phys. B: At. Mol. Opt. Phys. 43, 115401 (2010). [6] H. J. Lee, T. Jeong, and H. S. Moon, Phys. Rev. A 90, 033843 (2014). [7] V. A. Sautenkov, Y. V. Rostovtsev, and M. O. Scully, Phys. Rev. A 72, 065801 (2005). [8] H. J. Carmichael, R. J. Brecha, and P. R. Rice, Opt. Commun.82, 73 (1991).

Keywords:
Quantum opitcs, Cavity-QED, Photon statistics

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Gaussian 파속을 이용한 시간의존 Schrodinger 방정식의 계산: 문턱위 이온화와 고차조화파발생(1차원)

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Abstract:

강한 전기장과 원자의 상호작용은 비선형 양자 현상으로 양자역학적인 계산 방법으로는, 요구되는 기저함수의 지수함수적인 증가로 그 계산은 1차원 모델에서 벗어나지 못하고 있다. 이런 문제점을 해결하기 위해 Gabor frame에서 만들어지는 Gaussian 파속을 일정한 시간이 지난 후 다시 초기화하는 방법이 도입되었다. 계의 경계조건이 필요없고, 선형적으로 증가하는 기저함수의 갯수이므로 다차원에 대한 계산도 가능하다는 것이 장점이지만, 매 시간마다 일정한 양의 기저함수의 갯수가 끊임없이 증가되는 단점이 있다. Tunneling에 대한 성공적인 계산을 바탕으로 1차원 모델의 문턱위 이온화(ATI)나 고차조화파 발생(HHG)의 계산을 하여 양자역학적 계산인 B-spline을 이용한 결과와 비교하고자 한다.

Keywords:
TDSE, Gabor Frame, Gaussian 파속, 문턱위이온화, 고차조화파발생

Theoretical analysis of Atom interferometer gyroscope

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Abstract:

We solve the Schrödinger equation in the 3-level configuration when two lights with different frequencies are interact with atoms. The stimulated Raman transition is sloved. By applying the $\pi/2-\pi-\pi/2$ sequence, the output from the atom interferometer has confirmed. Considering the phase shift of the Raman laser due to the rotation, we show that atom interferometer can be a precise gyroscope.We discuss the sensitivity limit of the atom interferometer gyroscope when the characteristics of the atomic beam are inserted in the system.

Keywords:

sitmulated Raman transition, Atom interferometer gyroscope

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H-wire trap to improve atom number in BEC state

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Abstract:

We have made Bose-Einstein condensate (BEC) on the atom chip with dimple wire or T-wire. As shown in figure 1, dimple wire (a) uses main guide wire fully, but T wire (b) uses only half of it. The trap behaviors are very similar; however, T-wire has spatial advantage[1]. But transfer rate in T-wire trap is smaller due to shift of magnetic field minimum position when transferring atoms from external coil trap to T-wire trap. In order to increase transfer rate, we add H-wire trap process between external coil trap and T-wire trap. We compare the atom number in BEC state when transferring atoms in external coil to T-wire trap, and to T-wire via H-wire trap.

Keywords:
BEC, H-wire, T-wire, Dimple

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Reciprocity and time-reversal symmetry in quantum reection of atomic matter-waves from a diffraction grating

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Abstract:

The reciprocity theorem in wave optics states that the amplitude and phase of signal does not change if source and detector are interchanged in a given setup. We validate the reciprocity theorem in quantum reflection of helium atoms from a blazed diffraction grating. At grazing incidence conditions the helium atoms are quantum reflected tens of nanometer above the grating surface. We observe identical diffraction efficiencies of the n^{th} order diffraction peaks at standard grating mount and of the $-n^{th}$ orders at reversed geometry when plotted as a function of deflection angle, thereby confirming reciprocity. For purely elastic scattering as in quantum reflection, observation of reciprocity implies time-reversal symmetry. Considering time-reversal invariance we discuss details of the quantum reflection process such as the distances above the surface where quantum reflection occurs for diffraction beams of different order n.

Keywords:
reciprocity, time-reversal symmetry, quantum reflection

Key rate enhancement using qutrit states for uncharacterized quantum key distribution

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Abstract:

Quantum cryptography is a matured application of quantum informational theory that exploits quantum mechanical principle. At the very core of the protocol, there is a procedure called quantum key distribution (QKD), generating a secure key between two distant parties, under a potential attack by a malicious eavesdropper. It is known that measurement-device-independent quantum key distribution (MDI-QKD) provides ultimate security from all types of side-channel attack on detectors at the expense of low key rate. In the present study, we propose MDI-QKD using 3-dimensional quantum states and show that the protocol improves the secret key rate under the analysis of mismatched-basis statistics. Specifically, we analyze security of the 3d-MDI-QKD protocol with uncharacterized sources, meaning that the original sources contain unwanted states instead of expected one. We evaluate the secret key rate of the protocol and identify the regime in which the key rate is higher than the protocol with the qubit MDI-QKD.

Keywords:

Quantum Cryptography, Quantum Key Distribution, High-dimensional Quantum Key Distribution, High-dimensional Quantum State, Measurement-device-independent Quantum Key Distribution

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Investigation of optimal discrimination of 2 & 3 qubit states under a depolarization channel.

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Abstract:
본 연구에서는 두 개 혹은 세 개 큐빗 상태를 최소오류구별하고자 하는 상황에서 계에 depolarizing channel에 의해 잡음이 가해질 때 optimal discrimination과 추측확률에 끼치는 영향을 조사한다.

Keywords:
minimum error discrimination, noise, depolarizing channel

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유전 알고리즘을 이용한 X-Junction 이온트랩 칩의 RF 전극 설계

박윤재[1], 이민재[1], 박주호[1], 홍석준[1], 정창현[1], 권영대[1], 안준식[2], 김태현[2], 조동일[*1]
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Abstract:
이온트랩은 양자 정보처리 장치의 대표적인 구현 방식 중 하나이며, 최근에는 MEMS 공정을 이용한 대규모 이온트랩 칩도 개발되고 있다 [1, 2]. 대규모 이온트랩 칩은 다수의 이온트랩 영역을 포함하며, 개별 이온트랩 영역들은 X 또는 Y 형상의 junction 구조로 연결되어 있다. 개별 이온트랩 영역에서 양자 연산을 거친 이온 qubit은 junction을 통과해 이동하며, 다른 이온트랩 영역으로 양자 정보를 전달하게 된다. 이온이 junction을 통과할 때 발생하는 문제점 중 하나는 이온 포획에 사용되는 RF 전압에 의해 교차점 중심에 유사전위 장벽이 생성된다는 점이다. 또한 교차점 주변에서는 이온트랩 칩으로부터의 이온의 높이가 불균일해지는 문제점이 발생한다. 위의 두 현상은 모두 이온 가열을 유발하며, phonon 상태를 사용하는 양자 연산의 정확도를 감소시킨다. 본 논문에서는 X-junction 영역에서 유사전위 장벽과 이온 높이 변화를 줄이기 위해, X-junction 주변 RF 전극 형상에 대한 설계 방법을 제안한다. X-junction 주변의 RF 전극을 5 μm × 5 μm 크기의 정사각형 조각들로 나누고, 각 조각에서 전극의 존재 유무를 유전자로 설정하여 유전 알고리즘을 설계하였다. 세대당 64의 크기를 가지는 유전자 풀에서 5000세대를 결쳐 최적화가 진행되었으며, 4919세대에서 수렴하였다. 경계요소법 시뮬레이션을 통하여 분석한 결과, 본 방식으로 설계된 X-junction 구조의 유사전위 장벽과 이온 높이 변화량이 직선 형태의 RF 전극으로 구현된 X-junction 구조의 유사전위 장벽과 이온 높이 변화량에 비해 각각 6.8분의 1과 4.3분의 1로 줄었다. [1] D. Kielpinski, C. Monroe and D. J. Wineland, "Architecture for a large-scale ion-trap quantum computer," Nature, vol. 417, no. 6890, pp. 709-711. 2002. [2] J. M. Amini, H. Uys, J. H. Wesenberg, S. Seidelin, J. Britton, J. J. Bollinger and D. J. Wineland, "Toward scalable ion traps for quantum information processing," New journal of Physics, vol. 12, no. 3, pp. 033031, 2010. ※ 본 연구는 미래창조과학부 및 정보통신기술진흥센터의 대학 ICT 연구센터육성 지원사업의 연구결과로 수행되었음 (IITP-2016-R0992-16-1017)

Keywords:
이온트랩, 양자컴퓨터, X-junction, 유전 알고리즘

이온트랩 칩 위에서의 2-Qubit 양자 연산 구현을 위한 Raman-transition-induced Rabi Oscillation 측정

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Abstract:
이온트랩 안에 qubit 이온이 한 개 저장 되어 있을때, 1-qubit 양자 연산을 실행하는 가장 손쉬운 방법은 |0⟩ state와 |1⟩ state의 에너지 차이와 일치하는 파장의 microwave를 이온에 쏘여주는 것으로, 이를 통해 qubit을 임의의 양자 상태로 컨트롤 하는 것이 가능하다. 하지만 large-scale quantum computing device를 구현하기 위해서는 한 이온트랩 안에 많은 수의 이온을 저장해야 하는데, 이 경우에는 microwave의 파장이 이온간의 간격에 비해 너무 크기 때문에 다른 qubit에 영향을 주지 않고 하나의 qubit만 컨트롤 하는 것은 불가능하다. 우리는 이에 대한 대안으로 펄스레이저를 통한 two-photon Raman transition을 이용하여 microwave를 통한 방법과 동일하게 qubit의 양자 상태를 임의로 컨트롤 할 수 있음을 보였다. 이 경우에는 짧은 파장(355nm)의 펄스레이저를 diffraction limit에 가깝게 포커스하여 원하는 이온에만 가해줄 수 있고, 이를 통해 다른 이온에 영향을 주지 않는 individual qubit addressing이 가능하다. 또한, 펄스레이저의 강한 intensity를 활용하여 microwave를 사용했을때 얻을 수 있던 Rabi oscillation (~1kHz)보다 더욱 빠른 Rabi oscillation도 달성하였다.

Keywords:
이온트랩, 양자통신, 양자컴퓨터, Rabi oscillation, Raman transition, Two photon 펄스레이저

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람다 시스템에서 펌프광의 원편광 변화에 따른 EIT-EIA 변환 실험

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Abstract:
두 대의 독립된 D2 레이저를 이용하여 펌프광의 원편광에 따른 electromagnetically induced transparency (EIT) - electromagnetically induced absorption (EIA) 변환 실험을 하였다. 레이저 한 대는 조사광으로 사용했으며 나머지 한 대는 펌프광으로 사용하였다. 실험에서 사용된 람다 시스템은 각각 ^{87}Rb F=1→F'=2 (조사광), F=2→F'=2 (펌프광)이며 조사광의 레이저로 해당 전이선의 주파수에 고정을 했으며 펌프광의 레이저로 스캔하였다. 조사광의 편광은 좌원편광이며 펌프광의 빔은 두 개로 나눈 다음 각각 원편광을 만들어 편광을 변화시켜 루비듐 셀을 반대로 통과하게 만들었다. 실험을 통해 펌프광의 원편광에 따라 펌프광이 조사광과 같은 방향으로 통과할 경우 EIT 신호를 볼 수 있었고, 그 상황에서 반대 방향으로 펌프광을 루비듐 셀에 통과시킬 경우 EIA 신호로 변환되는 것을 확인할 수 있었다.

Keywords:
EIT, EIA, Conversion, Polarization, Rb, lambda-type

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Analytical study of polarization spectroscopy for the Jg=0→Je=1 transition

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Abstract:

We present an analytical study of polarization spectroscopy (PS) for the Jg=0→Je=1 transition in the weak probe intensity and Doppler-broadened limits. The analytical solutions are obtained up to the first (arbitrary) order of the Rabi frequency of the probe (pump) beam. The PS line shape is influenced by the coherent effect resulting from nonlinear interactions between laser lights via atoms. We also calculate the line shape by neglecting the nonlinear wave mixing. We find that the difference between the results of the accurate and rate equation calculations decreases as the pump beam Rabi frequency decreases or transverse decay rate increases. We also find the analytical solutions of the slope at the resonance and amplitude of the line shape in PS.

Keywords:
Polarization spectroscopy, Analytical solutions

Analysis of electromagnetically induced transparency in a V-type system of ^{87}Rb

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Abstract:
Electromagnetically induced transparency (EIT)는 대표적인 원자 결맞음현상 중 하나로서 결맞는 광원(레이저)과 원자와의 상호작용으로 생성된 결맞음 원자 매질에서 조사광이 흡수되지 않고 투과가 일어나고, 이 때의 투과 주파수 영역이 매우 좁다는 특성을 가진다. 3준위 원자계 중에 하나인 V형 구도에서의 EIT에 대해 알아보고, 특히 EIT 신호가 결맞음 효과의 유무에 따라 어떤 차이가 생기는지 실험 및 계산을 통해 비교, 분석하였다. 정확한 계산을 위해 밀도 행렬 방정식을 사용했으며, 실험은 조사광을 여러 전이선에 고정시키고, 결합광의 세기를 다양하게 변화시키면서, 조사광과 결합광의 편광이 각각 서로 수직, 수평 선편광일 때와 원자셀에 서로 같은 방향, 반대방향으로 입사시킬 때의 신호의 변화를 분석하였다.

Keywords:
EIT, coherence effect, V-type, Rb

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Cross Sections for Electron Collisions with NF_3

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Abstract:

Cross section data are compiled from the literature for electron collisions with nitrogen trifluoride (NF_3) molecules. Cross sections are collected and reviewed for total scattering, elastic scattering, momentum transfer, excitations of rotational and vibrational states, dissociation, ionization, and dissociative attachment. The data derived from swarm experiments are also considered. For each of these processes, the recommended values of the cross sections are presented. The literature has been surveyed through mid 2016. As group we are actively collaborating on the evaluation and recommendation of electron collision cross sections with key molecules, especially those of interest for plasma studies. A comprehensive review of electron-methane data was our first project; this was followed by acetylene and the present nitrogen trifluoride. Further reviews will follow in due course.

Keywords:
electron scattering, nitrogen trifluoride, cross sections, data evaluation

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자화전자빔을 이용한 총산란단면적 측정

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Abstract:
본 그룹은 이미, 연속적으로 변화하는 강한 자기장내에서 전자빔의 자기장 수직 성분 에너지와 자기장 세기의 비(比)는 보존된다는 사실을 이용하여 강한 자기장에 의해 유도되는 전자빔을 이용한 전자-분자 충돌장치를 개발한 결과를 보고한 바가 있다. 이 장치를 이용하면 gas cell 내의 자기장과 전자빔 에너지를 분석하는 retarding potential analyzer 내의 상대적 자기장 세기를 조절하여 총산란단면적, 각도미분단면적, 여기단면적 등의 다양한 단면적을 측정할 수 있을 것으로 기대한다. 국가핵융합연구소-ANU-충남대 협력팀은 이 장치를 제작하고 이를 시험 및 발전 시켜 왔다. 본 발표에서는 지난 2년간 진행된 장치 및 방법상의 개선과 총산란단면적 측정의 예비 결과를 설명한다.

Keywords:
전자산란, 총단면적, 자화전자빔

Electronic structures of CeM2Al10 (M=Fe, Ru, Os): Kondo insulator or not?

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Abstract:

CeM2Al10 (M=Fe, Ru, Os) exhibit anomalous behaviors in the resistivity, which are close to that of a Kondo insulator. The anisotropic c-f hybridization was reported in the resistivity and magnetic susceptibility measurements. Among CeM2Al10, CeFe2Al10 has the strongest c-f hybridization. Furthermore, CeFe2Al10 has attracted recent attention due to possible existence of spin-exciton. The Kondo insulating behavior in CeM2Al10 is suggestive of a possible topological Kondo insulator, as in SmB6. To explore the anisotropic nature of c-f hybridization and the pseudo-gap feature in CeM2Al10, we have investigated their electronic structures using both the density functional theory (DFT) and the dynamical mean-field theory (DMFT) band calculations. We have analyzed the band character and symmetry to examine the topological nature of CeM2Al10. Temperature-dependent band structures and densities of states are also examined.

Keywords:

Kondo insulator, CeFe2Al10, DMFT

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Doping dependent electronic correlations in FeSe : DFT+DMFT study

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Abstract:
Electron-doped FeSe shows an exotic phase diagram. Superconducting transition temperature (T_c) is increased from 8K for undoped case to 46K for electron doping level (x) around 0.12. Furthermore, with more electron doping, T_c decreases until an insulating phase emerges. According to the recent ARPES experiments, this behavior is accompanied by increasing effective mass and diminishing spectral weights of metallic bands near the Fermi level, indicating the effects of the electronic correlations are enhanced. In this regard, we study the doping dependence of the electronic correlations in FeSe using the first-principles density functional theory calculations combined with the dynamical mean-field theory. We analyze the evolution of the orbital-resolved effective mass according to the electron density. As a result, we illustrate the role of the local electronic correlations in FeSe. This work was supported by NRF of Korea (Grant No. 2011-0018306) and KISTI supercomputing center (Project No. KSC-2016-C3-002).

Keywords:
FeSe, DFT, DMFT

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Effects of Diffusion and Diffusionless Ionic Gate Bias on Strongly-Correlated Properties of Vanadium Dioxide

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Abstract:

Vanadium dioxide (VO_2) is a typical strongly-correlated material that exhibits insulator to metallic phase transition (IMT) at 340 K through doping, substitution and introduction of interstitial ions. This work is intended to study the origin of phase transitions in VO_2 using ionic liquids (ILs) with diffusion and diffusionless ions. Ionic liquids (ILs) are herein, used to study the fundamental properties of phase transition in VO_2. Ionic liquids with Li^+ diffuse into VO_2 unit cell, introducing strain and interstitial doping. While ionic liquids with heavier ions transfer electrons and induce electric field at the VO_2 interface. We attempted to elucidate the origin of IMT in VO_2 by electron transfer and electrostatic effect at the liquid-solid interface. The differences between electron transfer, electrostatic and Li^+ interstitial based IMT transitions has been addressed. The recovery of insulating state in VO_2 is also demonstrated by reverse biasing the IL gate. The VO_2 devices were characterized by current-voltage (I-V) measurement, Raman spectroscopy, x-ray diffractometry and x-ray photoemission spectroscopy.

Keywords:

Strongly correlated material, VO_2, Ionic liquid, Metal insulator Transition

Subtle Correlations Between Phase Transition and Charge Carrier Dynamics in Epitaxial n- type VO_2/p-type GaN/Al_2O_3 Thin Films

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Abstract:

The focus of recent research in VO_2 has been mainly on modulating phase transition via carrier density dynamics. Although many experimental approaches have been proposed to elucidate the metal insulator transition (MIT) by tuning carrier density in VO_2, the control of the carrier density in VO_2 is still limited due to a lack of reliable experimental technique. Herein, we report the successful implementation of p-n heterojunction based on the epitaxial n-VO_2/p-GaN heterostructure, which offers a unique opportunity to investigate the MIT characteristics of n-VO_2 across the interface between n-VO_2 and p-GaN thin films. By applying the bias voltage across the p-n junction, the immobile carrier concentration within the extended space charge region can be effectively adjusted, which affects the concentration and dynamics of mobile carriers, thus enabling to tailor the MIT behavior sof VO_2 thin films. We demonstrated that the MIT of VO_2 thin films is closely associated with the immobile carrier concentration within the space charge region. Resistance changes by 3 to 4 orders of magnitudes by bias voltage and thermal excitation was measured. Our findings offer novel opportunities for modulating the phase transition of VO_2 thin film in a reversible way as well as for extending the concept of electric-field modulation to other strongly correlated phase transition materials.

Keywords:
p-n junction diode, metal insulator transition, carrier dynamics, VO_2, GaN, strain

Unique Surface Metal Insulator Transition Behaviors of 2-dimensional V_2O_5 Nanosheets

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Abstract:
Two-dimensional (2D) metal oxides become one of the hot topics of today due to their exceptional properties originated from 2D geometrical confinement. However, to synthesize 2D metal oxides nanosheets with controlled morphology, size and thickness pauses as a great challenge. We successfully synthesized the ultrathin 2D V_2O_5 nanosheets with approximately 50 um in size and thickness of 10nm. The morphology and crystal structure of 2D V_2O_5 nanosheets are characterized by using scanning electron microscopy and x-ray diffractometry. Further, Raman spectroscopy and atomic force microscopy were also employed to verify the molecular identity and the dimension. We demonstrate its unique surface metal insulator transition behavior owing to the 2D geometrical confinement, that has not been reported elsewhere. We attempted to elucidate the underlying physics behind such unprecedented phenomenon.

Keywords:
two-dimensional, V_2O_5, nanosheet, surface metal insulator transition

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Magnetic exchange bias effect near room temperature in perovskite $YFe_{0.6}Mn_{0.4}O_3$

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Abstract:

We have investigated the magnetic properties and exchange bias in perovskite $YFe_{0.6}Mn_{0.4}O_3$. The weak ferromagnetic order arises order below $T_N \approx 375$ K, and spin reorientation occurs at $T_{SR} \approx 310$ K due to the anisotropy of Mn^{3+} ions. The ferrimagnetic compensation temperature is also observed at $T_{Comp} \approx 150$ K. Between T_{SR} and T_N, the exchange bias field of more than 4 kOe was found, consistent with the mixed weakly ferromagnetic and antiferromagnetic phases. No training effect was observed during many repeated field cycles, indicative of stable exchange bias with no aging phenomena. In addition, the tunable exchange bias was found below T_{Comp}.

Keywords:
exchagne bias

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Paramagnetic properties in a strong spin-orbit-coupled Jeff=0 double-perovskite: Ba2YIrO6

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Abstract:
Ba2YIrO6 has attracted recent attention due to its unusual magnetic properties. Ba2YIrO6 has a valence state of Ir5+(5d4), and so it is expected to have a nonmagnetic Jeff=0 ground state caused by strong spin-orbit interaction and crystal field effect. In magnetic measurements, however, Ba2YIrO6 exhibits a paramagnetic behavior with finite effective magnetic moment. Despite experimental and theoretical studies, the origin of finite magnetic moment of Ir in Ba2YIrO6 is not clear yet. In this study, we have carried out multiplet structure calculations to investigate magnetic properties of a double perovskite Ba2YIrO6, and shown that Ba2YIrO6 can be a paramagnetic system through interplay of spin-orbit and crystal field effects.

Keywords:
5d4, unusual magnetic, multiplet, spin-orbit interaction, crystal field

Electronic structure study of $Bi_{1.96}Gd_{0.14}Se_3$ by Angle-Resolved Photoelectron Spectroscopy

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Abstract:
Topological insulators(TIs) have been steady-attentive quantum matter in the recently few decades and attracted much interest as a candidate key-material of future spintronics device. The spin-momentum locked surface states with high mobility from which the spin polarized Dirac electron reside in a bulk band gap are protected by time reversal symmetry (TRS). This spin-polarized surface electron gives us new opportunities for a high efficiency spintronics device such as a topological insulator field effect transistor (TIFET), a spin battery, and a spin torque ferromagnetic resonance (ST-FMR)[1-4]. In order to realize a spintronics device, it is required to control the electronic structure. Bi_2Se_3 is the best condidate materials which have a single Dirac surface band in relatively large bulk gap. On the previous work, the various studies have been fulfilled for transition metal (TM) such as Cr, Mn, Fe and Zn to control the electronic structure[5-6]. Though TM elements give them the magnetic perturbation, then turn on the spin flip scattering channel, they accompany the chemical potential shift because TM prefers to be divalent when those are substituted for Bi site. In order to overcome this problem, the rare-earth (RE) elements such as Gd is good candidate which have localized 4f large magnetic moment with preferring a trivalent. We investigated the electronic structure of Gd doped TI single crystal, $Bi_{2-x}Gd_xSe_3$, x=0.14, by using of spectroscopy. From X-ray absorption spectroscopy (XAS), we confirmed that the Gd dopant prefers to be trivalent and showed no electrical charging effect by the time aging measurement of angle-resolved photoelectron spectroscopy (ARPES). In addition, we observed the large gap (Δ~60meV) at Dirac point induced by magnetic perturbation which is comparable with Fe doped TIs, $Bi_{0.88}Fe_{0.12}Se_{3.17}$ (Δ~44meV)[6] by means of ARPES. It can be favored to facilitate manipulating electronic structure by co-doping with TM elements. 1. Zhu, H. et al. Topological Insulator Bi2Se3 Nanowire High Performance Field-Effect Transistors. Scientific Reports 3, 1-5 (2013). 2. Baker, A. A., Figueroa, A. I., Collins-McIntyre, L. J., van der Laan G & Hesjedal, T. Spin pumping in Ferromagnet- Topological Insulator-Ferromagnet Heterostructures. Scientific Reports 5, 7907-5 (2015). 3. Fischer,M.H.,Vaezi,A.,Manchon,A.&Kim,E.-A.Spin-torque generation in topological insulator based heterostructures. Physical Review B 93, 125303-4 (2016). 4. Mellnik, A. R. et al. Spin-transfer torque generated by a topological insulator. Nature 511, 449-451 (2014). 5. Xu, S.-Y. et al. Hedgehog spin texture and Berry's phase tuning in a magnetic topological insulator. Nat Phys 8, 616-622 (2012). 6. Chen, Y. L. et al. Massive dirac fermion on the surface of a magnetically doped topological insulator. Science 329, 659-662 (2010).

Keywords:
Topological Insulators, electronic structure, Bi_2Se_3, angle-resolved photoelectron spectroscopy

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Polarized optical spectroscopy on quasi-one-dimensional $BaFe_2Se_3$

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Abstract:

The compound of AFe_2Se_3 (A = K, Cs, Ba), provides a good playground to understand the mechanism of iron-based superconductor, since the structure of which is similar to the that of iron-based superconductor. In particular, $BaFe_2Se_3$ (BFS) is known as a quasi-one-dimensional spin ladder compound with needle-like shape. The BFS has been reported as a Mott insulator with charge gap of 0.2 eV. However, due to its 1-D nature, different electronic ground state along different axis has been reported. In order to investigate this anisotropic behavior, we adopted an optical spectroscopy technique with polarized light. We will discuss the origin of anisotropic phenomena by analyzing our optical data.

Keywords:
FTIR, Polarized optical spectroscopy, Ansiotropy, Quasi-one-dimensional, Localization, $BaFe_2Se_3$

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Carrier Dynamic Study of Artificial Honeycomb Copper Structure

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Abstract:
We studied the optical properties of a micromesh-structured copper films fabricated on sapphire substrates via terahertz time-domain spectroscopy (THz-TDS). We extracted both the real and imaginary parts of the optical conductance from the measured complex transmittance in the THz regime. The conductivity of meshed copper films exhibits Drude behavior. We observed that the scattering rate of our meshed copper films is about 3 cm^{-1} as judged from their Drude lineshape and that their DC conductance is about 0.13 Ω^{-1} in the spectral range of 0.2-2 THz. These results pave the way for controlling free carrier parameters in conventional metals within an artificially tuned meshed-structure.

Keywords:
copperHoneycombCarrierterahertzconductance

Soft x-ray absorption study on hexagonal multiferroic $Lu_{0.5}Sc_{0.5}FeO_3$

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Abstract:

For decades, multiferroic materials are spotlighted because the coupling between ferroic orders provides us a way to control and design a new device[1]. Hexagonal $RMnO_3$ and $RFeO_3$ are one of the best candidate multiferroics, of which ferroelectric (FE) and antiferromagnetic (AFM) transition temperatures are relatively higher. The ferroelectricity of these compounds is attributed to the geometric frustration[2] while the AFM order is rather complicated because of a magnetic frustration in a hexagonal magnetic sublattice. $RMnO_3$ was widely investigated but its AFM transition temperature is relatively lower. In order to enhance the magnetic transition temperature, $RFeO_3$ has been synthesized because Fe^{3+} (d^5) configuration induces larger super-exchange coupling. Although h-$LuFeO_3$ has been investigated in a thin film, as well as a bulk crystal and a nano-compound, but it has narrow window to grow a bulk crystal[3]. The problem can be overcome by doping Sc, and $Lu_{0.5}Sc_{0.5}FeO_3$ single crystal has been grown[3]. In order to investigate the electronic structure, we performed polarization dependent x-ray absorption measurement and full-multiplet cluster calculation. While Fe ion is located in FeO_5 bipyramidal cage, Sc and Lu ion is located in more complicated local symmetry. Although Fe^{3+} ($3d^5$) has high spin configuration, it exhibits a large linear dichroism in Fe L-edge. Sc ion give us an opportunity to observe the electronic structure of A-site directly using Sc L-edge. Following cluster model calculation reveals those electronic structure where A-site also displays a strong hybridization effect which is a direct origin of ferroelectricity. Finally, we are going to summarize the electronic structure of a newly synthesized $Lu_{0.5}Sc_{0.5}FeO_3$ single crystal. [1] S.-W. Cheong & M. Mostovoy. Multiferroics: a magnetic twist for ferroelectricity Nature Mater. 6, 13-20 (2007) [2] Van Aken, B. B., Palstra, T. T. M., Filippetti, A. & Spaldin, N. A. The origin of ferroelectricity in magnetoelectric $YMnO_3$. Nature Mater. 3, 164-170 (2004) [3] Atsnobu Masuno, Inorg. Chem., 52, 11889-11894, (2013)

Keywords:

Multiferroic, geometrical frustration, h-$RMnO_3$, h-$RFeO_3$, LSFO, $Lu_{0.5}Sc_{0.5}FeO_3$, x-ray absorption, linear dichroism, cluster calculation.

Doping-dependent optical conductivity in $NiS_{2-x}Se_x$

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Abstract:
We report on the optical spectra of $NiS_{2-x}Se_x$ deduced from infrared reflectivity. As a function of doping x, this system is thought to display a bandwidth controlled Mott metal-insulator transition. We show that as the Se doping ratio is increased, incoherent spectral weight is gradually transferred to low energies, consistent with a correlation-driven metal-insulator transition. Our results provide insight into the metal-insulator transition and the nature of the low energy quasiparticles near the critical doping.

Keywords:
metal-insulator transtion, bandwidth controlled Mott transition,quasiparticle,$NiS_{2-x}Se_x$, optical conductivity

Tuning manganese valence state of epitaxial $Nd_{0.5}Sr_{0.5}MnO_3$ thin films

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Abstract:

$Nd_{0.5}Sr_{0.5}MnO_3$ (NSMO) is a well-known hole-doped manganite. Its transport, magnetism, and structure are closed linked. In addition, those physical properties are easily influenced by external stimuli such as magnetic field, electric field and mechanical stress. In this presentation, we show slight change of manganese valence state and resultant changes of physical properties by slight change of growth condition. We used pulsed laser deposition for growth condition optimization of epitaxial NSMO on (001) $La_{0.3}Sr_{0.7}Al_{0.65}Ta_{0.35}O_3$ (LSAT) substrates. We confirmed the crystallinity of the thin films and strain state by x-ray diffraction. Interestingly, we found slight difference in oxygen partial pressure in growth leads to enormous changes in transport and magnetization by temperature dependent transport setup and SQUID magnetometer. To understand possible origin of the difference, we used x-ray absorption spectroscopy (XAS) of Mn L-edge and O K-edge to see change of chemical composition. Based on XAS, magnetization, and transport data, we will discuss the possible change not from anion stoichiometry but from cation stoichiometry in growth. This work was supported by the Basic Science Research Program through the NRF funded by the Ministry of Education (NRF-2015R1D1A1A02062175). Also, this work was supported by the National Research Foundation of Korea (NRF) and grant funded by the Korea government (MSIP) through GCRC-SOP (No. 2011-0030013).

Keywords:

hole-doped manganite,transport,magnetism,x-ray absorption spectroscopy

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Thickness-driven metal-to-semiconductor transition in epitaxial MoO_2 films

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Abstract:

Varying thickness often leads to intriguing phenomena, i.e. metal-to-insulator transition and magnetic transition. In many cases, origin of these interesting phenomena has been thought mainly as size effect. Among many rutile oxides, molybdenum dioxide (MoO_2) shows unique metallic behavior. In this work, we observed thickness-driven metal-to-semiconductor transition in MoO_2 thin films from low temperature transport measurements. The slope in temperature dependent resistivity curves becomes negative for the thin film with 20 nm or less. To understand this unusual behavior, we performed the spectroscopic ellipsometry and x-ray absorption spectroscopy. We observed the changes of peak shape. The change of peak shape shown from our XAS spectra is similar to the case of MoO_x ($2 \leq x \leq 3$) with different oxidation. From this experiments, it gives us deep understanding on the origin of thickness-driven metal-to-semiconductor transition in epitaxial MoO_2 films.This work was supported by the National Research Foundation of Korea (NRF) and grant funded by the Korea government (MSIP) through GCRC-SOP (No. 2011-0030013). Also, this research was supported by the Basic Science Research Program through the NRF funded by the Ministry of Education (NRF-2015R1D1A1A02062175).

Keywords:

Molybdenum oxides, low temperature transport,spectroscopic ellipsometry, x-ray absorption spectroscopy, optical conductivity,

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Non-magnetic dilution effects on the Kitaev honeycomb lattice α-$RuCl_3$

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Abstract:
The Kitaev compass model on a honeycomb lattice hosts gapless/gapped spin liquids with emergent fractionalized excitations. Here, we investigate the dilution effects in the Kitaev materials $Ru_{1-x}Ir_xCl_3$ ($0 \leq x \leq 0.5$) through the substitution of non-magnetic (J_{eff}=0) Ir^{3+} ions. Magnetic susceptibility and specific heat measurements unveil that the long-range magnetic ordering with T_N=6.5 K is systematically suppressed with increasing Ir concentration up to x=0.2. However, the Curie-Weiss temperature Θ_{CW} remains largely intact. The disparate impact of the nonmagnetic impurities on T_N and Θ_{CW} implies the non-trivial nature of involved interactions, including nearest neighbor Kitaev and Heisenberg and further neighbor interactions. Above x=0.2, the specific heat gives no indication of magnetic ordering while a large magnetic entropy is released at low temperatures. Possibly, a novel ground state such as a glassy spin liquid is realized in the nonmagnetic-impurity substituted Kitaev material, deserving further investigations.

Keywords:
Kitaev spin model; Non-magnetic impurities; Spin liquids

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Doping and temperature dependence of the electronic structure of $(Sr_{1-x}La_x)_2IrO_4$

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Abstract:
We investigated the electronic response of $(Sr_{1-x}La_x)_2IrO_4$ by using optical spectroscopy. We observed a filling-controlled insulator-to-metal transition (IMT) in this system. La doping led to an emergence of an intraband response at the expense of the optical excitations across the Mott gap. The intraband response of the metallic compounds was found to be mostly incoherent, indicating a critical role of the electronic correlations. Further, we found an abnormal temperature evolution of the low-energy conductivity, which mirrors infrared spectroscopic manifestations of the pseudogap in the high-T_c cuprates. We will compare the infrared response of $(Sr_{1-x}La_x)_2IrO_4$ with that of the cuprates and will discuss the roles of the spin-orbit coupling and the electronic correlations on the electronic structure of the former.

Keywords:
La-doped Sr_2IrO_4, electronic correlations, pseudogap, optical spectroscopy

High pressure synthesis and magnetic/dielectric properties of $PbVO_3$

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Abstract:
We have synthesized polycrystalline sample of $PbVO_3$ under various high pressure conditions. Confirmed by power X-ray diffraction, the grown $PbVO_3$ crystallizes in a tetragonal structure with space group P4mm at room temperature (a = 3.8072Å, c = 4.6982Å), incorporating small amount of a 2nd phase. Expecting prominent magnetoelectric effects, we have investigated temperature and magnetic-field dependences of magnetic and dielectric properties.

Keywords:
Perovskite

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Chiral anomaly and current jet

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Abstract:

The electronic band structure of a Weyl metal contains Weyl nodes, pairs of singular points separated in momentum space, at nondegenerate band touch. Spin and momentum are locked except at node, and thus chirality is well defined. Due to the existence of a pair of chiral Fermi surfaces, the electromagnetic properties of Weyl metals are described by axion electrodynamics given by the topological E·B term. Transport properties of Weyl metals, particularly their magneto-conductivities are expected to show distinct behaviors of topological origin. Recent theoretical investigations of electrical and thermal conductivities of Weyl metals, based on Boltzmann transport theory with Berry curvature and chiral anomaly terms, predict that conductivities are enhanced proportional to B^2 when the electric or thermal current direction and the Bdirection are parallel [1, 2, 3]. However, the inhomogeneity of the sample or point like current contact also affect the conductivity like current jet. We investigated the transport properties of Bi and BiSb alloy, which are known as normal semimetal and Weyl semimatal, respectively. We compare the negative LMR of two classes of semimetals, and discuss the origins of their respective behaviors. [1] D. T. Son and B. Z. Spivak, Phys. Rev. B 88, 104412 (2013) [2] H.-J. Kim et al. Phys. Rev. Lett. 111, 246603 (2013) [3] Ki-Seok Kim, Phys. Rev. B 90, 121108(R) (2014)

Keywords:
Weyl, Chiral anomaly, Current jet

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First-principles constrained RPA calculations of correlation strengths in 3d/4d/5d transition metal oxide heterostructures.

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Abstract:
By using our recently-developed cRPA technique, we performed a systematic investigation of the on-site electron correlations, traditionally denoted by U, for 3d/4d/5d transition metal oxide heterostructures. The on-site Hubbard U and other parameters such as the bandwidth W, the nearest neighbor hopping parameter t, the next-nearest-neighbor hopping parameter t' were investigated. In particular, U/W and the electronic strcutures of the superlattices were compared to high-Tc superconductors.

Keywords:
Strong correlated system, Constrained random phase approximation (cRPA), Hubbard U

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Magnetic force theorem of Heisenberg exchange parameter within non-orthogonal localized pseudoatomic orbital basis method

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Abstract:

We report our recent progress of magnetic force theorem of Heisenberg exchange parameter. Our previous implementation was based on the reformulation of Liechtenstein et al's original LMTO version to be applicable for the non-orthogonal local orbital basis method [1], and it was basically designed for molecules and clusters. We extend this technique to periodic solids by introducing q-summation in the momentum space and Fourier transforming back into the real space. We achieved high numerical efficiency in order of . The results of numerical test calculations and transition-metal monoxides (MnO, FeO, CoO, NiO) will be presented and discussed. We used on-site Coulomb interaction Hubbard U parameters from constrained RPA method. [1] Myung Joon Han, Taisuke Ozaki, and Jaejun Yu Phys. Rev. B 70, 184421 (2004)

Keywords:

Exchange interaction, Heisenberg model

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Orbital-decomposed magnetic interaction based on the first-principles magnetic force theory

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Abstract:
We report our recent progress for the magnetic force theory to calculate Heisenberg exchange parameter. Based on the localized pseudo-atomic orbital method, we successfully implemented the orbital resolution for J (q) in momentum space. This technique is applied first to bcc Fe, and proven to be reliable. We also present and discuss the result of TM monoxides and complex heterostructure systems.

Keywords:
Exchange interaction, Heisenberg model, linear response.

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Metal-Insulator Transition and the Role of Electron Correlation in FeO_2

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Abstract:
Iron oxide is a key compound to understand the state of the deep Earth. It has been believed that previously known oxides such as FeO and Fe_2O_3 will be dominant at the mantle conditions. However, the recent observation of FeO_2 shed another light to the composition of the deep lower mantle (DLM) [Nature 534, 241 (2016)] and thus understanding of the physical properties of FeO_2 will be critical to model DLM. Here, we report the electronic structure and structural properties of FeO_2 by using density functional theory (DFT) and dynamic mean field theory (DMFT). The crystal structure of FeO_2 is composed of Fe^{2+} and O_2^{2-} dimers, where the Fe ions are surrounded by the octahedral O atoms. We found that the bond length of O_2 dimer, which is very sensitive to the change of Coulomb interaction U of Fe 3d orbitals, plays an important role in determining the electronic structures. The band structures of DFT+DMFT show that the metal-insulator transition is driven by the change of U and pressure. We suggest that the correlation effect should be considered to correctly describe the physical properties of FeO_2 compound.

Keywords:
Metal-Insulator Transition, Iron oxides

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Strain engineering of hybrid improper ferroelectricity in Ca3Ti2O7 thin film

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Abstract:
Recently, new mechanism of ferroelectricity named hybrid improper ferroelectricity (HIF) was theoretically predicted in ruddlesden-popper n=2 systems (Ca3Ti2O7, Ca3Mn2O7,....).[1] This HIF is driven by two non-polar distortion, octahedra rotation and tilting. When grwon to film, epitaxial strain can control these octahedra rotaion & tilting.[3] Based on this scenario, it was further predicted that epitaxial strain can make Ca3Mn2O7 a magnetoelectric material, and trigger novel polar to non-polar transition in Ca3Ti2O7. [1, 4] Recently, Prof. Cheong's group experimentally demonstrated the HIF in singlecrystal Ca3Ti2O7.[2] So far, the existence of HIF was verified experimentally in bulk only. If we can realize Ca3B2O7 (B=Ti, Mn) epitaxial thin film, the high tunability under epitaxial strain may realize many interesting phenomenon such as polar to non-polar transition, magnetoelectricity, and complex domain structures. [1] Benedek, N. A. & Fennie, C. J. Hybrid improper ferroelectricity: a mechanism for controllable polarization- magnetization coupling. Phys. Rev. Lett. 106, 107204 (2011) [2] Oh, Y. S., Luo, X., Huang, F.-T., Wang, Y. & Cheong, S.-W. Experimental demonstration of hybrid improper ferroelectricity and the presence of abundant charged walls in (Ca,Sr) 3Ti2O7 crystals. Nature Mater. 14, 407- 413 (2015). [3] Rondinelli, J. M., May, S. J. & Freeland, J. W. Control of octahedral connectivity in perovskite oxide heterostructures: an emerging route to multifunctional materials discovery. MRS Bull. 37, 261- 270 (2012). [4] Xue-Zeng, L., Rondinelli, J. M. Epitaxial-strain-induced polar-to-nonpolar transitions in layered oxides. Nature mater. online (2016)

Keywords:
ferroelectricity

Double-Layer Buffer Template to Grow Commensurate Epitaxial $BaBiO_3$ Thin Films

LEE Han-Gyeol[1, 2], KIM Yoonkoo[3], HWANG Sang Woon[3], KIM Gideok[1, 2], KANG Tae Dong[1, 2], KIM Minu[*1, 2], KIM Miyoung[3], NOH Tae Won[*1, 2]

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Abstract:

We propose a $BaCeO_3/BaZrO_3$ double-layer buffer template, grown on a $SrTiO_3$ substrate, for epitaxial growth of a target oxide film with large lattice constants of over 4.1 Å. Lattice mismatch from the substrate was mostly accommodated for by a compliant $BaZrO_3$ layer. Having an ideal in-plane lattice structure, $BaCeO_3$ served as the main buffer to grow the target material. We demonstrated commensurate epitaxy of $BaBiO_3$ (BBO, a = 4.371 Å) utilizing the new buffer template. Our results can be applied to heteroepitaxy and strain engineering of novel oxide materials of sizable lattice constants.

Keywords:

$BaBiO_3$, Buffer layer, Thin film, Commensurate epitaxy

Ferroelectricity induced by short range magnetic exchange interaction

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Abstract:

Multiferroics, where two or more ferroic order parameters coexist, is one of the hottest fields in condensed matter physics and materials science. In our research we are seeking multiferroicity induced by short range magnetic exchange interaction which proposed by Xiangang Wan, et al. [Scientific Reports 6, Article number: 22743]. We have chosen two simple binary oxides with rocksalt structure, MnO and NiO, to exclude the effect of magnetic dipole alignment on electric polarization from other effects. Pulsed laser deposition technique is used to deposit thin films. Atomic force microscopy, RHEED and X-ray diffractometery show that the films have good qualities and they show step and terrace structure on the surface which can be a sign for two dimensional growth. XRD reveals the fast relaxation of thin films even after 25 A^{o} of growth which suppresses strain level in the thin films. Decrease of the deposition temperature is a way to stop this fast relaxation.

Keywords:

Multiferroics, Spin-Phonon Coupling, Binary Oxides, Pulsed laser deposition, RHEED

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Phase change between metallic and insulating magnetic domain wall in epitaxial $Sm_2Ir_2O_7$ film

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Abstract:
Pyrochlore iridates $R_2Ir_2O_7$ (with R=rare earth element) have been predicted to exhibit a variety of exotic physical phenomena, such as the Weyl semimetallic state, topologically insulating behavior, and novel superconducting states [1]. In the compound $Nd_2Ir_2O_7$, the appearance of a magnetic domain wall conductance has been observed experimentally [2], which points to the possibility that topological phases can be realized in the pyrochlore iridates. Moreover, theoretical work has predicted the appearance of a topological insulator phase in pyrochlore iridates if this material is prepared as a thin film such that the cubic symmetry is broken [3]. On the experimental side, while the pyrochlore iridate compounds have been studied extensively in the form of polycrystalline bulk crystals, not many studies on thin films have been reported to date. The volatility of iridium and its oxides presents a key difficulty in the growth of such thin film samples. Here, we report a study of magneto-transport measurement on epitaxial $Sm_2Ir_2O_7$ and $Nd_2Ir_2O_7$ films grown on YSZ substrates by pulsed laser deposition. We find that the negative magnetoresistance (MR) to positive MR transition occurs at lower temperature (~20 K) in both Sm and Nd pyrochlore iridate films. We assume this transition is related to the ordering of rare earth side magnetic moments. Moreover, temperature dependent magnetic domain wall conductance were observed in $Sm_2Ir_2O_7$ and $Nd_2Ir_2O_7$ films. This domain wall conductance is closely related to the existence of Weyl-semimetallic state which theoretically predicted to have a peculiar metallic state with a Fermi arc at the surface. Reference [1] William Witczak-Krempa et al., Annu. Rev. Condens. Matter Phys. (2014).. [2] Eric Yue Ma et al., Science 350, 6260 (2015). [3] B.-J. Yang et al., Phys. Rev. Lett. 112, 246402 (2014).

Keywords:
Sm2Ir2O7, thin film, Pyrochlore iridate, Weyl Semimetal, Mott insulator

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Strain effect on electronic structure of epitaxial $BaBiO_3$ thin films

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Abstract:

$BaBiO_3$, perovskite oxide ABO_3, is the parent compound of well-known superconductor $Ba_{1-x}K_xBiO_3$. Epitaxial strain distorts the perovskite structure that attributes to the two valance states of Bismuth Bi^{+3} ($6s^2$) and Bi^{+5} ($6s^0$) due to charge disproportion of the formal Bi^{+4}, called charge ordering that lowers the potential energy of crystal. Substrate-based strain can tune the physical properties of perovskite thin films, which imposes its lattice parameter onto the film through coherent epitaxy, it can induce ferroelectricity and rotational phases etc. that can be expected in thin film, not in bulk counter parts. We have epitaxially grown thin films of $BaBiO_3$ on STO substrate for (001), (110) and (111) orientations. We have characterized it using XRD, XRR and AFM. We have investigated in-plane dielectric measurement.

Keywords:
BaBiO3, pulsed LASER Deposition, Dielectric measurement

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Investigation of polymorphism for amorphous and semi-crystalline poly (-ethylene terephthalate-) using high-pressure Brillouin spectroscopy

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Abstract:

High-pressure Brillouin spectroscopy was applied to clarify the physical and mechanical difference of a polymer with distinct structures consisting of the same elements quantitatively. The pressure dependences of elastic properties, Young's modulus, shear modulus, bulk modulus, and Poisson's ratio for an amorphous poly (-ethylene terephthalate-) [(-PET-)] and a semi-crystalline PET were compared for pressures up to 10 GPa. A collapse of free volume for two PETs was ascertained at the different value of pressure with different slopes of elastic properties, Young's modulus, shear modulus, and bulk modulus. Although the Poisson's ratios of a semi-crystalline PET increase linearly upon the pressure, those of an amorphous PET are almost constant. The P-V equation of state for an amorphous PET was also determined and its isothermal bulk modulus extracted from EOS is 6.3 0.2 GPa.

Keywords:
Brillouin spectroscopy; Poly(-ethylene terephthalate-); Equation of state; Elastic property; Diamond anvil cell

Fluorescence imaging of the transition of dsDNA to ssDNA

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Abstract:
Converting between dsDNA and ssDNA is common biological phenomena. The single-molecule imaging of dsDNA transition to ssDNA can reveal the mechanism of enzymatic reactions in many biological pathways that involve the DNA conversion. With developed single-molecule assays such as optical tweezers and magnetic tweezers, the dynamics of DNA conversion can be observed by determining its length variation. However, information on the spatial position of DNA conversion can be also required to understand DNA conversion involved-biological processes. Thus, to monitor the dsDNA transition with both its position and the dynamics of the conversion, we developed a single-molecule fluorescence imaging platform with human ssDNA binding protein that is fused with a photoactivatable fluorescent protein. Using the single-molecule fluorescence imaging, we visualized the exonuclease activity to remove a mismatch in DNA mismatch repair.

Keywords:
biophysics, single-molecule,mismatch repair, exonuclease

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Ab initio calculations of selective adsorption of carbon monoxide and oxygen molecules on transition-metal-incorporated porphyrin

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Abstract:
Carbon monoxide molecules have been known to interrupt transportation of oxygen molecules in the blood, which can cause carbon monoxide poisoning. In the previous research, adsorption of not only carbon monoxide molecules but also environmental gas molecules such as O_2, N_2, and CO_2 on Fe-incorporated porphyrin molecules has been studied. We have performed density functional theory (DFT) calculations to understand the interaction of carbon monoxide and oxygen gas with porphyrins having Fe and other 3d transition metal atoms. In particular, we focus on the investigation of binding energy and electronic structure of carbon monoxide on 3d transition-metal-incorporated porphyrins. The results of Fe-incorporated porphyrin is compared with the previous ones. In addition, the interaction of carbon monoxide with other types of oxygen-transporting proteins or their subunits is investigated.

Keywords:
Ab initio, Porphyrin, 3d metal, Carbon monoxide, Oxygen

Two conformational states in D-shaped DNA: From theory to experiment

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Abstract:
Bending with high curvature is one of the major mechanical properties of double-stranded DNA (dsDNA) for its biological functions such as packing the nucleosome, transcription-control, and viral-genome packing. In our recent study, a nanometer-sized dsDNA bent into a D shape was formed by hybridizing a circular single-stranded (ss) DNA and a complementary linear ssDNA, which induces bending in the short dsDNA portion. Our fluorescence resonance energy transfer(FRET) measurement of D-shaped DNA revealed two types of conformational states: a less-bent state and a kinked state, which can transform into each other in millisecond scales. To understand the origin of the two deformed states of D-shaped DNA, here we first study the presence of open base pairs in the ds portion by using the breathing-DNA model to simulate the system. We provide strong evidence that the two states are due to the emergence of local denaturation, i.e., a bubble in the middle and two forks at ends of the dsDNA. We also study the system analytically and find that the free-energy landscape is bistable with two minima representative of the two states. The kink and fork sizes estimated by the analytical calculation are also in excellent agreement with the results of the simulation. Thus, this combined experimental-simulation-analytical study corroborates that highly bent D-shaped dsDNA reduces bending stress via local denaturation.

Keywords:
DNA bending, local melting, denaturation, breathing-DNA model, single-molecule, FRET

Demonstrating single-molecule FRET probe for measuring short-range molecular interactions

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Abstract:

Over the last two decades, single-molecule Forster resonance energy transfer (FRET) has been widely used as a spectroscopic ruler for measuring inter-dye distance in the range of a several nanometers. While conventional single-molecule FRET is a powerful tool to study both the intra- and inter-molecular dynamics of biomolecules in real-time, it also suffers from the limitation of the working distance. In this work, we report Cy2-Cy7 dye pair as short-range FRET probe at single-molecule level, thus providing increased sensitivity to distance. The effective working distance can be easily reduced to 3-nm and below, which was previously inaccessible with conventional single-molecule FRET probe. As a demonstration, we use differently labeled DNA duplexes and show the capability for measuring changes in the short-range distance.

Keywords:

smFRET, dynamics, biomolecules, Cy2-Cy7, short-range

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Wavelength dependence of the refractive index of single crystal tetramethyltetraselenafulvalene

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Abstract:

Dispersions of refractive index of single crystal tetramethyltetraselenafulvalene (TMTSF) are studied using the unpolarized broadband photoluminescence spectra within range of wavelength between 650 and 800 nm. Single crystal TMTSFs were grown by physical vapor deposition process with flow of Ar as a carrier gas in a quartz tube which was regulated to be under a certain temperature gradient. He-Ar laser with an excitation energy of 2.4 eV (or a wavelength of 514 nm) was focused to a spot of size around half a micrometer radius and applied to the direction perpendicular to the ab-plane of single crystal TMTSs. Subsequent emission spectra due to excitonic transition were detected in the same direction. Strong modulation of the intensity in the photoluminescence spectra was found along with a broad peak around wavelength of 670 nm followed by a weak shoulder structure near 730 nm. The periodicity of the intensity modulation strongly depends on the length scale between a pair of crystal faces corresponding to the ab-plane. In fact, the pair of parallel crystal facets with molecular scale flatness function as Fabry-Perot resonator in which multiple internal reflections give rise to interference producing oscillations in the photoluminescence spectra. The spacing of oscillation depends on the group refractive index and thus the broadband character of the photoluminescence spectrum allow us to estimate the dispersion of refractive index of single crystal TMTSF. The group refractive indices gradually decrease from ~1.8 to ~1.7 as the wavelength increased from 650 to 800 nm. The dispersion of phase refractive index, estimate based on the empirical Sellmeier dispersion equation, is obtained as 1.7 depending weakly on the wavelength variation. As is the case for the most organic single crystals, it is expected that emission occurs mostly at the edges of crystals while the surface emission is nearly absent. We will discuss the unusually strong surface emission found in single crystal TMTSF in terms of the molecular arrangement.

Keywords:
TMTSF, Organic, Single crystal, Photoluminescence, PL, Organic single crystal

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Investigating the synergistic effect of the co-existence of a-Syn monomers and oligomers in Parkinson's disease

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Abstract:
During the initial phase of Parkinson's disease, a-synuclein(a-syn) monomers and oligomers are mixed in real neurons. Monomeric a-syn functions as a chaperone protein for SNARE complex formation, and promotes neurotransmitter release. However, large oligomers inhibit vesicle fusion by blocking SNARE complex formation. Interestingly, both bind to the N-terminal of synaptobrevin-2. Using in vitro bulk vesicle fusion assay, we found that a-syn oligomers and monomers inhibit lipid mixing synergistically. Also, we modified membrane lipid composition and observed that the inhibitory effect of α-Syn depends on the concentration of certain lipids. Our work can help us understand the pathology of Parkinson's disease by a-syn, Moreover, this result can give insight into insight into the relation between aging(lipid composition change), α-Syn monomers, and oligomers.

Keywords:
Parkinson's disease, SNARE, α-Synuclein, vesicle fusion assay

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The Flexibility Measurement of DNA Using Single Molecule FRET.

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Abstract:
The flexibility of DNA plays important role in life mechanisms, such as DNA replication, DNA-protein binding and gene expression and regulation. The persistence length commonly used for physical property quantifying flexibility of DNA and 50 nm is well noted persistence length of DNA at a micrometer scale by various experiments like optical tweezer. However, the recent studies shows the mechanics of DNA shorter than its persistence length which DNA-protein interaction actually occurs differs from the classical expectation. We developed a single molecule FRET based assay for measuring the bendability of DNA less then persistence length using ring DNA. The persistence length of this short DNA calculated by the worm-like chain model extremely small compare to long DNA. This result is also supported by the high curvature of DNA loop in the nucleosome.

Keywords:
single-molecule FRET, alternating-laser excitation, DNA bending, persistence length

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Mechanistic understanding of dynamin-like GTPase Sey1 related to ER fusion through FRET based single-vesicle lipid-mixing assay

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Abstract:

It is known that dynamin-like GTPase Sey1p protein maintain the structure of endoplasmic reticulum that constantly forms interconnected network in the cell. There is not yet consensus on how Sey1p mediate homotypic ER fusion in detail, however. Through the conventional ensemble measurements, where the individual interaction of vesicles cannot be distinguished, they have limitations for reveal how Sey1p works. To elucidating the detailed mechanism of Sey1p, we performed FRET-based single-vesicle lipid-mixing assay. It turns out that Sey1p can easily mediate tethering in proportion to protein density on the vesicle and GTP concentration while it can hardly stimulate vesicle fusion by itself. On the other hand, the time constant it takes to switch from "tethering" to "fusion" is not affected by the protein density on the vesicle and GTP concentration.

Keywords:
Endoplasmic reticulum, membrane protein, Single-vesicle, FRET, TIRF

Single-molecule studies on maltose transport system with maltose binding protein

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Abstract:
Efficient carbon utilization is critical to the survival of microorganisms in competitive environments. To optimize energy usage, bacteria have developed an integrated control system to preferentially uptake carbohydrates that support rapid growth. Maltose is transported across the cytoplasmic membrane of Escherichia coli by a maltose binding protein(MalE)-dependent transport system. The three membrane-associated components of the transport system, the MalK, MalF, and MalG proteins. This system has been studied extensively by crystallography and biochemical assays. Although crystal structures provide crucial snapshots of discrete states of the translocation cycle, but do not resolve the dynamics of the processes. Additionally, "bulk" biochemical experiments cannot provide insights into rare and/or transient events, crucial for the transport process, as these are lost in the ensemble averaging. Thus we are studying this transport system by using single-molecule technique to overcome these limitations.

Keywords:
Maltose transporter, MalFGK2, Maltose binding protein, MBP, MalE, Single-molecule, FRET, Fluorescence resonance energy transfer

DNA exonuclease sensing platform by the interaction between graphene oxide and fluorescence-labeled DNA

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Abstract:
Enzymatic Kinetics and Classification are main topics of modern biochemistry and molecular biology. A simple and versatile fluorescence sensing platform enabling both enzymatic characterizations has not been demonstrated yet. Here, we have developed an assay that utilizes a unique fluorescent DNA probe design and a graphene oxide-based fluorescence quenching. We have tested a series of exonucleases to validate the proof of concept. Our graphene-fluorescence based assay reports the enzymatic directionality and kinetic parameters simultaneously without designing a set of DNA substrates.

Keywords:
Exonuclease, Graphene oxide, sensing, fluorescence sensing

Functional complex formation and mechanical melting by the interaction between 5'-phosphate and λ exonuclease

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Abstract:

Phosphates along the DNA act as an energy source utilized by nucleases to perform their enzymatic reactions. Exonuclease functions as a machine that converts energy resulting from the hydrolysis of the phosphodiester-chain into mechanical work. However, the roles of phosphates during exonuclease activities remain unknown. We selected λ exonuclease as a model system and investigated the roles of phosphates during degradation via single-molecule FRET. We found that newly generated 5' phosphates by each cleavage step facilitate the subsequent post-cleavage melting of the terminal base pairs. Degradation of DNA with a nick requires backtracking and thermal fraying at the cleavage site for re-initiation via the formation of a catalytically competent complex. Unexpectedly, we discovered that a phosphate of a 5' recessed DNA functions as a hotspot for an allosteric trimeric-complex formation without passing through the central channel. Our study provides new insight into the unknown roles of phosphates during the processive enzymatic activity.

Keywords:
Single molecule, FRET, exonuclease, phosphate, DNA melting

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The Characterization of Cooperative Unwinding by SARS-CoV nsp13 Helicase

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Abstract:

SARS-CoV and MERS-CoV were epidemic in 2003 and 2015 in ASIA. SARS-CoV helicase plays critical roles in viral replication, and has been proposed to be a potential target for anti-SARS-CoV therapy. Thus, the characterization of enzymatic activity might be critical for drug development. We utilize single molecule FRET to examine the unwinding and rewinding mechanism of nsP13 helicase on partial DNA duplexes as a function of protein, ATP concentration, and tail length. Our results unravel that the tail length of the substrates governs the total amount of DNA unwound by increasing the number of proteins loaded. In contrast, unwinding rate and step size depend on protein and ATP concentrations with a long tail partial duplex (45nts long), but is independent of protein concentration for a short tail partial duplex (30nts long). We also observed a repetitive unwinding displaying multiple rounds of re-unwinding and re-zipping events where re-unwinding becomes favorable at higher protein concentration. We also found that the relative extent of constitutive unwinding and repetitive fluctuation is defined by the enzyme oligomerization formed in the presence of ATP concentration. The relative ratio between unwinding and re-zipping determines the processivity of the cooperative helicases.

Keywords:
Single molecule, FRET, nsp13, helicase, SARS-CoV

The Measurement of Force exerted by DNA sliding clamps

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Abstract:

Proliferating cell nuclear antigen (PCNA in eukaryotes; b-sliding clamp in prokaryotes), a processive factor of DNA polymerase, plays a critical role in DNA replication and repair through the protein-protein interaction on DNA. DNA sliding clamps have an extremely stable donut-like structure and diffuse freely along DNA through its empty region. Due to the extraordinary stability of sliding clamps, they can be accumulated on DNA. However, chromatin blocks may inhibit the diffusion of the sliding clamp complex for the signaling transduction along DNA. We hypothesized sliding clamps on DNA act like a 1D gas of freely diffusing particles interacting with one another by excluded volume (1D Tonks gas). The resulting pressure exerted by sliding clamps may change the kinetics of DNA binding proteins and remove the roadblocks on DNA. Using a single-molecule force-fluorescence spectroscopy that combines optical tweezers with a confocal fluorescence microscopy, we measured the force exerted by multiple b-sliding clamps by monitoring the unzipping force of dsDNA dependent on the number of Alexa647-PCNA clamps. The result indicates that the physical properties exhibited by sliding clamps can be directly related to biological processes.

Keywords:
1D Tonks gas, sliding clamp, optical tweezer

Single Molecule Studies on tR2 Terminator

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Abstract:

tR2 terminator is one of intrinsic terminator composed of a stem-loop hairpin structure and a poly-uracil(U) chain in e. coli. This terminator originates from bacteriophage λ and plays an important role as a regulator of lytic cycle with some factors such as NusA protein. As we know, these structures can induce the termination event, but how it is happening still remains uncovered. In this study, we observed the FRET change and Protein Induced Fluorescence Enhancement (PIFE) during the terminator process. Using DNA with various dye positions and mutant hairpin structure, we found the motion of RNA polymerase after RNA dissociation and the NusA effect on the dissociation of RNA polymerase. We will study the movement of RNA polymerase after the termination in more real condition and the effect of other factor related to RNA transcription

Keywords:
Fret, Single Molecule, tR2 terminator, RNAP

SMFRET analysis of Nucleosome Remodeling by CHD1

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Abstract:

Nucleosome is unit of DNA packageand deeply related to transcription regulation. To regulate transcription,various chromatin remodelers form, deform, and move nucleosomes, which disturb transcription. In these chromatin remodelers, CHD1 not only translocates nucleosome by itself, also plays a key role in transcription -form a complex with RNA polymerase II and overcome nucleosome in transcriptioninitiation and elongation-. So, Understanding the transcription regulation requires mechanism of CHD1 to be unveiled. Here, we are studying on detail mechanism of CHD1 by single molecule FRET technique. It provides nanometreresolution and video rate time resolution. We observed nucleosome DNA unwrapping during ATP hydrolysis cycle of CHD1 in nucleosome remodeling which is different phenomena from other known chromatin remodelers. We think this property helps CHD1 move nucleosome further than other remodelersusing single ATP.

Keywords:
Nucleosome, CHD1, FRET

Single-molecule co-IP imaging of EGFR derived from Extracellular Vesicles

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Abstract:
Epidermal growth factor receptor (EGFR), a receptor tyrosine kinase (RTK), is well-known for its role in tumorigenesis and maintenance of multiple types of cancers. In particular, non-small cell lung cancer (NSCLC), accounting for ~85% of lung cancers, is characterized by its high frequency of EGFR-activating mutations. In the course of developing resistance toward EGFR-targeting drugs, cancer cells harness the release and uptake of nanoscale liposomes called extracellular vesicles (EVs) that mediate intercellular communications. Here, we ask how distinct types of EVs differently represent their parental cells from an oncoprotein-delivery perspective. Specifically, we characterize the functionality of EGFR carried by two types of EVs. Our data show that microvesicles closely reflect the cellular EGFR in their downstream signaling potential while exosomes generally display upregulated PPIs. Using drug-resistant cells and EVs derived from them, we also study how EVs adjust their PPI landscape when it acquired drug resistance. We hope our results to be a stepping stone to the practical utilization of EVs in the clinic for precise diagnosis and therapeutic decision.

Keywords:
extracellular vesicles

miRNA detection by fluorescence in situ hybridization (FISH)

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Abstract:

miRNA is a small non-coding RNA (~21 nucleotides), and is a negative regulator of gene expression. Despite rapid advances in our understanding of miRNA biogenesis and mechanism, detection of miRNA in single cell is challenging due to its short length and low level of expression. Here, we describe a method for the detection of miRNA in single cell using fluorescence in situ hybridization. The method adopts point accumulation for imaging in nanoscale topography (PAINT) not only to increase the resolution but also to avoid the problem of non-specific and off-target binding.

Keywords:
miRNA, FISH

Reconstitution of RNA Transcription Machinery and Co-transcriptional Effects of TPP Riboswitch Folding

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Abstract:
A riboswitch is a non-coding region of an mRNA which recognizes a specific metabolite and regulates the expression of the mRNA itself. Recently, the fact that RNA folds sequentially as it is being transcribed is carefully considered for RNA structure prediction and dynamics study. It has been shown that this co-transcriptional effect strongly influences RNA folding pathway suggesting that the formation of transient conformations serves as a guideline for the following co-transcriptional folding. We used fluorescence resonance energy transfer (FRET) to study conformational dynamics of the Escherichia coli thiM TPP (thiamine pyrophosphate) riboswitch. Previously, we found that the open form and the closed form of the riboswitch recognize the ligand with similar preference and the final conformational transition of it is induced by the ligand. Using RNA polymerase elongation complex system, we will show that RNA folding processes including ligand bindings are strongly related to the transcription itself.

Keywords:
TPP riboswitch, single-molecule FRET, co-transcriptional RNA folding

Developing single molecule well-type assay with high-throughput device (SWAT) for probing protein-protein interactions

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Abstract:
Single molecule pull-down assay has been widely used to investigate not only protein-protein interaction (PPI) but the stoichiometry and assembly of many proteins. Basically, this assay has taken channel-type device with inlet and outlet. Despite the well-established device for single molecule pull-down experiment, several problems such as diffusion in the channel remain to be solved. Here, we develop single molecule well-type assay high-throughput device (SWAT). In this device, channels were substituted by wells made by laser cutter in acrylic and acrylics attached to PEGylated (Polyethylene glycol) coverslip with epoxy. By combining well-type single molecule assay with high-throughput device, the approach enables to (i) minimize the sample volume to 10ul, (ii) highly sensitive PPI detection by mixing solution directly about 1.4 times and (iii) scale up for high-throughput measurements.

Keywords:
Well-type device, Single-molecule assay, Protein-Protein Interaction, High-throughput

Pitch change dynamics of chiral nematic liquid crystal

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Abstract:
A chiral nematic liquid crystal has a helicity which relates to a pitch length of director. The director is an average directions of molecules for a long axis. The pitch length is kept constantly thoroughly in a homogeneous cell. An electric field changes the director distribution, since the molecule is a dielectric material. The molecule used in this study rearranges parallel with an electric field. The director distribution varies by an in-plane electric field with no pitch length change until the electric field strength is enough. The pitch length changes suddenly for a certain electric field strength, when the electric field strength increases or decreases gradually. We have an interest in pitch change dynamics for the pitch length change and investigate the dynamics experimentally with an appropriate model.

Keywords:
Liquid crystal, Chiral, Nematic, Dynamics, Pitch

Building signaling complexes on pulled down HER2 dimers

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Abstract:

Many RTK mediate the cellular signaling network by dimerisation which lead to direct downstream protein recruitments. We've managed to pull down the active form of HER2 dimer and then observed increased protein-protein interaction follwed by in-vitro kinase assay. But, pulled down HER2 dimer showed weak affinity toward GRB2 downstream protein regardless of it's activation. Therefore, we introduced another scaffolding protein SHC1 that provides the platform for the GRB2 binding. By introducing scaffolding protein in kinase assay, we recover the increased protein-protein interaction of GRB2 toward the HER2 dimer as expected. Moreover, we've introduced other downstream protein component such as sos1 that forms signaling complexes rather than interacts with HER2 directly. By adding or removing the components of such signaling component of protein network, we assured that the invitro-kinase assay for the Her2 dimer is indeed apt for observing signalling network that are made by multiple interaction of proteins.

Keywords:
scaffolding protein

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Imaging of frozen hydrated biological specimens at nanoscale resolution

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Abstract:
Radiation damage to biological specimens is a serious obstacle for high-resolution structural studies with X-rays. To mitigate this limitation, we have developed a cryogenic coherent diffraction microscope. Samples were prepared by rapidly freezing them below 100 K to preserve the native structures. Frozen hydrated specimens were then preserved below 100 K throughout the X-ray imaging experiments. We have successfully recorded high contrast diffraction patterns. Diffraction patterns from the specimen were monitored with X-ray dose to confirm that the radiation induced structural deformation is not involved. The attained resolution is not limited by the radiation, but by the numerical aperture from the detector. With this new capability, we expect to unveil internal compartments of frozen hydrated cyanobacteria and hierarchical structures of human chromosome at better than 30 nm scale in a near future.

Keywords:
coherent diffraction imaging, bio imaging, cryogenic imaging, high resolution imaging,

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The Influence of Chromatin Structure on Energy Dissipation and Dynamic Behavior

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Abstract:

Recent advances in imaging and chromatin conformation capture techniques allow us to glean the chromatin organization inside cell nucleus. The finding that there is a fundamental variation in the chromatin organization along the developmental stage of the cell motivated us to study the mechanical responses of cell nucleus. In this study, we used Hi-C contact maps to model the spatial organization of chromatin into a Gaussian network model, and calculated response functions. Human embryonic stem cell (ESC) and fibroblast (FB) retain different chromatin organization, and the contact probability calculated for an intermediate range of genomic separation s (1Mb $< s <$ 10 Mb) shows different scaling exponent. Our calculation of response function suggests that FB, whose dynamic behavior is constrained by hierarchical, self-similar organization composed of topologically correlated domains, displays a relatively lower energy dissipation. In contrast, ESC having an open structure displays independent domain motion. We discuss our findings of rheological properties of two distinct chromatin organization in conjunction with the gene expression at different developmental stages.

Keywords:

Chromatin Organization; Gaussian Network model; Enery Dissipation

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High speed Magnetic particles tracking system with scattering solutions.

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Abstract:
The magnetic tweezers is camera based particle tracking tool which process the images to make x,y,z position information of the beads. The micro-meter size of superparamagnetic bead is used to treat the biologically appropriate force from 0.01pN to 100pN. Sensitive and wide range of applicable force is one of advantages comparing other force spectroscopy like optical tweezers and AFM. Traditionally, the magnetic tweezers has low temporal resolution up to 60Hz because of the hardware limitation. This weakness makes hard to observe fast folding-unfolding event of DNA hairpin in few milliseconds. To solve this technical issue, we should get high frame rate of image using high speed complementary metal–oxide–semiconductor (CMOS) Camera and use graphic processing units (GPU) rather than CPU to get better computing power. One of the famous GPU processing technique, CUDA processing make the tweezers can track the beads in thousands Hz and beyond nanometer spatial resolution

Keywords:
magnetic tweezers

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Single-Molecule Mechanical Response of No Mechanoreceptor Potential C Channel Studied with Magnetic Tweezer

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Abstract:

Touch sensing is essential to human communication, quality of life and health; however, the underlying molecular mechanisms remain mostly unknown. Touch is mediated by ion channels on sensory neurons, such as TRP (transient receptor potential) channels. Recently drosophila's mechanosensory TRP channel, NOMPC (no mechanoreceptor potential c) has been illuminated as a possible direct gating ion channel that transduces mechanical stimuli into electrical and chemical signals by opening its ion pore. Here, we first demonstrate features of NOMPC using TIRF microscopy and magnetic tweezers. We showed the stable tetrameric formation by bleaching the eGFP-NOMPC recombinant protein with laser on TIRF microscopy. Also we pulled eGFP-NOMPC-Spytag recombinant protein using magnetic tweezers to discover the mechanical characteristics of NOMPC. Ours study established the preliminary experimental environments to understanding the unexplored mechanism of NOMPC.

Keywords:
Magnetic tweezer, Mechanosensing ion channel, TIRF microscopy, NOMPC, Membrane protein

Super-Resolved Nanostructure of Intercellular Nanotubes

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Abstract:

Intercellular nanotube has been known as a fragile structure after its first discovery on 2004, but recent studies report rigid nanotubes that maintain the structures for up to few hours. Thin (50~200nm) and long-ranged (up to few hundreds micrometer) tubes hover freely above the surface, but sustain themselves stably. We resolved the nanostructure of nanotubes by fluorescently visualizing F-actins inside the tubes using super-resolution microscopy (dSTORM and two-color PALM). We also exploited fluorescence imaging-combined force spectroscopy to study the dynamics of the nanobute formation in living cells. Taken together with a single-particle tracking of membrane receptors on nanobubes, we propose a physical model of the formation of intercellular nanotubes.

Keywords:
Super-resolution microscopy, dSTORM, 2-color PALM, intercellular nanotube

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Super-resolution Imaging of Neuron in Mouse with Line-scan Confocal Microscope

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Abstract:
We demonstrate super-resolution imaging of presynapse and postsynapse in mouse neuron cell and brain tissue with line-scan confocal microscope (LSCM). We combine LSCM with the method of transient binding oligonucleotides labeled with fluorescent dye (DNA-PAINT, point accumulation for imaging in nanoscale topography). Optical sectioning (about 1 μm) by LSCM suppress the excessive fluorescence background that would prevent the imaging of structures located far from coverslip. LSCM provides bright single molecule images. As super-resolution imaging with LSCM is not constrained by photobleaching, we could produce super-resolution images of presynapse and postsynapse in neuron cell and brain tissue. Through super-resolution imaging method combined with LSCM, we report that the distance between presynapse and postsynapse is about 150 - 300 nm.

Keywords:
super-resolution imaging, neuron, synapse, line-scan confocal microscopy, DNA-PAINT

Effects of dimethyl sulfoxide on surface water near phospholipid bilayers

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Abstract:
Despite much effort to probe the properties of dimethyl sulfoxide (DMSO) solution, effects of DMSO on water, especially near plasma membrane surfaces still remain elusive. By performing molecular dynamics simulations at varying DMSO concentrations (X_{DMSO}), we study how DMSO affects structural and dynamical properties of water in the vicinity of phospholipid bilayers. As proposed by a number of experiments, our simulations confirm that DMSO induces dehydration from bilayer surfaces and disrupts the H-bond structure of water. However, DMSO enhanced-surface water diffusivity, an intriguing discovery recently reported by a spin-label measurement, is not observed at solvent-bilayer interfaces in our simulations. In order to resolve this discrepancy, we examine the location of the spin-label, Tempo-PC, relative to the membrane-water interface. In accord with evidence in the literature, our simulations, which explicitly model Tempo-PC, find that the Tempo moiety is equilibrated at $\sim 8 - 10$ Å below the bilayer surface over the entire range of $0 \leq X_{DMSO} \leq 7.5$ mol%. Furthermore, the enhancement of surface water diffusion brought about by DMSO is confirmed only when water diffusion is analyzed around a Tempo moiety that is immersed below the bilayer surface, which implies that the experimentally detected signal of water using Tempo comes from the interior of bilayers, not from the surface. Our analysis finds that the increase of water diffusion below the bilayer surface is coupled to the increase of area per lipid with an increasing X_{DMSO} ($\lesssim 10$ mol%). Our detailed study of DMSO induced-surface water dynamics complements the recent experimental measurements.

Keywords:
DMSO induced dehydration,sucrose,spin-label measurements,Tempo-PC,surface water diffusivity,phospholipid bilayers

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NAP1L1 promotes dynamic CSB-DNA interactions and the nucleosome remodeling

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Abstract:

Cockayne syndrome protein B (CSB) belongs to the SWI2/SNF2 ATP-dependent chromatin remodeler family, and CSB is the only chromatin remodeler essential for transcription-coupled nucleotide excision DNA repair. CSB has been shown to remodel nucleosomes about 10-fold slower than that of the ACF remodeling complex; strikingly, NAP1-like histone chaperones interact with CSB and greatly enhance CSB-mediated chromatin remodeling. While chromatin-remodeling by CSB and NAP1-like proteins is crucial for efficient transcription-coupled DNA repair, the mechanism by which NAP1-like proteins enhance chromatin-remodeling by CSB remains unknown. Here we studied CSB's DNA-binding and nucleosome-remodeling activities at the single molecule level in real time, to determine how the NAP1L1 chaperone modulates these activities. We found that CSB interacts with DNA in two principle ways: by simple binding and in a more complex association that involves gross DNA distortion. Strikingly, NAP1L1 discourages both interaction modes by promoting more dynamic CSB-DNA interactions. Additionally, we demonstrate that nucleosome-remodeling by CSB and NAP1L1 is similar to ACF, consisting of three distinct phases: activation, translocation and pausing. Importantly, we found that NAP1L1 promotes CSB-mediated remodeling by accelerating both activation and translocation. Additionally, NAP1L1 increases CSB processivity by decreasing the pausing probability. Our study, therefore, uncovers novel mechanistic bases for how NAP1L1 regulates CSB.

Keywords:
Nucleosome, chromatin remodeler, CSB

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a Novel Observation Technique of Amyloid Fibril

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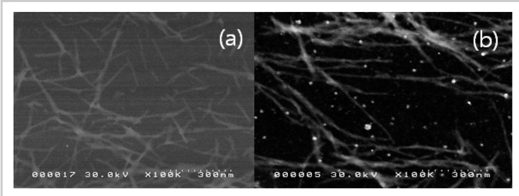

Abstract:
Amyloid fibril is a group of fibrous protein with nanometer scale, that may cause numerous of localized and systematic disorders in various parts of human body, such as Alzheimer's, Parkinson's disease, and type Ⅱ diabetes. The initial causes of such diseases are still unknown; and it is necessary to find therapies to cure the patients. Therefore, scientists are attempting to investigate aggregation process of the fibrils and understand these exact structures through Atomic Force Microscopy (AFM) and Electron Microscopy (EM). However, there are still some remaining disadvantages. AFM is a time consuming method and Transmission EM (TEM) requires sample staining step before imaging, which causes some artifacts. To overcome such issues, we aimed to seek for a novel technique to image the amyloid fibril without any treatment. Scanning Electron Microscopy (SEM) and low-voltage Scanning Transmission Electron Microscopy (LV-STEM) enable to obtain high resolution images of the amyloid fibrils. Furthermore, through our evaluation on various types of substrate, graphene is found to be suitable for supporting film for the fibril. Figure 1 shows fibrils on 20 nm carbon film (a) and graphene (b) at 30 keV, respectively. This method will bring us a step closer to the goal of imaging biological samples in their nature state, providing supportive information for understanding their structure and biological process.

Keywords:
Amyloid fibril, Scanning Electron Microscope(SEM), Scanning Transmitted Electron Microscope(STEM), Graphene

The phase transitions in the even $^{148-156}Sm$ nuclei

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Abstract:

Collective low-lying states are described in even Samarium isotopes within the framework of the model proposed by Iachello, whose symmetries are SU(3), U(5) and X(5). The transition occurs from ^{148}Sm to ^{156}Sm. The former is a vibrational-like isotope while the latter is a rotational-like one. The predicted theoretical results for energy spectra and B(E2) values of low-lying states of the even samarium nuclei are compared with experimental data. In this work it is shown that the low-energy collective structures of the even samarium isotopes have the phase transitions of SU(3) in the direction of U(5) as decreasing the neutron number.

Keywords:
Interacting boson modelDynamical symmetryPhase transitionU(5), SU(3), X(5)

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Large area position-sensitive ionization chamber for beam tracking system for KOBRA.

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Abstract:
Position information of beam particles is often very important for low energy nuclear physics. When a radioactive beam is made by In-flight method, the beam spot sizes is usually big at a diameter of about few cm. At KOBRA, radioactive beams will be produced by In-flight method, and therefore, developing a large area beam tracking system is essential. As the first step of developing large area position-sensitive ionization chamber, the prototype of a position-sensitive electrode was fabricated at SKKU and was tested with a α-emitting source. Details of the prototype development and test results will be discussed.

Keywords:
Beam tracking, posititon-sensitive, large area

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Dead time analysis for neutron capture cross-section measurement by using an NaI(Tl) detector

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Abstract:

The neutron capture cross-sections of ^{162}Dy, ^{164}Dy were measured at the MLF (Materials and Life Science Experimental Facility) of the Japan Proton Accelerator Research Complex (J-PARC). The dead time analysis for neutron capture cross-section measurement by using an NaI(Tl) detector. The pulse-width analysis (PWA) was applied to γ-ray spectroscopy. A method to estimate dead time and count loss in the present PWA measurement system, the following method was hired. The results of the calculation of the dead time rate P_{dt} for the boron sample. We also calculated the dead time rate for Au, ^{162}Dy and ^{164}Dy sample run to study the dead time at resonance peaks. *This R&D was supported by the NRF grant funded by MEST (Center for Korean J-PARC Users, Grant No. NRF-2013K1A3A7A06056592). *This work was supported by the National Research Foundation of Korea(DIRAMS) grant funded by the Korea government(MSIP) (No. 50496-2016)

Keywords:
J-PARC, neutron capture cross-sections, dysprosium, dead time

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Measurement of Delayed Gamma-Ray Energy Spectrum from Residual Nuclide for $^{nat}Pb(p,x)$ Reaction by 100 MeV Proton Accelerator

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Abstract:
$^{nat}Pb(p,x)$ nuclear reaction was measured from delayed gamma-ray spectrum by using HPGe detector. The experiments were carried out at the Korea Multi-Purpose Accelerator Complex(KOMAC). The proton beam in the experiment was derived from 100 MeV proton linear accelerator. The gamma-ray from irradiated samples were measured without chemical processing. The gamma-ray peak intensity in spectrum have information of proton nuclear reaction cross section with ^{nat}Pb isotopes ratio. We measured four delayed gamma-ray spectrum that has different cooling time. Because of different decay time in the residual nuclide for $^{nat}Pb(p,x)$ reaction, it could be measured the different intensity gamma-ray peak in the four spectrum. We compared the gamma-ray peak intensity to distinguish the decay serise. This process is important to obtain proton nuclear reaction cross-section.

Keywords:
proton nuclear reaction, 100 MeV proton accelerator, delayed gamma-ray spectrum

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Measurements of Cross Sections for ^{209}Bi (n, 4n) reactions with high energy neutrons produced by 30, 35, and 40 MeV protons

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Abstract:

Experimental cross sections on ^{209}Bi (n, xn) exist only at a few neutron energies, while such nuclear data are needed for the development of Accelerator Driven Systems with Pb-Bi coolants. We have thus measured ^{209}Bi (n, 4n) cross section at neutron energies in the range of E_n (26 ~ 39) MeV. Bismuth oxide samples were irradiated with the neutrons produced by proton beams on a thick beryllium target. The proton beams of 30, 35 and 40 MeV are available at the MC-50 Cyclotron of Korea Institute of Radiological Medical Sciences (KIRAMS). By measuring the gamma-rays from the irradiated samples with HP-Ge detectors, we analyzed the activities of ^{206}Bi and extracted the cross sections. The neutron flux $\Phi(E_n, E_p)$ generated by the proton beams impinging on the beryllium target with proton energies of E_p were obtained by GEANT4 Monte-Carlo simulations. We first tested the validity of the simulated neutron flux $\Phi(E_n, E_p)$ by extracting the experimental cross sections of ^{56}Fe (n, p) ^{56}Mn and ^{27}Al (n, α) ^{24}Na and found good agreement between our cross sections with other existing data. While $\Phi(E_n, E_p)$ is not mono-energetic, the differences in the neutron fluxes obtained by the proton beams with neighboring E_p, i.e., $\Phi(E_n, 40\ \mathrm{MeV}) - \Phi(E_n, 35\ \mathrm{MeV})$ and $\Phi(E_n, 35\ \mathrm{MeV}) - \Phi(E_n, 30\ \mathrm{MeV})$ can be used to extract the average cross sections. Using this method, we could obtain the (n, 4n) cross section at E_n = (26~34) and (31~39) MeV and compared our results with those from the TENDL-2009 and the EAF-2010 library.

Keywords:
^{209}Bi (n, 4n) cross sections, neutron activation, high energy neutrons

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Silicon isotope 에서의 양성자 비탄성 산란의 상대론적 분석

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Abstract:
^{28}Si와 ^{30}Si에서의 중간에너지 양성자 비탄성 산란에 대해 디랙현상론을 이용한 상대론적 분석을 시행하고 그 결과를 비상대론적 분석 결과와 비교하였다. 광학 퍼텐셜 모형과 1차 회전 집단 모형을 이용하였고 ^{28}Si에서 650MeV의 편극된 양성자 비탄성산란을 고려하고 ^{30}Si에서 650MeV와 800MeV 편극된 양성자 비탄성 산란을 고려하여 유효 퍼텐셜들의 에너지 의존성과 중성자수 변화에 따른 변형 변수의 변화도 분석하였다.

Keywords:
양성자 비탄성산란, 디랙현상론

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2016.10.19 - 2016.10.21

한국형 테스트 블랑켓의 주요 구조재에 대한 중성자 입사 핵반응 평가

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Abstract:
국제 핵융합로 (ITER) 개발의 주요 목적 중의 하나는 삼중 수소를 지속적으로 공급할 수 있는 Breeding Blanket을 제작, 설치 및 시험 운영하는 것이다. 이와 관련하여 한국은 헬륨 냉각의 세라믹 반사체 테스트 블랑켓(Helium Cooled Ceramic Reflector Test Blank Module, HCCR TBM)을 개발하고 있다. 제작에 들어가지 전 최적의 설계를 위해 neutronics 계산이 필수적이다. 이런 계산을 위해서는 핵반응 DB인 핵반응 라이브러리가 필수인데, 지금까지 핵융합용 라이브러리인 (FENDL-2.1)이 기본 라이브러리로 사용 되었다. 그러나 FENDL-2.1과 그 후속 버전인 FENDL-3.0은 실험데이터와 차이를 보였다. 이런 문제점을 극복하고자 주요 구조재에 대한 새로운 평가를 본 연구에서 수행하였으며, 그 결과로 핵반응 단면적 뿐만 아니라 neutronics 계산에서 가장 중요한 역할을 하는 중성자 스펙트럼을 향상시켰다.

Keywords:
핵반응 평가, 구조재, TBM

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NaI(Tl) 섬광 검출기를 이용하여 차폐체의 두께에 따른 감마선 Bulid-up factor 측정

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Abstract:
3″Φ ×3″ NaI(Tl) 섬광 검출기를 사용하여, 차폐체의 감마선 감쇠계수를 측정하고, 차폐체 두께에 대한 Build-up factor을 구하였다. 감마선원은 표준선원 22Na (511 keV, 1274 keV), 137Cs (662 keV), 및 Am-Be (4.4 MeV)을 이용하였다. 점선원으로부터 좁은 빔을 이용하기 위해 납 collimator를 사용하였다. 차폐체로의 크기는 10 × 10 cm 정사각형이며 차폐체는 알루미늄(Al), 구리(Cu), 아연(Zn), 철 (Fe), 주석(Sn)을 사용하였다. 감마선의 감쇠계수, 질량감쇠계수 및 두께에 따른 Build-up factor을 다른 연구자의 결과와 비교하여보았다. 통계오차 10 % 이내가 되도록 측정시간을 충분히 하였다.

Keywords:
NaI(Tl) 섬광 검출기, Build-up factor, 감쇠계수, 질량감쇠계수

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2016.10.19 - 2016.10.21

$\pi^+\pi^-$ partial wave analysis in central exclusive production at √ s=7 TeV in the ALICE.

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Abstract:

ALICE is one of main experiments at the CERN Large Hadron Collider and data in proton-proton collisions was collected during Run1 at center of mass energy TeV. ALICE has central detectors providing excellent tracking and particle identification and forward detectors with extended pseudorapidity () coverage, so it is proper to investigate central exclusive production (CEP), , in proton-proton collisions. As this type of collision is dominated by relatively small momentum transfer processes, measurements of CEP can contribute to the theoretical understanding of Quantum Chromodynamics in non-perturbative regime. According to Regge theory, this production is explained by exchanging of Pomeron at high energies, so final states can be , and so on. In ALICE, we can observe CEP using double-gap topology and f0(980) and f2(1270) particles are observed in final states. The properties of these particles such as mass, width, and spin number could be obtained using partial wave analysis tool and will be presented.

Keywords:
partial wave analysis, central exclusive production, ALICE

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중이온 충돌에서의 능선 구조

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Abstract:
상대론적 중입자 충돌 가속기(RHIC, Relativistic Heavy Ion Collider)에서 STAR 공동연구팀, PHENIX 공동연구팀, 그리고 PHOBOS 공동연구팀이 진행한 중이온-중이온 충돌실험(충돌실험)과 거대 강입자 가속기 (LHC : Large Hadron Collider)에서 CMS 공동연구팀이 진행한 양성자-양성자(충돌실험)에서 와 의 상관관계를 관찰한 결과, 와 에서 의 변화에 무관하게 입자가 관측되는 능선 구조(ridge structure)를 관찰할 수 있었다. 이 능선 구조를 설명하기 위한 다양한 모델들이 적용되었는데, 본 논문에서는 그 중에 제트와 족입자가 충돌하여 제트 방향으로 운동량을 얻어 능선 입자들이 생성된다고 가정하는 운동량 전달 모델(momentum kick model)을 재현하고, 실제 이 모델에서 능선 구조를 기술하는지 확인해 보았다.

Keywords:
Ridge StrutureHeavy Ion CollisionMomentum Kick Model

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Simulation to calculate differential cross section of electron-positron pair production & distribution of electron kinematics

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Abstract:
Heavy-ion 충돌에서 생성된 광자는 beam-pipe와 같은 물질과의 상호작용을 통해 에너지를 잃으며 전자-양전자 쌍을 생성할 수 있다. Bethe-Heitler 공식으로 광자로부터 생성되는 전자의 쌍생성 산란단면적을 기술할 수 있고, Tsai공식으로 광자의 진행방향에 대한 전자의 산란각도 분포를 구할 수 있다. 이 경우 event sampling 또는 확률 함수를 이용한 두가지 방법으로 전자의 운동량과 같은 kinematic변수들을 계산할 수 있고 수치적, 이론적인 값의 분포를 비교하였다. 이를 통해 고에너지에서 background electron에 대한 이해를 하기위해 전자와 충돌 꼭지점간의 최단거리인Impact parameter(IP)분포를 구하였다.

Keywords:
Pair production, Impact parameter

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2016.10.19 - 2016.10.21

중이온가속기 라온의 QWR 저온유지모듈 내 지구 자기장 차폐에 관한 연구

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Abstract:
라온의 선형가속기 구간은 초전도 가속관을 내부에 포함하고 있는 다수의 저온유지모듈과 그 모듈들 사이 상온 구간에 위치한 중이온 빔 집속 및 진단 장치들로 구성된다. 초전도 가속관의 가속 성능을 높이기 위해서는 극저온 냉각 동안 가속관 표면에 지구 자기장 포획을 최소화하여야 하는데, 이를 위하여 저온유지모듈 내부에 자기장 차폐 구조물이 설치되어야한다. 본 연구에서는 QWR 저온유지모듈 내 지구 자기장 차폐에 관한 이론 및 차폐 구조물에 대한 예비 전산모사 결과를 소개한다. 또한, 자기장 차폐를 위한 Mu-metal 견본과 실제 구조물에 대한 자기 특성 측정 결과를 해석하고 QWR 저온유지모듈 내 지구 자기장 차폐 보강을 위한 후속 조치를 제시한다.

Keywords:
중이온가속기, 초전도가속관, 저온유지모듈, 지구자기장 차폐

Study on characterization of ISOL target ion source system at off-line test facility

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Abstract:
In the Rare Isotope Science Project (RISP), the ISOL target ion source (TIS) system has been developed at off-line version of test facility. The test facility was established, in order to test core components of ISOL TIS system, which is composed of ion source system, beam transport system and beam diagnostic system. Sn and Cs ion beams have been extracted at 20 kV HV platform successfully from laser ion source and hot-cavity surface ion source, respectively. Sn and Cs isotopes are evaporated at 2000°C high temperature vacuum system. In order to evaluate characterization of TIS system, a mass separator, a Faraday cup and an emittance scanner have been utilized. The mass spectrum shows clearly separated ten stable Sn isotopes with the mass resolving power more than 500. In this work, an optimal condition of beam transport line from the hot-cavity to the Faraday cup and the current experimental results are presented.

Keywords:
ion source, off-line, hot-cavity,

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EBIS 전하 증식기 진단용 에미턴스미터 개발

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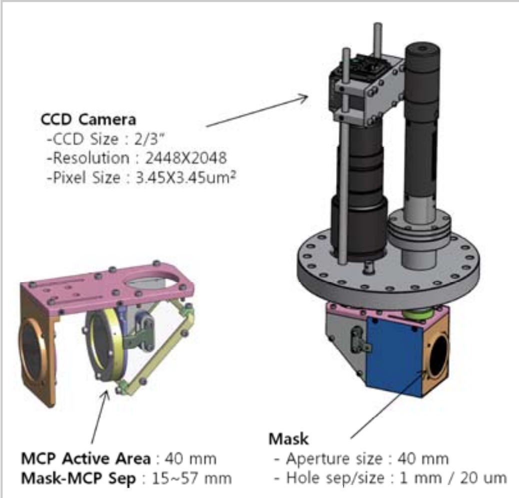

Abstract:
중이온 가속기 RAON에 설치될 EBIS 전하증식기의 빔진단 장치로서 pepperpot 에미턴스미터가 설계되었고 제작되었다. 에미턴스미터를 이용한 빔 품질의 측정은 패러데이 컵을 이용한 빔 전류 측정과 함께 EBIS 전하증식기의 최적 동작 파라미터를 정하기 위한 중요한 과정이다. Pepperpot 에미턴스미터는 Alison-type의 에미턴스 스캐너에 비해 장점이 있는데, 장치 구성이 보다 단순하고, 측정 속도가 빠르며, DC 빔뿐 아니라 펄스 빔에 대해서도 측정이 가능하다. 주요 구성품은 20 μm 크기의 구멍이 1 mm 간격으로 배열된 탄탈륨 마스크와 단일 MCP, 그리고 형광 스크린이다. 마스크와 MCP까지의 거리는 17 mm - 60 mm 사이의 범위에서 조절 가능하도록 하여 빔 발산 정도에 따라 최적 값을 선택할 수 있도록 하였다. 형광 스크린에 형성된 이미지는 반사경에 의해 뷰포트로 전달되며 챔버 외부에 설치된 CCD 카메라로 최종 검출된다(그림 참조). CCD 카메라의 이미지 센서는 픽셀의 크기가 3.45 μm로서 MCP 채널 크기(10 μm)보다 작은 값이다. 본 연구 발표에서는 pepperpot 에미턴스 미터의 전반적인 디자인과 제작 사양 등이 기술될 예정이다.

Keywords:
Pepperpot emittance meter,EBIS charge breeder, MCP

The measurement of concentration for the NIST sediment standard by photon activation analysis

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Abstract:
he Photon activation analysis of standard sediment SRM 1646a were determined by using the activation and the off-line γ-ray spectrometric technique with the end-point bremsstrahlung energies of 65-MeV at 100-MeV electron linac of the Pohang accelerator laboratory(PAL). The γ-spectrometer used for the measurements was a p-type coaxcial ORTEC high-purity germanium (HPGe) detector. Using Internal Standard Method, the concentrations of Sc and Mn has been determined, the results agree well with the values given by National Institute of Standards and Technology (NIST). However, a large amount of Zr in SRM 1646a was discovered which was not in the NIST certificate. The concentration of Zr was also determined. All of the results show that it is possible achieve reliable results with the PAA equipment at PAL labs.

Keywords:
Photon activation analysis,PAA, Internal Standard Method

The Calibration System for COSINE-100 Experiment

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Abstract:
The COSINE-100 searches for WIMP dark matter signals using an array of ultra-pure NaI(Tl) crystals at the Yangyang Underground Laboratory(Y2L). The target goal is to confirm or reject the DAMA/LIBRA claim of an annual modulation signature in similar NaI(Tl) crystals. For the energy-calibration of COSINE-100 detector, several gamma-ray sources were produced and a mechanical source mover was developed. Background radiation from the Y2L environment is attenuated by a multilayer radiation shield. In this presentation, the calibration system and the shielding of the NaI crystal detectors will be reported.

Keywords:
Dark metter search, Calibration source

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Bridgeman Growth and Characterization of Ce-doped $Cs_2LiGdBr_6$ Crystals

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Abstract:

We developed various Ce-doped $Cs_2LiGdBr_6$ single crystals by using Bridgman method. The developed samples are 10%, 15%, 20% and 30% Ce-concentrations. Melting point of the crystals are found to be ~600 °C and grown by pulling down rate of 0.3 mm/h. Cylindrical shaped samples are cut with the dimension of ϕ10 x 1 mm^3. We measured the pulse height and fluorescence decay time spectra of $Cs_2LiGdBr_6:Ce^{3+}$ with a bi-alkali photo multiplier tube (PMT) under γ-ray excitation from ^{137}Cs source. We also measured the X-ray induced emission spectra by using X-ray generator. The presence of lithium (Li) and gadolinium (Gd) ions in the crystal is useful for the neutron detection . We report a detail procedure of the crystal growth and scintillation property in this presentation, and consider the prospect for the high energy physics, nuclear physics and astrophysics application.

Keywords:
Brigeman, Characterization, $Cs_2LiGdBr_6$,scintillation property,crystal growth

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Electron Beam Ion Source (EBIS) 전하 증식 장치의 이온 전송 구간 설계

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Abstract:
한국 중이온가속기 RAON의 희귀동위원소 연구의 효율성을 높이기 위해 Electron Beam Ion Source (EBIS) 전하 증식 장치를 개발 중에 있다. EBIS는 전자빔과 희귀동위원소빔(Rare Isotope Beam)의 전기적 충돌을 이용하여 RI 빔의 전하 상태를 증가시키는 장치이다. 같은 동위원소이더라도 전하 상태가 높으면 재가속 효율이 높아 RI빔을 이용한 연구에 장점으로 작용한다. EBIS는 크게 전자빔 발생 수거 구간, 이온 가둠 구간, 이온 전송 구간으로 구분할 수 있다. 이온 전송 구간은 테스트 이온 소소, 이온 전송 렌즈, A/Q 분리 및 빔 진단 장치로 구성된다. 전하증식 테스트를 위해 Cs+1 이온 소스를 사용할 예정이며, 주입 이온빔의 에너지는 30keV이다. 추출 빔의 전하 상태는 +32이며, 빔 에너지는 0.96MeV이다. 테스트 이온 소스로부터 A/Q 분리까지 이온 빔의 거동과 이온 전송 장치의 설계를 완료하였다. 이번 연구에서는 EBIS 전하증식 장치를 위한 이온 전송 구간 설계를 중심으로 다루고자 한다.

Keywords:
EBIS, 전하증식기, 중이온가속기, RAON

Measurement of the mobility-lifetime products of charge carriers and trap level in CdZnTe crystal

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Abstract:

Recently, several compound semiconductors are developed for radiation detection. There are some problems facing by these detectors such as low carriers transport properties and difficult to grow pure crystal. The candidate for radiation detector must have high drift mobility, high mobility-lifetime products and free of defects. One of the potential candidates for the next generation radiation detector is CdZnTe (CZT). In this study, the carriers mobility and trap levels of CZT crystal are studied.

Keywords:
CZT, compound semiconductor, radiation detection, drift mobility, mobility-lifetime products

Recovery of Calcium Molybdate Powder from its Crystal Waste using Hydrochloric Acid

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Abstract:

The AMoRE (Advanced Molybdenum based Rare process Experiment) collaboration uses $^{dep48}Ca^{100}MoO_4$ (CMO) crystals in a search for neutrinoless double beta ($0\nu\beta\beta$) decay of ^{100}Mo. The objective of the present study is to develop technology for recovering calcium molybdate powder from its crystal waste products by decomposition with concentrated HCl. The crystal waste was crushed, milled, and sieved to get fine powder (< 0.01 mm). The fine powder was dissolved in HCl then molybdenum and calcium matrixes were separated from the solution using NH_4OH. The isolated compounds were purified separately using a co-precipitation method in order to remove low background radioactive impurities. The $CaMoO_4$ powder was re-synthesized from the purified $CaCl_2$ and $(NH_4)_2MoO_4$ solution. Several samples from each step of experiment were taken for subsequent ICP-MS analysis to measure the effectiveness of purification. The results of the present study show that the recovery efficiency could be increased by reducing the undissolved portion of CMO.

Keywords:
Neutrinoless double beta decay, co-precipitation, radioactive impurities, ICP-MS

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EPICS based local control system for ECR-IS & LEBT section at RISP

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Abstract:
SCL Demo(Superconducting linear accelerator demonstration) was installed in SRF test facility at RISP. SCL Demo has ECR ion source, LEBT, RFQ, MEBT, QWR cryomodule, RF, and beam diagnostics. ECR ion source and LEBT section is the starting point to extract and accelerate heavy ion beam. ECR ion source started to test beam extraction, and remote control system was built for the machine. The remote control system was developed on the EPICS(Experimental Physics and Industrial Control System) platform. It shows the remote control strategy, procedures, system structure details, and future plans.

Keywords:
SCL Demo, ECR ion source, LEBT, EPICS

Development status of the focal plane detector for the KoBRA spectrometer

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Abstract:
A focal plane detection system is required at the KoBRA spectrometer to obtain information on the position, angle, timing and energy for identification of reaction products. A hybrid proportional gas counter was rented for the development of KoBRA focal plane detector, which had been used as a focal plane detector at the CNS radioactive ion beam separator (CRIB), RIKEN. It consists of two position counters and two energy-loss counters. The position counters have resistive wires as anodes and the position information is derived by charge division of signals from the two ends. The energy-loss counters have anodes of conductive wires. The performance test of the detector is being done with 90Sr source and Ar(90%)+CH4(10%) gas of 1 atm. In this poster, current status and results of the hybrid proportional gas counter test will be presented.

Keywords:
Focal plane detector, hybrid proportional gas counter, KoBRA

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Detection of thermal neutrons by using a MICROMEGAS detector

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Abstract:

A MICROMEGAS detector is a gaseous particle detector that can detect charged and neutral particles. We used our MICROMGEAS to detect thermal neutrons generated by MC-50 Cyclotron of the Korea Institute of Radiological Medical Sciences (KIRAMS). Neutrons are produced by bombarding a 1.05 cm thick beryllium target with protons by the MC-50 cyclotron. As a converter we used a thin film of ^{10}B that a high ^{10}B(n, α) ^{7}Li cross-section for thermal neutrons. By calibrating our MICROMEGAS detector for various energies of α particles, we could measure the energy of alpha particles ejected from the ^{10}B(n, α)^{7}Li reactions, which is used to detect the neutrons.

Keywords:

MICROMEGAS detector,thermal neutron, PHITS

Purification of commercial MoO_3 powder by using high vacuum sublimation method

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Abstract:
The AMoRE (Advanced Mo Based Rare Process Experiment) collaboration is using calcium molybdate $CaMoO_4$ (CMO) crystals in a search for neutrinoless double beta decay of ^{100}Mo. As part of the R&D in support for this effort, commercial MoO_3 powder is purified by high vacuum sublimation method. The purification is done at different temperatures in order to determine the optimum conditions for high decontamination purification factors and for high recovery efficiencies. The purified MoO_3 powder is subsequently used to grow CMO crystals. The effectiveness of the purification techniques are evaluated with ICP-MS (Inductively Coupled Plasma Mass Spectrometry) measurements. "Measurements for radioactive decays such as U and Th using HPGe detector at Yangyang underground lab are ongoing."

Keywords:
AMoRE, Vacuum Sublimation, ICP-MS, Radioactive decay

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프로토타입 IF-target의 제어계측시스템의 설계연구

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Abstract:
중이온가속기사업의 In-flight fragmentation target system (IF-target system) 개발을 위한 초기 모델의 제어계측을 위해 제작된 시스템이다. 제어계측 시스템은 CompactRIO (National Instrument) 와 I/O 모듈을 사용하여 LabVIEW 환경에서 기능을 구현해 낸다. 초기 모델의 실험은 1MeV/u의 에너지와 100kW의 파워를 가진 전자빔 가속기 (ELV-6) 와 3장의 다중 흑연 타겟을 이용하여 진행한다. 제어계측 시스템은 실험동안 빔전류와 모터의 회전속도 그리고 각 부분의 온도를 써모커플과 복사온도계 그리고 열화상 카메라를 이용하여 측정하고, 이상사태에 대비하여 전자빔가속기와 인터록 신호를 통신한다. 초기모델의 제어계측 시스템의 기능과 디자인은 앞으로 다양하게 논의 될 것이다.

Keywords:
In-flight fragmentation, Target, Graphite, Electron beam, Multi slice.

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Development of scintillation detectors for medical use

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Abstract:
치료용 방사선은 정확한 양을 정확한 위치에 조사시켜야 하는데 그를 위해서는 그 양을 측정할 검출기가 필요하다. 본 연구에서는 광섬유와 플라스틱 신틸레이터를 활용하여 소형화된 방사선 검출기를 제작하였다. 이 검출기는 유연성, 공간 분해능, 무게, 소형화 등의 장점으로 의료활동 및 방사선을 활용하는 다양한 분야에 사용이 가능하다. 또한 정확한 방사선량을 알기 위해 방사선에 의한 신틸레이터의 섬광과 체렌코프 효과에 의한 섬광을 분리하였다. 이 분리과정은 Colorimetric discrimination method를 이용하여 이루어지며, 신틸레이터와 광섬유에서 발생되는 빛을 CMOS의 R, G, B 픽셀 값을 이용하여 방사선 측정 정확도를 높였다. 또한 여러다발의 다중 검출기로 제작하여 활용도를 넓히고 그 유용성을 배가시켰다.

Keywords:
Scintillator, Cerenkov light, Optical fiber, Colorimetric discrimination method

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Growth and scintillation properties of $Cs_2Mo_3O_{10}$ single crystal

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Abstract:

The growth and scintillation properties of new $Cs_2Mo_3O_{10}$ single crystal are presented. The crystal is grown by using convential Czhochrlaski method. The crystal growth conditions such as pulling rate, rotation speed and cooling rate are optimized. The single phase is confirmed from X-ray diffraction analysis. The optical properties are measured at room temperature. This crystal showed transmittance of 35 % in the visible region. From the transmittance data, band gap is calculated to be 3.32 eV. The luminescence properties are measured under the excitation of 266 nm laser source in the 300-10 K temperature range. The emission spectrum is obtained at 225 K and its intensity enhanced as the temperature decreased down to 10 K. The luminescence intensity showed an increase of 45 times at 10 K as compared to that measured at 225 K. The scintillation decay time is measured by exciting the crystal using 280 nm light emitting diode with pulse width of 100 μs in the temperature range of 300-10 K. The decay time is found to be 58 μs at 225 K which got longer as the temperature decreased and found to be 1890 μs at 10 K. The total energy intensity at 10 K is found to be 30 % as that of $CaMoO_4$. This crystal could be a possible candidate for the neutrinoless double beta decay and dark matter search experiments.

Keywords:
Scintillation, $Cs_2Mo_3O_{10}$, Czhochrlaski method, Neutrinoless double Beta Decay

Measurements of 89Y(n,2n)88Y and 89Y(n,3n)87Y cross sections for fast neutrons by using the Korea Institute of Radiological and Medical Science MC-50 cyclotron

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Abstract:

For the development of fast neutron systems, nuclear data for neutron induced reactions at energies above 20 MeV are required, but they are not precisely measured. The data on 89Y(n, 2n) and (n, 3n) reactions are only scarcely measured with large uncertainties. In this work, we consider the neutron induced reactions of Yttrium for fast neutrons. The reaction products 88Y and 87Y emit gamma-rays, and their half-lives are long enough to measure. By using the neutron activation analysis method, we measured 89Y(n, 2n) and (n, 3n) cross-sections. A proton cyclotron MC-50 in Korea Institute of Radiological & Medical Science (KIRAMS) is used to carry out neutron activation experiments with Y2O3 targets irradiated with neutron beams of a continuous spectrum produced by proton beams on a thick beryllium target. Gamma-rays emitted by the reaction products 87Y and 88Y are measured with HPGe detectors. From the measured gamma-ray activities induced in Yttrium, the gamma-ray disintegration rate in each sample was deduced. By using a subtraction method, the average cross section of 89Y (n, 2n) and (n, 3n) reactions in the neutron energy ranges of 28 ~ 33 MeV and 33 ~ 38 MeV are obtained and are found to be close to the existing EXFOR data. The present study shows that continuous energy neutron spectra can be used to obtain the average cross section of (n, xn) reactions by using a subtraction method.

Keywords:
cross section, fast neutron, activation, subtraction method, Yttirum

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EBIS에 반사형 time-of-flight mass spectrometer에 대한 설계연구

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Abstract:
반사형 time-of-flight mass spectrometer는 물리학, 화학 그리고 생물학 등에서 넓게 사용되는 이온 성분 분석 장치 중 하나이다. 왜냐하면 이것은 분해능이 높고 분석속도가 빠르며 측정범위가 넓다. RAON안에 EBIS를 위한 time-of-flight mass spectrometer (TOFMS)는 charge breeder에서 나오는 이온의 charge state를 분석하기 위해 디자인 되었다. Time-of-flight mass spectrometer (TOFMS)의 ion optical system의 키 포인트는 이온의 인출(extraction), 조정(adjustment), 집속(focus), 분리(separation)과 검출(detection)이다. Ion optical system의 parameter가 변하면 ion의 움직임도 변하고 장비의 성능도 영향을 받는다. Ion optical system의 simulation 결과는 parameter 선택과 design 도움을 준다. Ion optical system의 simulation 상태 진행 각 부분의 parameter 그리고 정확한 분석까지 SIMION software안에서 제작 되었다.

Keywords:
time-of-flight mass spectrometer, high-resolution, reflection

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Developement status of large area (20 cm * 20 cm) PPAC at RAON

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Abstract:
A parallel plate avalanche counter (PPAC) is a common detector to monitor the beam profile and track the particles of RI beam experiment. We have developed PPACs of 10 cm * 10 cm active area and checked its performances successfully using standard ^{241}Am alpha sources. Besides the normal size PPAC, a bigger size PPAC, having active area of 20 cm * 20 cm, is being developed to increase the geometrical acceptance at the focal plane. The PPAC is also composed of double layers to measure x1, y1 and x2, y2 and reduce any random or secondary backgrounds. These PPACs will operate for the KOBRA spectrometer and IF separator at RAON. In this poster, current development status and issues of the bigger size PPAC will be shown.

Keywords:
PPAC, Parallel, Plate, Avalanche, Counter, RAON, RISP, Acceptance, Big, Large, KOBRA, spectrometer, IF, Separator, Detector, Beam, Tracking, RI

Large Single Crystal Growing at CUP

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Abstract:
The Center of Underground Physics (CUP) at IBS is performing experiments for the KIMS experiment to search a dark matter and the AMoRE experiment to search neutrinoless double beta decays at the underground laboratory in Yangyang. These experiments require ultra pure and large scintillation crystals, which are halide crystals like NaI:Tl for the KIMS and $XMoO_4$ (X = Ca, Zn, Pb, Na, Li, etc) crystals for the AMoRE. We have worked on R&D to grow such scintillation crystals since 2015. Using our own crystal growers, we have studied on growing $CaMoO_4$, $Li2MoO_4$, and NaI crystals. In this poster, we will present our crystal growing facility, crystal growers, grown crystals, raw material purification and etc.

Keywords:
Single crystal, KIMS experiment, AMoRE experiment, Czochralski, Kyropoulos, Bridgman

Mode-locked beam properties of an 80 MHz Ti:sapphire oscillator with tens of energy

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Abstract:

Tens of nJ energy 80 MHz Ti:sapphire oscillator to be applied as seed beam of 30 TW laser system has been developed. A brewster-cut Ti:sapphire crystal of which thickness is 6 mm has been used as a laser media. To compensate positive group delay dispersion of the crystal, a pair of Fused silica prisms was set 408 mm apart. In the same manner, 3 chriped mirrors were placed inside cavity. The pulse energy of mode-locked beam was ~18 nJ with 7.5 W pump power. Spectrral width(FWHM) was 107 nm. The spectral width was approximately 50 nm shorter than an existing 100 MHz oscillator in 30 TW system but energy was 5 times higher than before. Pulse width(FWHM) was 12 fs, it was measured with an intensity autocorrelator. Also, beam pointing stability were 31 urad horizontally, 34 urad vertically. M_x^2 ,M_y^2 were 1.6, 4 respectively.

Keywords:

Mode-locking,Ti:sapphire oscillator, High power

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Investigation of the mode spectra in a hexapolar deformed liquid-jet microcavity

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Abstract:

Asymmetric optical cavities can be utilized as photonic devices such as microcavity laser, owing to its directional emission and high quality factor. A deformed liquid-jet microcavity is a type of asymmetric cavity exploiting a cross-section of liquid-jet as a two-dimensional cavity and its boundary shape depends on the initial condition of the ejected jet. In this study, we developed microjet nozzles by using focused ion beam technique. A triangular orifice was fabricated to realize liquid-jet microcavity containing a hexapolar component. The mode dynamics of the hexapolar cavity agrees well with the simulation results by using boundary element method. As a result, the microcavity shape can be expressed by a combination of quadrupole, hexapole and octapole, showing the hexapolar and octapolar components with comparable sizes. Furthermore, we found intermode interactions affected by the resonance-assisted tunneling as previously reported in a quadru-octapolar microcavity.

Keywords:
microcavity, liquid-jet, hexapole, focused ion beam, spectrum

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톨루엔 액체 코어 광섬유의 tapered diameter에 따른 광 투과 스펙트럼 변화

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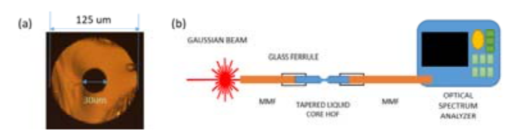

Fig. (a) facet of HOF (b) Experimental setup

Abstract:
최근에, 액체 기반의 광학 부품들이 많은 관심을 끌어 연구되고 있다. 고체 기반의 광부품들과 비교해 보았을 때, 액체 기반의 광학 부품은 응용할 수 있는 범위가 넓다. 예를 들어, 고체 광섬유에 도핑을 할 수 있는 물질은 한정적이다. 반면, 액체 코어 광섬유를 활용하면 용매에 따라 다양한 gain medium을 활용할 수 있다. 이번 논문에서는, Tapered된 액체 코어 광섬유의 광학적 특성에 대해 다루어 보고자 한다. 실험에서 사용된 광섬유는 Fig.(a)와 같은 30um의 hole diameter를 가진 hollow optical fiber(HOF)이다. HOF의 hole을 toluene을 주입하여 액체 코어로서 사용하였다. 톨루엔은 fused silica보다 높은 굴절률을 갖고 있어 빛을 guide 하는 데 유용하다. 제작된 액체코어 광섬유의 outer diameter를 80um에서 30um로 바꾸어 가며 tapering을 진행 하였다. Fig.(b)와 같이 제작된 서로 다른 radius를 가진 tapered된 액체 코어 광섬유의 양쪽을 glass ferrule를 이용하여 Multimode fiber(MMF)와 연결하였다. 광원은 800nm laser를 사용하였고, 제작된 파이버를 통과한 빛의 스펙트럼을 Optical spectrum analyzer를 통하여 스펙트럼의 변화를 확인하였다.

Keywords:
Tapered optical fiber, Liquid core optical fiber

장적외선 영역에서의 은(Ag) 홀 배열 표면 플라즈몬 투과도 특성 변화 연구

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Abstract:
Si 웨이퍼 위에 은(Ag) 홀 배열 필름을 포토리소그래피와 전자빔 증착기를 통해 만들었다. 공정 과정 중에 금속 증착속도를 다르게 하고 은(Ag) 및 티타늄(Ti) 두께를 달리하거나 공정 후 열처리를 통해 산화은(AgO)을 만들어 투과도가 어떻게 변화하는지 퓨리에 변환 적외선 분광기(FTIR)로 10㎛~25㎛ 장적외선 대역에서 측정하였다. 이 때 홀 사이의 간격과 홀 사이즈는 고정했다. 장적외선 영역에서 17㎛에 최고 투과도가 나타났다. 티타늄(Ti) 두께가 얇을수록, 은(Ag) 두께가 50nm일 때 그리고 은(Ag)증착 속도가 낮을 때 좋은 투과도를 보였다. 열처리 후 투과도는 열처리 온도를 높일수록 최고 투과도와 반치폭(FWHM)이 감소하였다.

Keywords:
표면 플라즈몬, Ag 홀 배열, 장적외선, 투과도 변화

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Active thermal fine laser tuning in a broad spectral range and optical properties of cholesteric liquid crystal

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Abstract:
Through temperature control, we realized active fine laser tuning in a broad spectral range with dye-doped cholesteric liquid crystal wedge-type cells. To achieve maximum tuning range, chiral dopant concentration, thickness and thickness gradient of the wedge cell and temperature gradient on the wedge cell should be properly matched. In order to understand the laser tuning mechanism for temperature change, we studied the temperature dependence of optical properties of the photonic band gap of cholesteric liquid crystals. In our employed cholesteric liquid crystal samples, regardless of left-handed and right-handed helicity, as temperature increases the photonic band gaps are blue shifted and photonic band gap widths are decreased, which mainly results from a combination of the three effects of decrease of refractive indices, high molecular anisotropy of the chiral molecules, and increase of chiral molecular solubility. We envisage that this kind of study will prove useful in the development of practical active tunable CLC laser devices.

Keywords:
active laser tuning, cholesteric liquid crystal laser, thermal effect of cholesteric liquid crystal

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FDTD simulations to study ultrafast dynamics of electrons emitted from nano-structrues

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Abstract:
Ultrafast electron dynamics in the strong laser field has been extensively studied with gaseous targets. Recent studies show that such a strong field phenomena also occurs in metallic nano-structures. When an intense laser field is irradiated on the nano-structures, the process of the ionization is more complicated due to the deformation of the field near the nano-structures. The applied field can be strengthened due to the localized electrons of the nano-structures. To understand the ultrafast ionization dynamics of the electrons emitted from the nano-structure, it is essential to analyze the near field distribution in space and time. We present the results of the numerical calculations obtained for various nano-structures using FDTD simulations.

Keywords:
ultrafast dynamics of electrons, FDTD simulations, nano-structures

Third-order Nonlinear Optical Properties in Disperse Orange 3 doped PMMA

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Abstract:
The third-order nonlinear optical properties were measured by Z-scan method with Argon laser beam at 458 nm. The sample is prepared with 104 μm thickness in 1 wt % disperse orange 3 (DO3) using dip coating method. The sign and magnitude of nonlinear refractive index n_2 of the dye doped polymer were determined by the closed aperture Z-scan. The nonlinear absorption coefficient β was measured by the open aperture Z-scan. The growing behaviour of third-order susceptibility was investigated by time resolved z-scan method and discussed in parallel or perpendicular polarization direction to the pumping polarization direction.

Keywords:
dye doped polymer, nonlinear absorption coefficient, nonlinear refractive index, z-scan

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Study on above-threshold photoemission from tungsten nanotips using few cycle laser pulses

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Abstract:

We study above-threshold photoemission from tungsten nanotips using ultrashort laser pulses. The tungsten nanotips are made by a chemical etching technique called "DC etching Lamella", and the apex sizes of 30 ~ 70 nm have been measured by an optical microscope or scanning electron microscope (SEM). When the strong laser field is irradiated on a sharp metallic nanostructure, the field strength can be greatly enhanced due to localized electrons in the nanostructure. To investigate the ultrafast photoionization dynamics, we first study the field enhancement effect using finite-difference time-domain (FDTD) simulation. Then, the photoelectron spectrum is calculated by solving Schrodinger equation. We confirm that the photoelectron spectra change over the carrier-envelop-phase of the laser pulses. Furthermore, the design of the time-of-flight (TOF) spectrometer will also be presented.

Keywords:
above-threshold photoemission, nanotip

Simulation study for Above-Threshold Ionization(ATI) based on Strong-Field Approximation(SFA)

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Abstract:

An atom can be tunnel-ionized in intense laser pulses. With few-cycle laser pulses, this ultrafast ionization dynamics strongly depends on the carrier-envelope phase (CEP) of the laser pulses. One can directly solve the time dependent Schrodinger equation (TDSE) to study the ultrafast dynamics. However, it is extremely difficult to analyze the ultrafast electron dynamics using the evolution of the wave function. Here, we introduce a semi-classical approach based on strong field approximation to study the ultrafast electron dynamics of the above threshold ionization. In this work, the photoemission spectra are calculated by both semi-classical and TDSE methods. They are compared under various parameters of the laser pulse such as the pulse duration and intensity.

Keywords:
TDSE, ATI, few-cycle, CEP, SFA, semi-classical

Transmittance of Long-Wavelength Infrared Surface Plasmon by Two dimensional Ag Hole Arrays on Flexible Substrates

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Abstract:
A two-dimensional metal hole array (2DMHA) structure is fabricated by conventional photo-lithography and electron beam evaporation. The transmittance of the 2DMHA is measured at long wave infrared (LWIR) wavelengths (l ~ 10 to 24 μm). The 2DMHA sample shows transmittance of 70.3% at 15.4 μm due to plasmonic resonance with perforated silver thin film, under surface normal illumination at LWIR wavelengths. The same hole and pitch sizes get the results of the flexible plasmonic device about the transmittance of a LWIR wavelengths.

Keywords:
surface plasmon, plasmonics, long-wavelength infrared, flexible device

RGB 3색 LED 투광등 패턴 분석 및 광학 시뮬레이션에 관한 연구

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Abstract:
최근 개발된 300 W급 경관조명용 RGB 3색 LED 투광등의 투영 패턴에 관한 분석 연구를 수행하였다. 분석 결과를 조명 설계 소프트웨어인 LightTools를 사용한 광학 시뮬레이션 결과와 비교하였으며, 구현 가능한 다양한 광학적 효과 및 투영 패턴을 제시하였다. 본 논문은 산업통상자원부 디자인혁신역량개발사업으로 지원된 연구결과 입니다(10054112, 인터렉션 디자인 기반의 경관조명제품 개발).

Keywords:
LED 투광등, 경관조명, 패턴 분석, 조명 설계, 광학 시뮬레이션

300 W급 경관조명용 LED 투광등 개발에 관한 연구

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Abstract:
빛 축제, 일반 및 특수 경관조명에 활용될 수 있는 300 W급 LED 투광등을 설계 및 제작하였다. 제작된 LED 투광등의 광학 및 전기적 특성인 전광선속, 광효율, 지향각, 소비전력 등을 측정하였다. 본 논문은 산업통상자원부 디자인혁신역량개발사업으로 지원된 연구결과 입니다(10054112, 인터렉션 디자인 기반의 경관조명제품 개발).

Keywords:
빛 축제, 경관조명, LED 투광등, 광학 특성, 전기적 특성

LED 우산의 조명부 배광 해석 및 최적 배광을 위한 광학구조 설계

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Abstract:
최근 보행자 안전성 확보, 다양한 미적 외관 효과 연출 등의 장점 때문에 LED 우산에 대한 관심이 증가하고 있다. 본 논문에서는 조명설계 소프트웨어인 LightTools를 사용하여 LED 우산의 조명부 배광에 대한 해석 연구를 수행하였으며, 최적의 배광분포를 얻기 위한 광학구조 설계 연구를 수행하였다. 본 연구는 한국연구재단을 통해 교육과학기술부의 미래유망 융합기술 파이오니어 사업으로부터 지원받아 수행되었습니다(2011-0027920).

Keywords:
LED 우산, 조명설계, 배광분포, 광학설계

레이저 조사 방법 변화를 이용한 레이저 유도 기계적 효과의 제어

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Abstract:
레이저 빔 크기, 파장 성분 추가 등의 레이저 조사 방법 변화를 이용한 레이저 유도 기계적 효과 제어법에 대해 시뮬레이션을 수행하였다. 열탄성 파동 방정식에 대한 수치해석적 해를 구하였으며, 레이저 조사 방법에 따른 표면 변위 변화에 대한 결과를 분석하였다. 본 연구는 한국연구재단을 통해 교육과학기술부의 미래유망 융합기술 파이오니어 사업으로부터 지원받아 수행되었습니다(2011-0027920).

Keywords:
레이저 유도 기계적 효과, 열탄성 파동 방정식, 수치해석, 레이저 조사, 표면 변위

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레이저 단일 펄스와 반복 펄스에 의한 피부 온도 변화 시뮬레이션에 관한 연구

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Abstract:
열 및 유동 해석 툴인 ANSYS Fluent를 사용하여 레이저 단일 펄스와 반복 펄스에 의한 피부 온도 변화에 관한 시뮬레이션을 수행하였다. 레이저 펄스 에너지 밀도에 따른 온도 상승치에 대한 결과를 얻었으며, 촉각 자극 응답률 실험 결과와 비교하였다. 본 연구는 한국연구재단을 통해 교육과학기술부의 미래유망 융합기술 파이오니어 사업으로부터 지원받아 수행되었습니다(2011-0027920).

Keywords:
열 해석, 펄스 레이저, 온도 상승치, 촉각 자극, 레이저 에너지 밀도

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Fast 2D material layer-number counting based on quantum contrast estimation of optical image

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Abstract:

To count the exact number of stacked layer composed of 2D materials like graphene, Raman spectroscopy, Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM) are generally used. And a widely used in-situ technique to determine the number of layer is to use an optical microscopy, and corresponding contrast analysis. This method simply compares the contrasts between the sampled image and the result of theoretical calculation based on Fresnel's equation. Although it is easy to implement in a laboratory scale, this method requires much efforts to identify a correct reference. In addition, polynomial fitting procedures should be performed in the spectral domain, which is very time-consuming [1-3]. Starting from the same idea of counting layer number with contrast spectroscopy, we developed a rather automated imaging analysis method into a computer program which can determines the layer number only from the optical image without fitting the contrast values to theoretical simulations. Once this program gets an optical image of layered flake as an input, it first scans the image and draws boundary between regions with different contrast to classify the samples into a few fractions representing each layer. The result of those image processing is shown in Fig. (a). To convert the contrast information into the number of layer, the program sweeps an integer multiple of values within a particular contrast range and computes the root-mean-square (RMS) error of that from contrast differences between fractions, finding the 'Quantum of contrast'. Figure (b) shows the schematic of the algorithm to find the quantum contrast. As a result, the quantum contrast is decided among the candidate range for having the smallest error and therefore each sample group from respective layer is now can be expressed as multiple of single layer, which means number of stacked layers. [1] A. Castellanos-Gomez, N. Agrait, and G. Rubio-Bollinger, Applied Physics Letters 96, 213116 (2010) [2] Z. H. Ni, H. M. Wang, J. Kasim, H. M. Fan, T. Yu, Y. H. Wu, Y. P. Feng, and Z. X. Shen, NanoLett. 7(9) 2758 (2007) [3]Y. Y. Wang, R. X. Gao, Z. H. Ni, H. He, S. P. Guo, H. P. Yang, C. X. Cong, and Ting Yu, Nanotechnology 23 495713 (2012)

Keywords:
Exfoliation, 2D materials, Layer-number counting, Contrast spectroscopy

광단층영상을 이용한 자외선 광감성 유리의 노광 패턴 관찰

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Abstract:
최근들어 자외선 광을 이용한 패턴 생성을 위한 노광 과정은 특수한 패턴을 미리 만들어진 마스크를 이용하는 대신 원하는 패턴의 영상을 레이저 가공기술과 접목하여 집적 샘플에 패턴을 그리는 기법으로 발전하여 마스크 기반의 노광과정에서의 여러 문제점들을 해결하고자 노력하고 있다. 하지만 노광의 특성을 확인하는데 있어서 샘플의 절개를 통해 노광 특성을 파악하므로 레이저 직접 노광 과정에서의 최적 조건을 찾는데 시간 및 비용의 소모가 큰 단점을 가지고 있다. 본 논문에서는 이러한 문제점을 해결하고 노광패턴에 대한 특성을 파악하고자 광단층영상을 이용한 결과를 제시하고자 한다. 광단층영상은 샘플의 물리적인 절개없이 샘플 내부특성을 파악하는데 있어서 유용한 도구로써 비파괴 검사 및 비절개 단층영상을 구현하는데 널리 이용되고 있다. 본 실험에서 사용한 샘플은 노광으로 많이 이용하는 자외선 레이저에 노출되어 굴절률 변화가 유도되는 광감성 유리로써 노광에 의해서 내부적으로 물리적인 변화가 아닌 광학적 특성의 변화가 유도된다. 하지만 광단층영상의 기본 원리를 고려할때 비절개적으로 내부 노광패턴의 형태를 관찰하는데 유용하기 때문에 샘플 내부의 굴절률 변화의 특성을 비절개적으로 획득할 수 있다. 본 결과를 통해 마스크를 이용하지 않는 노광기법의 유용성을 확인하고 노광조건의 최적화에 필요한 자원을 최소화 하는데 광단층영상기법이 활용될 수 있음을 확인하고자 한다. This work was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(grand no.2014R1A1A2059532) and also supported by the Ministry of Trade, Industry & Energy (MOTIE, Korea) under Industrial Technology Innovation Program(No. 10063530).

Keywords:
광단층영상, 직접노광, 비파괴검사

A computation framework for propagation of THz beam reflected from a metallic medium having a smaller size than the beam waist

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Abstract:
In this work, we present the computation framework describing the propagation nature of THz beam reflected by the metallic medium whose size is smaller than the waist of an incident THz beam. Right after the reflection of THz light overfilling the sample, we decompose the THz electric field into super-Gaussian and Gaussian components with appropriate phase terms. Also, we take account of the effective size of the THz beam which can be accepted by detection parts of our experimental geometry. In order to validate our model, performed the experiments in the same conditions and obtained the results in good agreement with the modelling. By applying our model, it is possible to predict how much of the beam is diffracted at the given sample geometry, and such prediction can be used for the spectroscopy system having the problem related with the minimum beam waist at the focal point.

Keywords:
Terahertz, diffraction

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측면 발광형 POF 가공에 의한 LGP의 발광효과 분석

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Abstract:
발광다이오드(LED)를 이용한 디스플레이용 백라이트유닛(BLU; Back Light Unit)의 심플하고 얇으면서 가벼운 제품 설계방식에 최적화된 요구 조건을 반영하는 기술 공정 개발 관련 진행이 급속도로 다양하게 이루어지고 있는 실정이다. 하지만 여전히 플렉서블 디스플레이(Flexible Display)의 완벽한 실현을 위해 기술적으로 해결해야 될 부분이 많고, 무엇보다 다양한 부분의 기술 개발이 필요하다. 본 연구에서는 측면 발광형 플라스틱 광섬유(POF; Plastic Optical Fiber) 양단 끝에 두 개의 LED를 배치시켜 클래딩층(cladding)에 Line 패턴을 가공한 POF 광원장치를 도광판(LGP; Light Guide Plate)에 결합하고, 도광판 발광효과를 향상시키기에 적합한 Line 패터닝 가공변수를 선정하여 최적화된 측면가공조건에 대한 LGP의 발광효과를 분석하였다.

Keywords:
발광다이오드(LED), 백라이트유닛(BLU), 플라스틱 광섬유(POF), 도광판(LGP)

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중적외선용 10X 줌 망원광학계 설계 및 공차해석

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Abstract:
3~5 μm의 중적외선 대역에서 10X의 줌 배율을 가지는 줌 망원광학계를 설계하고, 공차를 분석하였다. 설계된 망원광학계는 PNN 형식의 3군 기계보정식 줌 module과 고정된 배율을 갖는 relay module로 구성되었고, tele position에서 FOV 1.24으, EFL 560 mm 이고 wide position에서 FOV 12.4으, EFL 56 mm이며, 전 zoom position에서 f-4의 밝기를 가지도록 설계되었다. 광학계의 시야와 해상력은 15 μm의 pxel pitch를 가지는 VGA급 sensor를 기준으로 선정되었다.

Keywords:
중적외선, 줌, 망원광학계

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2016.10.19 - 2016.10.21

광섬유 스캐닝 방법을 이용한 Optical Resolution Photoacoustic Microscopy

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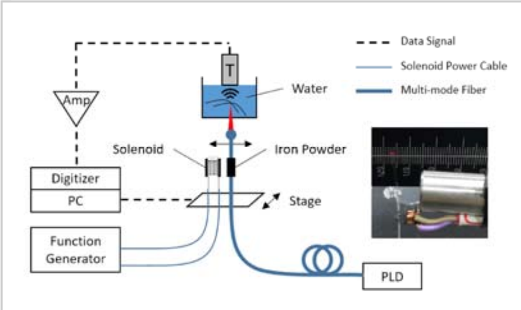
Abstract:
광음향 효과를 이용한 Optical Resolution Photoacoustic Microscopy (OR-PAM) 시스템에서 생체시료의 광흡수 영상(광음향 영상)을 제공하기 위해 보편적으로 기계적 동작 방식의 스테이지가 사용된다. 하지만, 이로 인해 시스템의 소형화 및 스캐닝 속도 향상에 어려움이 있다. 본 연구에서는 이러한 문제를 해결하고자, 자기력을 이용한 광섬유 스캐닝방식을 OR-PAM에 적용해 보았다. 여기 광원으로 광섬유 타입의 Pulsed Laser Diode (PLD)을 사용하고, 광섬유 끝에 lensed fiber를 직접 제작하였으며, 이를 통해 여기 광원을 시료에 포커싱하여 조사하였다. 자기력을 이용한 광섬유 스캐닝을 위해 광섬유에 iron powder를 부착하고, 솔레노이드의 원리를 이용하여 1축 스캐닝을 구현하였다. 광섬유 길이, 인가 전압과 주파수에 따른 솔레노이드 기반의 1축 스캐닝의 동작 분석과 실제 광음향 영상 실험을 통해 그 가능성을 파악하였다. 향 후, 3차원 광음향 영상 획득을 위해 2차원 광섬유 스캐닝에 관한 연구를 진행할 계획이다.



Keywords:
Photoacoustic Microscopy, Optical Fiber Scanning, Solenoid, Lensed Fiber

레이저를 이용한 초정밀 가공 기술 및 광학소자 응용 연구

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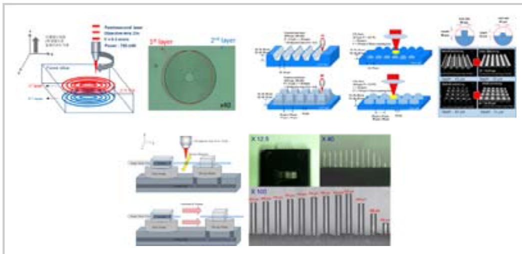

Abstract:
현재 레이저를 이용한 다양한 가공 기술 및 방식이 개발 되고 있으며, 이렇게 개발된 가공기술들은 여러 분야에서 다양한 방법으로 적용 및 응용되어 사용되고 있다. 다양한 레이저 가공 기술 개발을 위해서 본 연구에서는 펨토초와 CO_2 레이저를 이용하여 광학소자 제작 및 특성 분석에 대한 연구를 진행하였으며, 광주과학기술원 고등광기술연구소에서 보유하고있는 펨토초와 CO_2 레이저를 사용하였다. 먼저, 펨토초 레이저를 이용하여 투명물질 내부에 Fresnel Zone Plate 제작 및 특성 분석에 대한 연구를 진행하였으며, 그 다음 펨토초와 CO_2 레이저를 이용하여 Fused silica 표면에 Micro-Lens Array 제작을 통한 형상 제어 및 특성을 확인 하였다. 마지막으로, CO_2 레이저를 이용하여 광섬유 끝단 형상 및 각도 제어 연구를 진행하였다.

Keywords:
Femtosecond laser, CO_2 laser, Fresnel Zone Plate, Micro-Lens Array, Optical fiber cleaving

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Super-resolution optical fluctuation imaging based on point illumination

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Abstract:

In original superresolution optical fluctuation imaging (SOFI) Method, quantum dot is used as a source of blinking phenomena which is able to induce the fluctuation of emission. However, because blinking phenomena is intrinsic emission property of quantum dot, it has limitations for widely use in conventional microscopy. Recently, to overcome these limitations, we established another method using speckle pattern illumination induces similar fluctuation of fluorophore emission, instead of blinking of quantum dots. In our method, fluctuation is externally controlled by illumination beam. On top of that, we propose new equivalent method as alternative of speckle pattern illumination method by simulating the speckle pattern illumination with combination of point scanning illumination and the detection through multiple scattering in the perspective of fluctuation. While fluctuation comes from speckle pattern illumination in the speckle pattern illumination method, fluctuation in new proposed method comes from detection fluctuation. Conceptually these two methods are linked by way of Lorentz reciprocity relation. In perspective of point calculation, the data point rearrangement of one method leads to the other method. Therefore, the image with the same resolution in this new method can be expected to be obtained.

Keywords:
SOFI, fluctuation, imaging, superresolution, speckle, multiple scattering.

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2016.10.19 - 2016.10.21

레이저 충격 피닝 시 사각 빔 균질기의 DOF의 형상에 대한 연구

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Abstract:
본 연구에서는 레이저 충격 피닝 시 DOF(depth of focus)의 3차원 형상에 사각 빔 균질기가 미치는 영향에 대해 분석하였다. 여러 빔렛으로 갈라지고 다시 합쳐져 이미지를 형성하는 빔 균질기는 설계 변수에 따라 초점 앞과 뒤의 형상이 변화한다. 사각 빔 균질기의 DOF 형상은 레이저 피닝 품질에 영향을 주기 때문에 DOF 형상을 여러 빔 균질기 조건에 대하여 시뮬레이션하였다.

Keywords:
빔 균질기, 레이저 피닝, DOF

Broadband coherent perfect absorption of epsilon-near-zero tunable indium tin oxide thin films in the near infrared

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Abstract:
Coherent perfect absorption (CPA) is an optical phenomenon occurring in an absorbing thin film or in a subwavelength periodic structure by the interaction of two counter-propagating coherent waves. It is the time-reversed counterpart of a laser, and this is why CPA is called as an anti-laser. It was first demonstrated in a Fabry-Perot cavity with a wavelength-scale Si slab. Incident light is trapped in a cavity, bouncing back and forth, until it is completely absorbed and converted to heat or other form of energy. The CPA was proposed for various nanostructures and subwavelength thin films, including even one-atom-thick graphene. However, the proposed CPA structures are mostly limited to single-frequency or narrowband operation, and are hard to be extended to a broadband structure - especially in the high, optical frequency region. Here, we propose a new broadband CPA scheme based on epsilon-near-zero (ENZ) multilayer films. In this study, we report the broadband CPA design of multilayer tunable ITO thin films in the near infrared wavelength regime using the admittance matching method and investigate their optical properties. Also, we introduce CPA conditions in terms of reflection/transmission amplitude coefficients and phase that can be obtained from the scattering matrix. Figure 1 presents the ENZ ITO CPA thin film structure of [ZnSe/ ITO-2 (9.93 nm) / ITO-1 (14.66 nm) / ITO-2 (9.93 nm) / ZnSe] configuration at 45 degree incident angle. The CPA bandwidth with greater than 99% absorptionis as large as 134 nm, which is much broader than the singlelayer ENZ CPA film. This design method using the admittance matching can be used for various nanophotonic devices, such as optical modulators, sensors, switches, detectors, transducers, and notch filters

Keywords:
absorption, epsilon-near-zero

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Optimal Photo-excitation Condition for Terahertz Modulation on Organic-Inorganic Hetero-junction Structure

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Abstract:
We demonstrate the characteristics of the optical control of terahertz (THz) wave transmission in photoexcited bilayers of pentacene/Si and 6,13-bis(triisopropylsilylethynyl) pentacene (TIPS pentacene)/Si. The modulation efficiency is influenced significantly by the photoexcitation wavelength of the optical beams. Lower optical absorption of organic materials leads to higher modulation efficiency because the photocarriers excited on Si with a higher diffusion rate and mobility are far more instrumental in increasing the modulation than the excitons generated on the organic layers. Securing a sufficient depth for carrier diffusion on organic layers is also important for increasing the THz modulation efficiency. These findings may be useful for designing highly efficient and spectrally controllable THz wave modulators.

Keywords:
terahertz, TIPS-Pentacene, modulator

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Development of a 25 TW/30 fs Ti:sapphire laser system for laser-plasma acceleration

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Abstract:

High power and femtosecond laser systems based on the chirped-pulse amplification (CPA) technique have been utilized for high energy electron generation in plasma-based accelerators. For this purpose, we developed a 25 TW/30 fs laser system which has higher energy and shorter pulse duration than the previous system. An acousto-optic programmable dispersive filter (AOPDF), which can control the spectral bandwidth and the amplitude of each frequency, is adopted to achieve a shorter pulse. In order to increase a contrast ratio, moreover, two multi-pass amplifiers are installed after a regenerative amplifier. In this presentation, we report the development results of the 25 TW/30 fs Ti:sapphire laser.

Keywords:
Laser plasma acceleration, TW Ti:sapphire laser, acouto-optic programmable dispersive filter

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Design of high-efficiency klystron with multi-cell coupled cavity

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Abstract:
Klystron, an amplifier tube at microwave frequencies or radio frequencies, is widley used as RF source in the following fields: particle accelerators, nuclear fusion devices and radar system etc. The current commercial pulsed high-power klystron operates in the efficiency range between 40% and 50%. Recetly demands for high-efficiency klystron have been increased to reduce an operational cost of large-scale accelerators. It will also allow downsizing of the power plant and thus reducing the investment cost. In this regard, we have designed a new S-band klystron for high-conversion efficiency with multi-cell coupled cavity (extended-interaction cavity) for use in PAL. The RF section design in the klystron is done by FCI (field charge interaction) code for various cavity parameters including cavity resonant frequencies, inter-cavity distances and coupling constants.

Keywords:
Klystron, FCI, Klystron simulation, Efficiency

Femtosecond laser machining of capillary plasma sources for laser wakefield acceleration

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Abstract:
In laser wakefield acceleration, capillary gas cell/plasma sources can be used for high energy electron generation, where the gas-filled capillary can be discharged or it may be used as a gas cell without electrical discharge. The capillary is constructed by sandwiching the sapphire plates which are fabricated by using a femto-second (fs) laser machining system. Thus, we developed the micro-machining system with a 3 mJ/40 fs laser operating at 1 kHz in our laboratory and various types of capillary sources can be fabricated with this system. We will use an interferometry method for gas/plasma diagnostics and the detailed experimental results are addressed in this presentation.

Keywords:
LWFA, plasma source

100 MeV 양성자가속기 MEBT 고주파 결합기 물리 설계

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Abstract:
양성자가속기연구센터에서 운영 중인 100 MeV 양성자가속기의 MEBT 시스템은 두 개의 DTL형 번쳐 가속공동으로 구성되어 있다. 빔동력학 계산에 따르면, 빔의 종방향 정합을 위해 각 번쳐 가속공동으로 44 kW 및 18 kW의 고주파 전력이 인가되어야 한다. 가속공동으로 고주파 전력을 인가하기 위한 고주파 결합기의 물리 설계를 수행하였다. 결합기의 형태는 동축형이며 세라믹 고주파창을 포함한 내부 도체 및 외부 도체로 이루어져 있다. MEBT에서는 빔의 가속이 이루어지지 않으므로 빔로딩 효과는 고려할 필요가 없고 따라서 결합계수는 1로 설정하였다. MEBT에 사용될 고주파 시스템은 SSA 기반으로 상당 부분 구축이 완료된 상태이다. 본 연구에서는 MEBT의 번쳐 가속공동으로의 고주파 인가를 위한 고주파 결합기의 설계에 대해 논한다. 본 연구는 미래창조과학부의 연구비 지원을 받았음.

Keywords:
MEBT, KOMAC, 양성자가속기, 고주파결합기

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2016.10.19 - 2016.10.21

Diagnotics of the PAL-XFEL

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Abstract:
The Pohang Accelerator Laboratory (PAL) started an X-ray Free Electron Laser (PAL-XFEL) in 2011. The construction of the PAL-XFEL was finished at the end of 2015 and the commissioning was started from April of 2016. The electron beam energy of 10 GeV was achieved at the end of April and the bunch compression was tried in May. The undulator commissioning was started from June. During the commissioning process, various kinds of instruments were used for the beam parameter monitoring including beam position monitors, beam profile monitors, beam charge monitors, and beam loss monitors. This work will introduce the PAL-XFEL diagnostic system which were used in the commissioning process.

Keywords:
PAL-XFEL, Electron Beam,Diagnostics

Investigation of the effect of drift length at the plasma-vacuum interface to the electron-beam bunch evolution.

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Abstract:

The advantages of laser wakefield generated electron beams compared to the conventional RF accelerators have attracted many researchers in this field. With state of the art of TW-class laser technology, electron beams with a charge of 10 pC order and a duration of ~10 fs can be generated in typical density of 10^{18} -10^{19} cm^{-3}. This leads to generation of at least kilo-ampere range of beam current. However, there are still many challenges to be overcome. One of the challenges is the generation of high quality beam, besides producing high energetic electron beams. One of the important beam quality parameters is the emittance and the evolution of the emittance is a very important issue in beam physics. The studies of emittance evolution at the plasma/vacuum interface is especially important to produce high quality electron beams by mitigating the emittance growth. In this work, we will present the 2D particle-in-cell (2D-PIC) simulation results of the plasma-vacuum interface effect on beam quality.

Keywords:
laser wakefield, emittance, beam quality

Design of the button-type beam position monitor for SCL3 in RAON

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Abstract:
RAON is a heavy-ion accelerator to accelerate various ions such as uranium, oxygen. SCL3 in RAON is a low beta(0.03<beta<0.2 for U) section with electric charge of beam bunch less than 10pC. Beam Position Monitor (BPM) will be the most important diagnostic devices and should provide the transverse beam position, RF phase, and relative intensity. Various types of BPM are simulated with CST particle studio and a button-type BPM is chosen for SCL3. Design and simulation of the button-type BPM will be discussed in the poster.

Keywords:
BPM, accelerator, diagnostics,

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Theoretical investigation of relativistic transmittance of circularly polarized laser pulses in plasma systems

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Abstract:
레이저 기술의 발전 덕분에 초고출력 레이저 펄스와 고밀도(overdense) 플라즈마의 상호작용에서 상대론적 투과성(relativistically-induced transmittance, RT)은 더 이상 무시할 수 없는 현상이 되었다. RT 현상은 시스템에 따라 장점 또는 단점이 될 수 있다. 광압을 이용한 이온 가속 (radiation-pressure-acceleration, RPA)에서는 반사율이 높을수록 레이저의 모멘텀이 입자로 잘 전달되므로 RT가 낮을수록 좋다. 그러나 충격파 이온 가속 (collisionless-electrostatic-shock ion acceleration, CES)의 경우, 투과된 레이저가 전자를 가열시켜야 충격파가 잘 생성되어 가속 효율을 높이므로 RT가 어느 정도 있어야 한다. 우리는 RPA와 CES에 사용될 수 있는 원편광 레이저의 일차원(1D) RT 이론들을 개발했다. 이미 기존의 이론이 RPA 시스템에서의 타겟의 반사율과 최적 두께를 근사적으로 제안했으나, 매우 얇은 타겟에서만 적용될 수 있는 이론이었다. 우리는 타겟이 비교적 두꺼울 때에도 적용될 수 있는 최적 두께 조건을 찾았다. 또한 충격파 이온 가속에서 주로 나타나는 전자분포, 즉 two-step 플라즈마에 대한 RT 이론 모델을 개발했다. 포스터에는 각 이론들의 간단한 유도과정을 제시하였다. 그리고 그 결과가 1D particle-in-cell 시뮬레이션 결과와 잘 일치함을 확인하였다.

Keywords:
PIC, RPA, CES, shock, transmittance, laser, plasma

Design of phase probe to determine beam energy for 81.25MHz in RAON.

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Abstract:
The RAON (the heavy-ion accelerator in Korea) will accelerate heavy-ion beams from a few keV to a few hundreds of MeV. The phase probe is the RF phase measurement system of the beam bunch for 81.25MHz. The phase probe is a kind of capacitive probe. The capacitive probes along the beam transport line are simulated to measure the RF phases of beam. The ion beam energy is determined from RF phase measurements by using the TOF(Time-Of Flight) method. Various simulation studies for RF phase measurements are carried out with CST particle studio program. The beam bunch length measurement using this system will also be discussed.

Keywords:
heavy ion accelerator, diagonistic system , energy measurement

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Gun Solenoid, Spectrometer Magnet, and Thin Quadrupole Magnet Design for PAL-XFEL

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Abstract:

Commissioning PAL-XFEL of 10 GeV is ongoing. A focusing solenoid for an electron gun will be update. And a dipole magnet as a spectrometer for 7 MeV electron beam and two thin quadrupole magnets after the solenoid will be added. This paper shows the design process of these magnets.

Keywords:
solenoid, spectrometer dipole magnet, quadrupole magnet

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2016.10.19 - 2016.10.21

Upgrade of High Voltage Gas Discharge System for Generation of Capillary Plasma Waveguide in Laser-Plasma Acceleration

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Abstract:
One typical method for generating plasma waveguides, the instrument capable of guiding intense laser pulses over a long distance via plasma, is HV (High Voltage) discharge of gas which fills a dielectric structure so-called the capillary. The capillary is a narrow hole made in a dielectric material (for example, sapphire) and is several cm in length and 100 to 400 μm in radius. The low Z gas such as hydrogen fills the capillary and is discharged by HV pulse. Due to thermal conduction to the wall, electron density at off-axis position is higher than that of on-axis position. This results in parabolic electron density profile (density increases along the radial direction) and it can guide laser pulse over long distance in similar manner of an optical fiber. This plasma optical fiber or plasma waveguide can be used for generation of high-energy electron beam in laser-plasma acceleration. The electron density profile in the plasma waveguide is highly related to the discharge current and its rising time. Short rise time and higher peak current are always preferred. Recently we upgraded the discharge system in pursuing these characteristics and better stability of HV discharge and the result is shown in this presentation.

Keywords:
Gas Discharge, Plasma Waveguide, Laser-Plasma Acceleration

Investigation of the Laser-Plasma Acceleration with a Density-Tapered Gas Cell

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Abstract:
Laser-plasma accelerators can generate high energy electron beams in much shorter distance than the conventional accelerators. In this field, development of a plasma source to generate higher electron energy is one of the main issues. Therefore, we particularly investigated the density-tapered gas cell which will increase the electron beam energy by lengthening the dephasing distance. In this poster, the experimental results of electron beam acceleration, the gas density measurement and the simulation results from CFD (Computational Fluid Dynamics) for gas-cell design and fabrication are comprehensively presented.

Keywords:
Laser-Plasma Acceleration, Capillary Gas Cell, Particle-In-Cell

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2016.10.19 - 2016.10.21

Determination of pumping speed with an orifice method and Molflow Simulation

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Abstract:

A superconducting heavy-ion linear accelerator with high current up to 400 kW beam power is developing in Rare Isotope Science Project (RISP). In order to achieve a high beam current, a sufficiently high vacuum level is required to avoid beam losses by collision with residual gases. Therefore the vacuum system has to be designed carefully with proper pumps and locations of the beam line. With the aid of a simulation tool, each pump is to be estimated its pumping speed and locations, which are satisfying the vacuum requirements. In the beam line many pumps will be employed to maintain high vacuum levels so that the determination of pumping speed of each pump is critically important. Usually the pumping speed of a pump can be measured by one of three standard methods. In this work, the pumping speed of an ion pump was measured with a standard method based on an orifice flow in the calibration chamber. The measured pumping speed will be compared with that estimated by Molflow simulation.

Keywords:
Pumping speed, orifice method, Molflow simulation, heavy ion accelerator

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100 MeV 양성자 가속기 고주파시스템 제어 특성에 관한 연구

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Abstract:
양성자가속기연구센터에서는 100 MeV 양성자가속기 운영을 위하여 총 9기의 독립된 고주파 시스템을 사용하고 있다. 고주파 시스템은 가속관에서의 고주파 크기 및 위상을 각각 1%, 1도 이내에서 제어하여야 하며, 이를 위하여 디지털 제어 시스템을 사용하고 있다. 본 연구에서는 운전 중인 고주파시스템의 특성을 정의하고, 이로부터 고주파 제어 시스템의 제어 여유분에 대해서 논한다. 본 연구는 미래창조과학부의 연구비 지원을 받았음.

Keywords:
양성자가속기, 고주파, 제어

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2016.10.19 - 2016.10.21

RAON 가속기의 LLRF 시스템 개발 현황

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Abstract:
기초과학연구원 중이온가속기사업단에서는 라온(RAON)이라는 가속기를 만들기 위한 연구를 진행하고 있다. 이 가속기에는 RFQ에서 나온 빔을 가속시키기 위하여 3개의 초전도 선형가속기가 설치될 예정이다. 이 선형가속기 섹션에는 81.25MHz, 162.5MHz, 325MHz의 주파수에서 운전되는 초전도 가속관이 설치될 예정이다. 이 초전도 가속관에 공급되는 RF 시스템은 SSPA (Solid State Power Amp) 기반의 고출력 RF 전원장치와 이를 제어하기 위한 LLRF (Low Level Radio Frequency)으로 구성될 예정이다. 이 발표에서는 현재까지 진행된 라온 선형가속기의 LLRF 시스템 개발 현황이 소개될 예정이다.

Keywords:
LLRF, RAON, RF

Experimental Studies of He^{+} and He^{+2} ionization using an EBIS

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Abstract:
Electron beam ion source (EBIS) is a powerful ion source for the production of highly charged ions by electron impact ionization. EBIS employs a magnetically compressed, high energy and density electron beam to sequentially ionize atoms or ions in a low charge state. Formation processes of multiply charged ion in the EBIS can be categorized into three; charge changing reactions, energy dynamics and ion spatial distributions. They are strongly related with electron current density and electron energy, and also related to each other. We mainly concentrate on charge changing reactions of helium (He) in the EBIS. He is one of the simplest systems to study charge changing reactions through balance equations. At Korea Multi-purpose Accelerator Complex (KOMAC), we have a compact EBIS, operated at room temperature. With a dipole bending magnet and a Faraday Cup, ions from the EBIS are charge-separated. By scanning magnetic fields for the dipole bending magnet, charge spectra of an ion beam is measured. Firstly using this setup, He gas has been tested to produce charge spectra. Detailed studies of He ion peaks are performed in various electron beam conditions to understand charge changing reactions with various electron ionization times. We present experimental results of He ion dynamics in the EBIS and corresponding interpretation, and also briefly mention about a superconducting EBIS, which is next in line of research development. This work has been supported through KOMAC operation fund of KAERI by Ministry of Science, ICT and Future Planning.

Keywords:
Highly charged ions, electron beam ion source

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장치 Girder의 변화를 지속적으로 측정하고 기록하는 WPS

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Abstract:
과학 장치들은 측량(survey)과 정렬(alignment)을 통해 장치 부품들이 놓여야 할 정확한 3차원 위치좌표(X, Y, Z)에 설치된다. 그러나 지반은 시간이 지나면서 융기(uplift) 또는 침강(subsidence) 현상이 발생하고, 이로 인해 건물 바닥의 변형이 발생한다. 지반과 건물의 변형으로 인해 설치된 장치 부품들의 위치(X, Y, Z)가 변화하고, 이로 인해 장치의 정렬 오차가 발생하면서 시스템 전체의 파라메터가 변화되어 장치 성능이 저하된다. PAL-XFEL은 지속적으로 장비가 놓여있는 Girder의 변화를 측정하고 기록하기 위해서 Wire position system (WPS)를 Undulator Intersection Girder에 설치하였다. 일반적으로 건물 건축 완료 후, 지반이 안정화 되는 2~3년은 지반 변화가 많이 발생하고, 5~6년은 서서히 변화한다. 최소한 6년 동안은 지반과 건물의 변화 추이를 지속적으로 측정하고 기록해야 한다. 본 논문에서는 WPS 센서의 동작원리와 WPS 설치 및 측정 과정을 소개한다.

Keywords:
측량정렬, WPS

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Physics applications for the beam commissioning of the RAON heavy ion accelerator

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Abstract:
Physics applications are under development for the beam commissioning of the RAON heavy ion accelerator which include the applications for the phase scan, beam parameter measurement, transverse matching, RFQ set-point, and the linac scaler etc. These applications that are based on Matlab or Python will operate through the interface with the EPICS that facilitates a real time data measurement and accelerator control.

Keywords:
beam commissioning, physics applications,

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Operating scenario for the SCL demo of Rare Isotope Science Project

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Abstract:

The test facility for the front-end section of the RAON accelerator being built by the rare isotope science project (RISP) has been constructed since 2015 and will be firstly tested with an oxygen beam at the end of 2016. This test facility is named SCL demo and consists of an electron cyclotron resonance ion source (ECR-IS), a low energy beam transport (LEBT) section, a radio-frequency quadrupole (RFQ), a medium energy beam transport (MEBT) section, and a superconducting linac (SCL) section. Compared to the RAON accelerator, each section of the SCL demo is simplified because of the limitation of the space. For the beam commissioning of the SCL demo, we are preparing an operating scenario from an angle of the control system and will present it with the lattice design of the SCL demo.

Keywords:

SCL demo, RAON accelerator

Corrector Magnet Power Supply for PAL-XFEL

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Abstract:
All magnets and magnet power supplies (MPS) for PAL-XFEL had been installed at the site. The all MPSs had been tested with the magnets at the field. The total number of assembled MPSs was amounted to 688, which were grouped into nine categories by their power capacities in order to reduce the manufacturing cost and make maintenance easy. The general specifications for the MPS for the PAL- XFEL were summarised. The design configurations of the MPS were also explained to satisfy the given requirements such as the output current stability. The test results of performances of the MPSs for corrector magnets were described here.

Keywords:
power supply

포항방사광가속기-II / 4B 빔라인의 광학현미경 조정장치

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Abstract:
포항방사광가속기-II의 4B 빔라인은 X-선 마이크로빔을 이용한 미세회절 실험과 미세형광 실험을 수행하고 있다. 4B 빔라인에는 마이크로빔을 집속하는 K-B 거울시스템과 함께, 시편상의 마이크로빔을 45도 방향에서 관찰하는 광학현미경이 운용되고 있다. 이 광학현미경은 실험허치 내부의 현미경 영상을 관찰하면서 빔 방향 축과 수직축의 이동을 조정하는 두 개의 손잡이를 수동 조정함으로써 조정되어 왔다. 본 연구에서는 광학현미경의 조정을 자동화하기 위한 광학현미경 조정장치가 개발되었다. 제작된 광학현미경 조정장치는 랩잭 상부에 X축(빔 방향에 직교하는 수평축) 스테이지, 그 상부에 Z축(빔 방향 축) 스테이지 그리고 그 상부에 Y축(빔 방향에 직교하는 수직축) 스테이지가 구성되어 있다. 따라서 Y축 스테이지에 부착되어 있는 광학현미경은 3자유도 구동성을 갖추게 된다. 광학현미경의 3자유도 구동은 LabVIEW 구동 프로그램에 의해서 수행된다. 추후에는 현미경 영상을 스스로 인식하여 요구하는 위치로 광학현미경을 자동 조정하도록 본 구동 프로그램을 심화 발전시켜 나갈 계획이다. 본 발표에서는 광학현미경 조정장치의 설계와 구동 프로그램을 상세히 기술하고, 시운전 결과를 보고한다.

Keywords:
X-선 마이크로빔, 미세회절 실험, 미세형광 실험, 광학현미경 조정장치, 구동 프로그램

Pal-xfel Dipole Magnet power supplies

JEONG Seong Hun*, PARK Ki-Hyeon, SUH Hyungsuck, LEE Sang-Bong, OH Bongi, JUNG Young-Gyu, LEE Hong-Gi, KIM Dong Eon, KANG Heung-Sik, KO In Soo
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Abstract:
The all magnet power supplies for PAL-XFEL had been installed and under operation. These magnet power supplies can be categorized as three types - corrector, quadrupole and dipole magnet power supplies. The power capabilities of the dipole magnet power supplies are ranging from 110A/80V for bipolar MPS to 310A/200V for unipolar MPS, respectively. The dipole MPSs were satisfied the required specifications. This paper describes the configurations of the dipole MPS and shows their performance test results.

Keywords:
Magnet power supply

Collisional Radiative Simulation for the initial phase of transformation of solid density Aluminum heated by X-ray Free Electron Laser Pulse

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Abstract:

Since X-ray Free-Electron Lasers (XFELs) opens up new regimes in x-ray—matter interactions, there have been several discoveries of nonlinear optical phenomena in the soft and hard X-ray regions at XFEL facilities. One of the interesting phenomena we propose is the initial phase of transformation of solid density aluminum plasma by analyzing time-resolved extreme ultraviolet (XUV) absorption spectroscopy with a time resolution of 10 fs or less. The material state is produced with XFEL via K-shell photo-absorption and probed by a few fs XUV pulses at various delays. XUV absorption edges are directly related to ionization energies of core electrons (ex. Al L-level) and electron distributions at the continuum. In order to verify the mechanism, XFEL heating is modeled using the collisional-population kinetic code SCFLY. We calculate the temporal evolution of charge states and temperature of 200 nm aluminum irradiated with 5 keV XFEL pulse of 10 fs duration. This calculation, which will be mentioned in the presentation, could show the ultrafast dynamics of inner-shell electrons, and electron thermalization during intense XFEL - matter interaction.

Keywords:
Solid density Aluminum, XFEL, Initial phase transition, XFEL pump -XUV probe

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Characteristics of laser-forced betatron oscillation in laser wakefield acceleration

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Abstract:

In laser wakefield acceleration, X-rays can be generated by an oscillating and accelerated electron beam, which is called betatron radiation. In our previous studies, we have shown that the betatron oscillation amplitude can be significantly enhanced by the off-axis laser injection method in discharged-capillary plasma source and it provides shorter wavelength x-rays. But in our new scheme, oscillation amplitude of an electron beam can be enhanced by electric field of the driving laser pulse tail. Furthermore, the brightness of betatron x-rays is affected by charge of the beam, and we can control the charge by changing gradient of the plasma density transient region. We have performed two dimensional (2D) particle-in-cell (PIC) simulations and we show some results in this presentation.

Keywords:
betatron radiation, laser-forced betatron oscillation, density transition injection

Status of RRR for Niobium Superconducting Cavities

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Abstract:

Nb superconducting cavities require various processes such as e-beam welding, chemical etching, and rinsing with high pressure water. Assembling these parts by electron beam welding is critical to produce the cavity. Residual Resistance Ratio, which is called RRR, is one of important factors determining a cavity performance. RRR values tend to be degraded during the e-beam welding depending on the welding conditions. Therefore, it is important to weld niobium parts without serious RRR degradation. We have conducted e-beam welding experiments to find optimal welding conditions for a prototype cavities. In this presentation, we will show the results from the e-beam welding, and RRR characteristics as a function of welding power, welding speed, and the distance from the welding zone.

Keywords:
Superconductor, Accelerator, Residual Resistance Ratio, RRR

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이동형 중성자 발생장치용 티타늄 타겟의 개념설계 (Conceptual design of titanium target for movable neutron generator)

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Abstract:
한국원자력연구원 핵융합공학기술개발부에서는 2016년 민.군겸용기술개발사업의 일환으로 고선량/이동형 중성자 발생장치를 개발하고 있다. 고선량/이동형 중성자 발생장치는 deuterium이 흡착되어 있는 티타늄 타겟에 고에너지 deuteron 빔을 조사하여 D-D 반응을 유도해 중성자를 발생하는 장치이다. 따라서 deuteron 빔 조사시 티타늄 타겟은 deuterium 탈착온도 이하로 유지되도록 열 부하 설계를 하여야 한다. 본 연구에서는 티타늄 타겟의 구조 및 재질과 사용조건 등을 가정하여 기초 설계한 2가지 타겟 모델에 대해 ANSYS 분석을 실시하였다. ANSYS 분석은 구조 및 재질에 대한 열 부하와 냉각수 유동해석을 주로 수행 하였으며, ANSYS 분석결과를 바탕으로 기초 타겟 모델을 수정하여 최적화된 타겟 모델에 대한 개념을 정립하였다. -- "이 연구는 2016년도 민.군겸용기술개발사업의 재원으로 수행되었음 (No. 74901-16)."

Keywords:
중성자, 티타늄 타겟, deuterium, deuteron, 열 부하, ANSYS

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XUV Absorption Spectroscopy Apparatus for Investigating Ultrafast Dynamics in Warm Dense Matters

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Abstract:
The time-resolved absorption spectroscopy has been used as a versatile technique to study electronic structures and/or the local geometries of matter. The extreme ultraviolet (XUV) created by high harmonic generation (HHG) has a few tens femtoseconds to a few hundreds attoseconds pulse duration, and has enormous potential for ultrafast pump-probe researches. In femto and attosecond time scales, the ultrafast dynamics of matter could be investigated. Ti:Sapphire pulse laser (800 nm of central wavelength, ~10 mJ of pulse energy, ~50 fs of pulse duration) mainly performs creating XUV and even heating solid target. Fs laser increase temperature of target near ~ 1eV, matter condition falls in warm dense matter condition. This work is supported by the NRF (No. 2016R1A2B4009631) and the TBP research project of GIST. This research has been supported in part by Global Research Laboratory Program [Grant No 2009-00439] and by Max Planck POSTECH/KOREA Research Initiative Program [Grant No 2011-0031558] through the National Research Foundation of Korea (NRF) funded by Ministry of Science, ICT & Future Planning.

Keywords:
XUV, Spectrospcopy,Warm Dense Matter, EUV, Absorption

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Experiment design of frequency domain interferometry for femtosecond laser-produced warm dense matter

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Abstract:

In a very short time, high energy density matter created by a femtosecond laser is expended and changed from solid state to plasma state. Between that phase transition, matter stays in condition of warm dense matter (WDM). In order to catch WDM characters, Fourier domain interferometry(FDI) is designed to measurement of these short time event. This paper introduces the configuration of the frequency domain interferometry for stimulated a solid target using a femtosecond laser pulse. By combining femtosecond pump-probe tehcnique and interferometry, the phase shifts of expanded target, as well as changes in reflection and transmission of warm dense matter could be deteremined. This study was proceeded by funding from GIST Top Brand Project and 한국연구재단(NRF-2015R1A5A1009962)

Keywords:
Warm Dense Matter, FDI

K-shell emission spectral simulation of titanium targets irradiated by intense laser pulses

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Abstract:
Measurements of characteristic inner-shell Kα emission have been widely used and reliable spectroscopic plasma diagnostics. Laser-plasma interactions on the target front surface generate two electron temperature distributions (the hot and the bulk ones). In particular, the bulk electrons induce the shifts of Kα emission spectra by creating M-shell vacancies. Therefore, modified Kα emission spectra can be served as a bulk electron temperature. In this contribution, I will discuss the Kα spectral simulations with different bulk electron temperatures to obtain the Kα emission properties of titanium plasmas with various thick targets. Accordingly, the intensive computational work would be required such as the collisional-radiative population kinetics code SCFLY. A new x-ray - matter interaction process with an intense laser pulses and the energy distribution ascribed to plasma conditions will be discussed. This work was supported by the Institute for Basic Science under IBS-R012-D1 and National Research Foundation of Korea (NRF-2016R1A2B4009631).

Keywords:
Kα emission, laser-plasma interaction, electron temperature distribution,collisional-radiative population kinetics code

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Measurement of pre-pulses of high-power femtosecond Ti:sappire laser system using third-order autocorrelator

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Abstract:

In order to progress high intense laser experiment more than ~10^{16} W/cm^2, the temporal pulse monitoring is essentially needed, because preformed plasma by prepulse laser beam could be interrupted main pulse propagation, change reflection, transmission and absorption ratio. The autocorrelation using third harmonic generation is considered for monitoring of the temporal pulse shape. This third-order correlation technique base on three-photon absorption. The second-harmonic 2 is first generated in the second-harmonic BBO crystal (Type 1), and then is mixed with the remnant first-harmonic in the third-harmonic crystal (Type 1) to produce the third-harmonic 3. In this paper, we report a measurement of the temporal pulse shape of femtosecond Ti:sapphire laser system (20 mJ, 35 fs). The temporal pulse shape was scanned from -5.5 to 5.5 ps using third-harmonic autocorrelator by adjustment of temporal delay between 2 and . This is work was supported by the TBP research project of GIST and the National Research Foundation (NRF-2013R1A1A1007084 and NRF-2015R1A5A1009962) of Korea.

Keywords:
Third-order autocorrelator

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Basic research on wave-breaking phenomenon of magnetized plasma.
자화된 플라즈마의 wave-breaking 현상에 대한 기초연구

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Abstract:
최근 라만 증폭(Backward raman amplification)연구를 진행함에 있어서, O-mode(ordinary mode)에서 외부자기장이 펄스에너지의 에너지양을 증가시킴을 관찰하였다. 기존의 이론으로는 이를 설명할 모델이 없으며, 특히 외부자기장이 wave-breaking을 억제함을 라만증폭 시뮬레이션의 입자데이터에서 확인하였고 이는Upper-hybrid oscillation에 대한 기존 연구들로 알 수 있는 X-mode(extraordinary mode) 에서 자기장의 증가에 따른 wave-breaking amplitude의 감소와는 반대의 결과를 보여주며, 기존 이론에서 O-mode 자기장의 역할은 이론적으로 고려되지 않았기 때문에 이를 중점적으로 기초연구를 진행하였다. 저온 플라즈마(cold plasma)에서 nonlinear traveling wave에 대한 Akhiezer 와 Lyubarskizs의 해와 Dawson의 기존 이론을 확장하여 이론 및 시뮬레이션(PIC particle-in-cell)을 통하여 검증을 해보고자 한다.

Keywords:
wave breaking, plasma oscillation growth, magnetized plasma,PIC code(Particle In Cell code)

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Stabilizing effect of periodic dipole magnets on the diocotron instability of a hollow electron beam

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Abstract:
The diocotron instability is a non-neutral plasma instability due to a shear in the flow velocity of surface waves, which can be observed in vacuum electronics devices or high-energy colliders. And, control of a diocotron instability is one of the important issues in the field of non-neutral plasma physics. In this study, the evolution of the diocotron instability during the propagation of a hollow beam with periodic dipole magnets is observed in two-dimensional particle-in-cell simulation. The dipole magnetic field is applied along the direction of the propagation of the electron beam to suppress the instability. We observed that the dipole magnetic field stabilizes the diocotron instability with optimally chosen oscillating frequency of the dipole magnetic field. The stabilizing effect is more clearly observed when the amplitude of the dipole magnetic field is increased.

Keywords:
Diocotron instability, Particle-in-cell simulation, Periodic dipole magnetic field

여러가지 조건에서 Al이 도핑된 산화아연의 박막성장

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Abstract:
알루미늄이 도핑된 산화아연의 박막을 조건에서 성장한 결과, 박막성장이 일정한 초기시간 (incubation time)후 성장됨을 단면과 표면 사진에서 확인되었고, 박막 단면형상은 박막 표면의 입자(grain)형상과 크기 사이즈 등을 결정 하였다. 이는 박막 성장시 박막이 만들어질 때 유입되는 가스와, 증착 시간, 증착온도, 공급된 파워 세기의 영향과 밀접한 관계가 있다는 것을 알았다.

Keywords:
알루미늄 도핑 산화아연산화아연 박막표면입자

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2016.10.19 - 2016.10.21

Observation of pulse shortening based on plasma discharge phenomenon in W-band Gyrotron

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Abstract:

A gyrotron, the high-power millimeter wave oscillator, is a beneficial device for plasma applications such as nuclear fusion research. It is essential to control a pulse length of RF wave from milliseconds to hundreds of seconds. In this study, we show that pulse shortening of RF wave from the gyrotron is available using a plasma discharge effect at a fixed output power. The main technique for this is to vary the inner pressure of vacuum chamber. A pulse forming network (PFN) modulator is initially operated at fixed pulse length of 20 μs, but it is changed from 1 μs to 17.5 μs for varying the pressure. Moreover, the contracted pulse length is detected in various output power at fixed pressure. Therefore, this switch mechanism of pulse length may be convenient for fusion diagnostics and biomedical applications.

Keywords:
gyrotron, plasma discharge, pulse length

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Solutions in N=1 D=7 gauged supergravity and their higher dimensional origins

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Abstract:
We study D=7 minimal gauged supergravity which can be uplifted to both D=11 supergravity and D=10 massive IIA supergravity. We study the supersymmetric vacuum, and also the solutions which are spontaneously dimensionally reduced to D=3,4,5. Their string/M theory interpretation and implications on AdS/CFT correspondence are also discussed.

Keywords:
Supergravity; AdS/CFTS

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Analysis of X

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Abstract:

The meson mass spectra have been calculated in quarkonium model by varying three parameters such as quark mass , strong coupling constant , and linear potential parameter . The spin independent potential is assumed to be linear plus Coulomb (potential). The calculated values were compared with the experimental values of the meson summary table published on 2016 by the particle data group. We have been found the three parameters , , for and respectively from the best fit of each mass spectra. The possible states of meson denoted by X are discussed using the root mean squares method.

Keywords:
meson spectrum, X-particle

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Study of the effect of jet charge for top quark mass at LHC accelerator

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Abstract:

As the improvement of detector performance, to separate jet's constituents was possible. It means that we can acquire jet's charge information from jet's substructure. For ttbar dilepton decay channel, to pair correct lepton and b-jet is a very difficult job. In this case, the jet charge information can reduce pairing ambiguity. We are studying to calculate how much reduce the error using ttbar dilepton channel and background monte carlo samples.

Keywords:

LHC CMS Jet Charge top mass effect

Measurement of the mass of top quark by using D meson in jet

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Abstract:
The measurement of the top quark mass is a very important topic at LHC because top quark mass is one of fundamental parameters to research “Standard Model”. The large dependence of one loop corrections to the higgs boson mass on top quark mass makes its precise determination of extreme importance for constraining the model itself. On previous results, we already knew that energy peak of b-quark can mapped to top quark mass because of unchanged energy peak. Same as method, we can also research some meson to acquire b-jet's energy. In this presentation, we researched ttbar events include D-in-jet to measure top quark mass. These events were extracted from 13TeV LHC data in 2016. This method used an isolated lepton from W boson and 3-tracks from D meson in b jet.

Keywords:
D mesonTop quark massb-jet

Study of ME0 muon system upgrade at the CMS experiment.

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Abstract:
The ME0 detector will increase the muon acceptance in the high eta region of the CMS experiment. Using full simulation, the performance of the muon reconstruction is presented together with the expected fake rate and the composition of the fakes.

Keywords:
CMS, ME0, muon, detector

The study of higgs to dimuon search with the CMS detector

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Abstract:
we present the first result in the search for the standard model Higgs boson decaying to dimuons with 2016 data collected by the CMS experiment at proton-proton collisions with sqrt(s) = 13 TeV

Keywords:
LHC, higgs, CMS, 2016 data, dimuon

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Monte Carlo Study of Microscopic Black Holes at LHC Energies

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Abstract:
The strength of fundamental interactions are very different from each other and this hierarchy problem is one of the most important problems to be solved. The problem may be explained by introducing extra dimensions and promising models on extra dimensions are currently the ADD and RS models. One of the interesting predictions of these models is the production of microscopic black holes in high energy collisions. We study the production and decays of microscopic at the LHC energies and physical features of signal events in various black hole scenarios and theoretical parameters. For this study, we use the customized Charybdis black hole generator program as well as the generic Delphes detector simulation program.

Keywords:
Extra dimension, Miscroscopic black holes

Kicker field simulation and measurement for the muon g-2 experiment at FNAL

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Abstract:
In Muon g-2 experiment, muon beam is injected to the storage ring in a slightly tilted orbit whose center is 77 mm away from the center of the ring. The kicker is needed to send the muon beam to central orbit. The magnetic kicker is designed for the experiment and about 0.1 Tm field integral is needed. The peak current pulse is 4200 A to make this field integral. This strong kicker pulse could occur unwanted eddy current. This eddy current could affect to the magnetic field of the storage ring. The kicker field simulation has done using OPERA to estimate the effects. The kicker field also needs to be measured for the experiment based on Faraday effect. The measurement has tested in the lab before install the experiment area. In this presentation, the simulation and measurement results will be discussed.

Keywords:
Muon g-2, Kicker magnetic field, Faraday effect, OPERA simulation

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Ladder Assembly Procedures for Silicon Vertex Detector of the Belle II

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Abstract:

The Belle II experiment will be ready in 2018 to search physics beyond the standard model (SM) by observing rare/violated decays of B-meson pairs at an election-position collider, SuperKEKB (Tsukuba, Japan). A silicon vertex detector (SVD) for the Belle II is now under developing for tracking and vertexing. The SVD consists of four cylindrical layers, L3-L6, and each layer is made of assemblies of the double-sided silicon strip detectors (DSSDs), called “ladders”. In the outermost layer, a L6 ladder has five DSSDs and central three DSSDs of them are connected with APV25 signal read-out chips by a novel chip-on-sensor concept. During the assembly of the L6 ladder, we encountered some mechanical issues such as tilt and rotation of the DSSDs. To improve the mechanical position precision of the DSSDs, so some assembly procedures were studied again and then slightly modified, and a shim method has also been employed. In this poster, we present the modified procedure, the shim method and its mechanical precision results.

Keywords:
Belle II experiment, Silicon Vertex Detector, SVD, Ladder assembly

Energy Spectrum of 12B/12N Beta Decays from the RENO Experiment

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Abstract:
12B and 12N radioactive isotopes can be generated by cosmic muons and they quickly undergo a beta decay process, emitting either an electron or a positron. In the RENO detector, these particles produce scintillating photons which can be converted to the energy by proper calibrations. We present the energy spectrum of the beta decay of the isotopes by analyzing the data collected by the RENO experiment. The results provide not only an important check of the energy calibration of the RENO detector but also useful information on the underlying physics process of the decay.

Keywords:
12B and12N radioactive isotopes, RENO, beta decay energy spectrum, energy calibration

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Measurement of the attenuation length of liquid scintillator for the neutrino experiment

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Abstract:
액체섬광검출 용액은 중성미자 검출실험에서 주요하게 사용되고, RENO50실험에서 18kton이 검출기에 채워져 사용될 예정이다 . 이 액체섬광검출용액은 입자를 검출할때 나오는 빛의 양과 감쇄거리가 아주 중요하게 작용한다. 특히 감쇄거리는 검출장비 로 사용하는 PMT 까지 도달하기 위해서 큰값을 가질 필요가 있고, 검출기의 크기가 클수록 중요한 요인으로 작용된다. 또한 시간에 대한 검출기의 특성변화를 이해하는데 중요하게 작용된다. 이에 따라 감쇄거리를 정확하게 측정하기 위하여 감쇄거리 측정장비를 설계하였고, 이를 이용한 감쇄거리 측정 결과에 대하여 정리하였다.

Keywords:
Scintillator, 액체섬광검출용액, 감쇄거리, Attenuation length, RENO, Neutrino

Effort on increasing attenuation length of liquid scintillator

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Abstract:
The RENO-50 detector of 18 kton liquid scintilator is expected to measure neutrino mass ordering and neutrino oscillation parameters of θ12, ⊿m212, and ⊿mee2. The detector requires sufficiently large (>25 m) attenuation length of liquid scintilator at 420nm. An R&D effort is underway to enlarge the attenuation length in the reqion of 350 to 450 nm by several methods. They are use of micro-filters, water-extraction, use of alumina (AlO3) powder, and distillation. In this talk, we present our efforts and results for increasing the attenuation length of liquid scintilleor.

Keywords:
Neutrino Oscillation, Reno50, Reno, Liquid Scintillator, Attenuation length

R&D study of liquid purification using distillation for the next generation neutrino experiment

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Abstract:
중성미자 실험에 사용되는 액체 섬광 검출 용액(liquid scintillator)의 구성은 기름에 섬광체와 파장변경물질을 녹여 실험에 최적화 된 검출 용액을 이용한다. 이 때 액체섬광검출용액의 구성중 주요 성분인 기름의 순도는 중성미자 실험 결과에 영향을 미치기 때문에 기름의 순도를 높이는 것은 중성미자 실험에 있어 매우 중요하다. 이에 따라 중성미자 실험에 사용되는 주요 기름들의 순도를 높이기 위해 증류장치를 이용하여 증류(distillation)하였고 증류된 기름들의 물리 광학적 특성을 조사하여 정리하였다.

Keywords:
중성미자(neutrino), 액체 섬광 검출 용액(liquid scintillator), 증류(distillation)

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Development of DAQ electronics for RENO-50

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Abstract:
A data acquisition system is under development for the RENO-50 experiment. The RENO-50 experiment is a next generation of reactor neutrino experiment for determination of the neutrino mass ordering and high precision measurement of neutrino oscillation parameters of θ12, ⊿m212, and ⊿mee2. It will be a large neutrino telescope to observe neutrino burst events from a supernova and to measure the neutrino flux from the Earth. To obtain data for these goals, it needs a DAQ electronics system with almost no dead time, good time & charge resolutions, a wide charge dynamic range, and high-speed signal processing. The first prototype of ADC module is produced and debugged. The status and plan of the electronics development will be presented.

Keywords:
RENO50, RENO, neutrino, neutrino oscillation,neutrino mass hierachy,neutrino telescope, DAQ, ADC, notice

Statistical Analysis Method for the NEOS Experiment

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Abstract:

The NEOS is an experiment to seach for sterile neutrino by measuring the energy spectrum of reactor anti-neutrinos. The experimental result with a single detector measurement is compared with several reactor anti-neutrino flux models. Chi-squares are constructed to test the oscillation parameters. The validity of the statistical analysis method is checked with Monte Carlo pseudo-experiments. Major features of the statistical analysis method such as the pull test and the exclusion using raster scan are presented.

Keywords:

sterile neutrino, statistical method, reactor neutrino, neutrino oscillation, neutrino experiment

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Overview of T2HKK

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Abstract:

The Hyper-Kamiokande (Hyper-K) experiment is proposed as a next generation neutrino experiment consisting of two water Cherenkov detectors with almost twenty times the fiducial volume of the Super-Kamiokande (SK) detector. The Hyper-K detector serves as far detectors at the baseline distance of 295km from J-PARC neutrino facility. The Hyper-K experiment is expected to observe a definite CP violation in the lepton sector, determine the neutrino mass hierarchy and measure oscillation parameters precisely. Recently a new proposal to place one of the detectors in Korea called T2HKK is made in order to enhance physics reach of the Hyper-K experiment. The korean detector will be located at a baseline distance of ~1100km and at an off-axis angle of 1~3 degrees from the J-PARC neutrino beam. In this presentation, we give an overview of the T2HKK proposal. We also compare the physics potentials of the T2HKK configuration to those of the current Hyper-K configuration especially for the measurement of the leptonic CP violation and neutrino mass hierarchy as well as atmospheric neutrinos and neutrinos from astronomical origin.

Keywords:
Hyper-Kamiokande, T2HKK, CP violation, neutrino mass hierarchy, J-PARC

Sensitivity Studies Using the Hyper-K detector in Japan and the 2nd Detector in Korea

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Abstract:
The Hyper-Kamiokande (Hyper-K) detector is a next generation underground water Cherenkov detector. It consists of two identical detectors with the total mass of nearly half a million metric tons which serve as far detectors for the J-PARC neutrino beam. The main purpose of the Hyper-K detector is to observe CP violation in the neutrino oscillations and to determine the neutrino mass hierarchy. A new configuration called T2HKK is proposed to enhance physics potentials of the Hyper-K experiment. According to the T2HKK configuration, one detector is placed in Japan at a baseline distance of 295 km and the other detector is placed in Korea at a baseline distance of ~1100 km from the J-PARC. Using simple models on detectors and the operational parameters of the J-PARC facility, we study the sensitivities of the CP violation and neutrino mass hierarchy measurement and compare them to those of the original Hyper-K configuration.

Keywords:
Hyper-Kamiokande, CP volation, mass hierarchy, sensitivity, T2HKK

Sensitivity Studies Using only the 2nd Detector in Korea

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Abstract:

Hyper-Kamiokande (HK) detector is a successor of Super-Kamiokande (SK) and has 20 times larger fiducial volume mass than SK in two identical tanks. Main goals of the HK include determining the neutrino mass ordering and measuring the leptonic CP violation phase using J-PARC neutrino beam at 295 km baseline. The J-PARC neutrino beam also arrives to Korea at a baseline of 1000-1300 km with off-axis angle of 1-3 degree. This naturally provides a possibility to host one of the two HK tanks in Korea and we find there are many good candidate sites in Korea to achieve more interesting physics results. In this talk we present sensitivity studies using only one HK tank in Korean candidate sites. There are many good candidate sites in Korea to host one of the two HK tanks. In this talk we present sensitivity studies using only one HK tank in Korean candidate sites.

Keywords:
neutrino, J-PARC, neutrino oscillation, Hyper-K, HK, Hyper-Kamiokande, neutrino beam, long base line experiment, CP violation, neutrinomass hierachy

Low Energy Physics Benefits Using the 2nd Hyper-Kamiokande Detector in Korea

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Abstract:
Hyper-K is a multipurpose experiment with a very broad science impact. This poster will cover the science potential of Hyper-K and a second detector in Korea for the topics of nucleon decay, solar neutrinos, supernova neutrinos, reactor neutrinos, dark matter searches, neutrino geophysics and non-standard neutrino oscillations. We will focus on the additional benefit of a 2nd Hyper-Kamiokande Detector located in Korea compared to a two detectors in Japan.

Keywords:
Hyper-K, Low energy physcis

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Development of neutron monitoring detectors for the COSINE experiment

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Abstract:
The DAMA/LIBRA experiment have been reported a positive evidence of an annual modulation signal of the event rate interpreted as WIMP scattering off NaI nuclei with 9.3 sigma significance. The goal of COSINE experiment is to confirm or refute the controversial observation of the DAMA/LIBRA experiment using same NaI(Tl) detectors. Possible systematics of annual modulation may be caused by similar annual modulation of environmental background especially neutron. For continuous monitoring of neutron flux in the COSINE experiment, prototype neutron detector filled with liquid scintillator target and read out by two PMTs(Photo Multiplier Tubes) has been developed. In this presentation, we will report the status of the neutron detector development as well as future prospect.

Keywords:
Dark Matter, DAMA, COSINE, Neutron

Multiple-cavity detector for axion dark matter search

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Abstract:

Exploring higher frequency regions in axion dark matter searches using microwave cavity detectors requires a smaller size of the cavity as the TM010 frequency scales inversely with the cavity radius. One of the intuitive ways to make a maximal use of a given magnet volume, and thereby to increase the experimental sensitivity, is to bundle multiple cavities together and combine their individual outputs ensuring phase-matching of the coherent axion signal. The Experiment of Axion Search aT CAPP (EAST-C) is a dedicated project to develop multiple-cavity systems at the Centre for Axion and Precision Physics Research (CAPP) of the Institute for Basic Science (IBS). In this poster, the conceptual design of the phase-matching mechanism and experimental feasibility using a quadruple-cavity system will be presented.

Keywords:
axion, dark matter

Improving the quality factor of microwave cavities for axion search experiments

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Abstract:
In cavity-based axion search experiments, the quality factor (Q) of microwave resonant cavities is an important parameter to be sensitive to faint signal from the axion-to-photon conversion. One of the R&D efforts conducted at the Center for Axion and Precision Physics Research (CAPP) of the Institute for Basic Science (IBS) is to improve the quality factor of resonant cavities by employing two approaches - pure material and heat treatment. Using a 4K cryocooler and liquid helium, we measure the temperature dependence of Q value to find the effect of material purity and an optimal condition of heat treatment. The measurements are performed on Cu and Al cavities and the results are shown in this presentation.

Keywords:
Axion Search Experiment, Microwave Cavity

Enhanced Q factor of quasi-cylindrical microwave cavity for halo axion searching experiment

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Abstract:
High quality factor (Q factor) cylindrical microwave cavities are widely used in halo axion search experiments. In most cases, the cylindrical cavity is mechanically designed as an open cylinder with two disk shaped endcaps imposing discontinuities for longitudinal currents at the junction of cylinder and endcaps. These discontinuities can critically affect the Q factor of the TM010 mode which best matches our haloscope geometry. The creation of vertical divisions is a reasonable solution for this so called ‘contact problem’, by changing the discontinuous line to be parallel to the free electrons’ oscillation direction. N-polygon quasi-cylindrical aluminum cavities consisting of multiple vertical cuts of cylindrical bodies have been fabricated and the microwave performance is measured with respect to temperature, down to 15mK. Details will be presented in the conference.

Keywords:
quality factor, axion, haloscope, N-polygon quasi-cylindrical cavity

중성 케이온 붕괴모드인 $K_L^0 \rightarrow$pi0pi0pi0의 2 gamma에 대한 융합 및 빔홀을 통과한 1 gamma에 대한 측정

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Abstract:
[illegible] 붕괴과정은 수명이 긴 중성 케이온의 여러 붕괴과정중 하나이다. [illegible] 붕괴과정에서 생성된 3개의 파이온이 붕괴하여 생성하는 6개의 감마선으로 붕괴 되어 융합 또는 중앙에 위치한 빔홀로 1개의 감마선이 빠져나감으로 최종적으로 CsI 전자기 열량계의 표면에 5개의 신호가 검출된다. 본 발표에서는 중성 케이온 [illegible] 을 이용한 실험에서 [illegible] 붕괴과정으로 오인될 수 있는 [illegible] 붕괴 과정에 대해 5개의 감마선으로 오인되는 경우인 융합과 검출기 중앙으로 감마선이 빠져나감으로 검출이 안되는 확률을 계산할 것이다. 결과적으로 KOTO CsI 검출기에서 [illegible] 붕괴과정이 [illegible] γ 붕괴 과정으로 오인하는 경우중 하나인 2개의 감마선이 융합될 확률은 약 [illegible] 로 계산되고 하나의 감마선이 빔홀 중앙으로 빠져나가는 확률은 약 [illegible]% 로 계산 되었다

Keywords:
5-gamma, 붕괴모드

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An update on HPGe detectors at Y2L

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Abstract:
The underground Laboratory at the YangYang pumped water power plant (Y2L) has a dedicated facility for the low background gamma spectroscopy measurements with High Purity Germanium (HPGe) detectors. Out of two 100% relative efficiency HPGe detectors currently operating in the laboratory, the newer one has been installed with its dedicated shielding and is being tuned for routine measurements of samples. The older HPGe detector set up with shielding already optimized has been running stably for the screening of raw materials to be used in other low background experiments at the Y2L including a new very low background HPGe array which is being assembled. A well type Ortec HPGe detector was delivered in summer and has been being tuned for measurements of samples in raw materials purification processes to find the best purification method. Status of all three HPGe detectors at the Y2L is going to be presented.

Keywords:
HPGe detector, background gamma spectroscopy measurement,

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An overview of AMoRE pilot and phase 1 detector

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Abstract:
The Advanced Mo-based Rare process Experiment (AMoRE) is a search for neutrinoless double beta decay ($0\nu\beta\beta$) process with CaMoO4 crystals. We illustrate an overview of detectors in the AMoRE-Pilot experiment, an engineering version of the experiment that is currently taking place in the Yangyang underground laboratory. We also present plans for the upgrade to the next phase, AMoRE-I, which till be the first main phase of the experiment.

Keywords:
Neutrinoless Double Beta Decay

Performance Test of Muon Detectors for AMoRE Experiment

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Abstract:
Cosmic-ray muons can cause substantial backgrounds for rare event searches like AMoRE (Advanced Mo-based for Rare Experiment), a search for neutrinoless double beta decay of 100Mo using cryogenic techniques. To suppress of cosmogenic induced events, Cosmic-ray muon detectors based on 5-cm thick plastic scintillator panels will surround the AMoRE detector at the Yangyang underground laboratory. Before mounting the muon detectors around the AMoRE apparatus, the muon scintillation panels have been operating underground for a few months to characterize their performance and evaluate the responses of their PMTs. We report the test results for the PMTs and the performance characteristics of the muon panels, including an analysis of the coincidence events induced by incident muons.

Keywords:
AMoRE experiment, muon veto system, neutrinoless double beta decay, detector performance

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Developing Trigger Algorithms for Continuous Measurements for AMoRE experiment

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Abstract:
The AMoRE (Advanced Mo-based Rare process Experiment) is an experiment searching for a neutrinoless double beta decay of Mo-100. A pilot experiment, AMoRE Pilot, has been running with about a total of 1.5 kg of five 40Mo100MoO4 (CMO) crystals in the Yangyang underground laboratory (Y2L) to minimize the background level. The AMoRE Pilot has collected data from photon and phonon detectors in the five CMO crystals in a continuous mode without a hardware trigger for a fixed period. From the data, we have studied on how to select actual events which is very critical for the data analysis under a certain noisy condition. By trying some software trigger algorithms (height trigger, band-pass filter, height trigger with averaged signal), we could tell how to obtain the real signal from the continuous data. Details on the trigger study is going to be presented.

Keywords:
trigger algorithm, amore, continuous data, band-pass filter

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Heat pulse and filter studies for CaMoO4 cystals and MMC operations of AMoRE detector

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Abstract:

중성미자 미방출 이중베타붕괴 탐사 실험인 AMoRE는 CaMoO4 (CMO) 섬광결정과 자기양자센서(MMC)를 이용한 극저온 검출기를 사용한다. 극저온검출기는 온도 변화에 따라 그 분해능이 저하될 수 있다. 이에 CMO 섬광결정에 일정한 열을 가하는 히터를 작동하여 신호의 온도 의존성을 보정하고자 한다. 또한 히터의 설치로 인해 발생하는 노이즈를 줄이기 위해 RLC low-pass filter에 대한 연구를 수행하였다. 이를 통해, Cut off Frequency가 수kHz인 필터가 히터로 들어가는 노이즈를 차단하도록 하였다. MMC는 입사한 입자에 의한 온도변화를 측정하기 위해 자기변화량을 측정한다. MMC 회로가 정전기 및 과전류로 인해 손상되는 것 을 방지하기 위해 MMC heater와 field에 설치할 low-pass filter에 관한 연구를 수행하였다. 연구결과 MMC를 작동시키는 100mA크기의 전류는 손실 없이 인가하면서 회로를 손상시키는 고주파수영역의 전류는 차단하는 것을 확인하였다.

Keywords:
중성미자, 이중베타붕괴, 저온검출기

First-principles calculations of V-doped SiC

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Abstract:
Silicon carbide (SiC) is a promising semiconductor material because it has a wide band gap and excellent high-temperature, high-power, high-frequency properties. Thus, SiC single crystals have been very actively investigated for various applications such as power transistors and rectifiers, turbine engine combustion monitoring, temperature sensors, analog and digital circuitry, flame detectors, and accelerometers. Vanadium is frequently added to obtain semi-insulating SiC through the sublimation growth method. Maximum potential for device applications can be obtained using semi-insulating V-doped SiC. In this study, the electronic properties of V-doped SiC are investigated using first-principles calculations in relation to its growth. Details in electronic structure are analyzed in terms of partial density of states, projected band structures and charge density difference.

Keywords:
V-doped SiC, First-principels calculations

Crystal Growth and Characterization of CdMnTe for Radiation detector

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Abstract:
CdMnTe는 II-VI 족 화합물 반도체로써, 감마선 검출기 센서로서 잘 알려진 CdZnTe 화합물 반도체의 단점을 보완한 대체물질로 몇 가지 이점을 가진다. CdZnTe와 CdMnTe는 zinc-blende 구조를 가지고 있고 비저항이 높아 누설 전류를 감소시킬 수 있으며, 상온에서도 충분한 band gap energy를 가진다는 점은 두 물질이 동일하지만 CdZnTe는 Zn의 무른 성질 때문에 내구성이 좋지않은 단점이 있다. 이에 반해 CdMnTe는 Mn 자체 강도가 우수하여 반영구적으로 사용가능하다는 점과 편석계수에서 CdMnTe가 더 유리하여 결정성 또한 더 우수하다. 본 연구에서는 3단 전기로를 사용하여 수직 Bridgeman 법으로 우수한 품질의 CdMnTe 화합물 반도체 단결정을 성장시키고, 그 특성과 Mn 조성비에 따른 품질을 비교 분석해본다. 결정 성장시, 충분한 성장시간과 안정성, 석영관 끝 원추모양의 각도, 석영관의 길이, 탄소 코팅 등을 고려하여 우수한 품질의 CdMnTe 결정을 성장한다. $Cd_{1-x}Mn_xTe$의 Mn을 0, 0.05, 0.1, 0.15, 0.2몰의 조성비로 결정을 성장시키고, 각 조성비에서 성장된 CdMnTe의 특성을 X-ray diffraction 측정으로 결정의 구조와 결정성을 알아보고, Photoluminescence 측정으로 광학적 특성을 조사한다. 또한, sputtering system을 이용해 Au-CdMnTe Schottky diode를 제작하여 전류-전압 특성을 조사하고, 광전류 측정으로 감마선 검출기 센서로써의 동작 여부를 확인한다.

Keywords:
CdTe, CdMnTe, Schottky diode

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산성 분위기에서의 Chemical Bath Deposition법에 의한 완충층 ZnS 박막 성장

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Abstract:
CIGS 박막 태양전지의 p형 CIGS 광흡수층 위에 n형 ZnO:Al 창층 박막을 제작 할 때, sputtering 공정에 의하여 CIGS 층에 충격이 가해질 수 있다. ZnS 박막은 이 과정에서 CIGS 흡수 층에 가해지는 충격을 완화시켜 줄 뿐만 아니라, 비저항이 높고 광학적 띠 간격 에너지가 3.4~3.9 eV 정도로 비교적 높아 전자-정공 재결합을 감소시켜 CIGS 흡수층과 AZO 창층 박막 사이에 완충층으로 사용된다. CBD법은 여러 가지의 ZnS 박막 성장방법 중 제조 단가가 가장 낮고 성장 시간이 짧으며 효율이 비교적 높아 많이 사용된다. 특히, CBD법에 의한 ZnS 박막은 주로 암모니아를 이용한 염기성 분위기 용매에서 성장되는데, 암모니아의 독성과 악취 때문에 신체에 악영향을 미칠 수 있다. 본 연구에서는 CBD법에 의한 ZnS 박막 성장시 염산을 이용한 산성 분위기에서 complexing agent로 Na_2EDTA와 HMTA를 사용하여 박막을 성장시켰으며, 특히 금속이온을 격리시키는 Na_2EDTA와 화합물 합성에 도움이 되는 HMTA의 농도 변화에 따른 박막의 성장 속도, 표면 그리고 광학적 특성에 대해 조사하였다. Na_2EDTA의 농도를 0.0035 M에서 0.0107 M까지 변화시킴에 따라 ZnS 입자의 크기가 작아졌으며 HMTA의 농도가 0.01 M에서 0.03 M까지 늘어남에 따라 입자의 크기가 커졌다. 또한, ZnS 입자의 크기가 커지면서 광학적 띠 간격 에너지가 3.71 eV에서 3.56 eV까지 감소하였다.

Keywords:
CBD, ZnS, CIGS, Buffer layer

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초음파 SILAR 합성법을 이용한 초음파 에너지 변화에 따른 CdS 양자점 합성 및 연구

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Abstract:
현재 연구되고 있는 양자점 물질로는 CdS, CdSe가 있다. 크기가 작을수록 에너지 띠 차이가 커지며 이것을 양자점 크기에 따른 발광 소자에 응용할 경우 많은 장점이 있다. 본 연구에서는 TiO2 paste를 스크린 프린터를 이용해 FTO 기판 위에 프린팅 작업을 하여 TiO2 나노 입자를 합성하였고 SILAR 방법을 이용하여 CdS 양자점을 합성하였다. 기존 SILAR 공법으로 양자점을 형성할 때 효율이 떨어지는 것을 보완하고자 초음파주입 공정을 사이에 넣어 양자점 형성 효율이 어떻게 변하는지 알아보았다. 초음파 SILAR 과정에서는 150W, 225W, 300W, 375W로 에너지를 바꿔가며 실험을 하였다. 에너지를 변화시켰을 때 에너지가 양자점의 크기에 영향을 미치는 변수라는 것을 TEM과 UV-Visible spectrum을 통해 확인 하였다. 초음파 화학법의 공정은 다른 태양전지에 비해 비교적 용이하여 실용화 단계에서도 수월할 것이다.

Keywords:
양자점,CdS, SILAR

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TiO2 광전극 제작 및 초음파 SILAR를 이용한 Mole 수에 따른 CdS 양자점 연구

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Abstract:
본 연구에서는 CdS 양자점/TiO2 광전극 구조의 태양전지 효율 개선을 중점으로 한다. 하판으로 쓰일 FTO 기판 위에 Doctor blade coating을 통해 TiO2 나노입자를 바른 횟수에 따른 두께 차이를 SEM을 통해 1회 당 약 6μm정도가 나옴을 확인하였다. 이와 같이 제작한 TiO2 광전극에 Sono-chemical SILAR를 통해 CdS 양자점을 흡착시켰다. 기존의 Cd전구체와 S전구체에 TiO2 광전극을 담가 합성하는 SILAR에 초음파가 가미된 Sono-chemical SILAR를 통하여 흡수파장대의 변화를 확인해보고 Mole 수에 따른 CdS 양자점의 흡수 스펙트럼을 TEM과 Uv-Vis spectrum을 통해 분석하였다.

Keywords:
Sono-chemical SILAR, 양자점, QDSC, CdS

Sputtering 방법으로 증착한 ZnO:Al 박막의 물성 분석

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Abstract:
유리 기판(Corning 7059 glass) 위에 sputtering 장비를 이용하여 ZnO:Al 박막을 증착하였다. 각각 ZnO(99.99%) target 과 Al(99.99%) target을 co-sputtering 방법을 사용하여 증착하였으며 ZnO target은 RF power를 Al target 은 DC power를 이용하였다. 기판은 할로겐 램프로 400℃로 고정시킨 후 DC power를 변화시켜 박막을 증착하였다. 그리고 비저항이 최저가 되는 DC power를 찾아 증착 온도를 변화시켜가며 ZnO:Al 박막을 증착하였다. 이후 XRD, AFM, SEM, Hall measurement, spectrophotometer, photoluminescence를 이용하여 증착된 ZnO:Al 박막의 물성을 분석하였다. 그 결과 증착온도가 증가함에 따라 비저항은 감소하였고 가시광 영역에서 투과율은 80~90%로 높게 나타났다.

Keywords:
ZnO:Al, co-Sputtering, thin film

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ZnO/ZnTe biaxial 나노선의 결정 성장과 광학적 특성 연구

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Abstract:

새로운 형태의 ZnO/ZnTe biaxial 나노선이 단일 성장의 물리기상전달법으로 성장되었다. 촉매로써 역할을 하는 직경 50nm의 Au 콜로이드를 SiO_2 기판에 코팅한 후 반응관의 하류에 둔다. 전기로(furnace) 중심에 ZnO와 Graphite powder 혼합물 보트를 두고 그 상류에 ZnTe powder 보트를 두어 나노선을 제작하였다. 본 연구에서는 전계방출주사전자현미경(FESEM), 투과전자현미경(TEM)을 이용해 ZnO/ZnTe 나노선의 결정구조를 파악하고 성장원리를 알아본다. 또한 micro-PL 장치를 이용해 단일 나노선의 성장방향과 레이저 파워에 따른 PL 파장의 천이현상을 mapping 통해 분석하고 광전소자로서의 가능성을 모색한다. This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2015R1D1A3A01015615).

Keywords:

ZnO, Zinc Oxide, ZnTe, Zinc Telluride, biaxial, 나노선, nanowire, VLS, micro-PL

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FTO 유리 기판 위에 성장된 계층구조 ZnTe 나노선의 결정성장 및 광학적 특성

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Abstract:
나노선 성장은 기상-액상-고상 (vapor-liquid-solid) 기구을 통해 주로 이뤄진다고 알려졌다. 그 과정에서 금(gold)은 대표적은 금속 촉매이지만, 반도체 나노선 물질에 깊은 준위를 형성하게 결합을 생성시킨다. 이를 대체할 목적으로 저온의 융점을 가진 주석(Sn)을 이용해 나노선을 성장한다. 태양전지의 투명전극으로 널리 사용하는 FTO (Fluorine-doped Tin Oxide) 유리 기판을 이용해 계층구조를 가지는 ZnTe 나노선 및 나노구조물을 제작하였다. 물리기상수송법으로 고온부에 ZnTe 분말을 보트에 두고, 저온부에 유리 기판을 위치시켜 실험을 수행하였다. 전계방출 주사전자현미경 (FESEM), 투과전자현미경 (TEM), X선회절(XRD) 분석법을 각각 이용해 결정학적 구조와 성장원리를 알아내고, micro-PL을 통해 광학적 특성을 분석했다. This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2015R1D1A3A01015615).

Keywords:
ZnTe, Zinc Telluride, Sn, tin, nanowire, nanostructure,VLS, FTO, micro-PL

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ZnO:Al/p-Si heterojunction photovoltaic device with TiO_2 barrier layer

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Abstract:
ZnO semiconductor material has been widely utilized in various applications in semiconductor device technology owing to its unique electrical and optical features which are a promising as solar cell material, because of its low cost, n-type conductivity and wide direct band gap (3.37 eV). For device application, doped ZnO is usually preferred because of its instability due to native defects such as zinc interstitial (Zn_i), oxygen vacancy (V_o), interstitial oxygen (O_i) and anti-site oxygen (O_{Zn}). Group III metal dopants, like aluminum (Al), indium (In), and gallium (Ga) have been suitably doped to increase the electrical conductivity of ZnO thin film. Among the doping candidates, Al has been widely used to show as high-quality thin film. In this work, the ZnO:Al/p-Si heterojunction diodes with TiO_2 thin barrier layer were fabricated by pulsed laser deposition and atomic laser deposition system, respectively. Vacuum chamber was evacuated to a base pressure of approximately 2×10^{-6} Torr at pulsed laser deposition. A pulsed (10 Hz) Nd:YAG laser operating at a wavelength of 266 nm was used to produce a plasma plume from ablated ZnO:Al targets, whose density of laser energy was 10 J/cm^2. Optical property was characterized by photoluminescence and crystallinity of ZnO:Al was analyzed by X-ray diffraction. Photovoltaic devices with ZnO:Al/p-Si heterostructure were formed by deposition of indium metal and Al grid patterns on back and front sides, respectively, by using thermal evaporator. Finally, the photovoltaic properties were measured by Air Mass 1.5 Global solar simulator with an irradiation intensity of 100 mW/cm^2.

Keywords:
pulsed laser deposition, photovoltaic, ZnO:Al

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Si 기판 위에 성장한 CdTe/ZnTe 이중 양자점의 결합에 따른 광학적 특성

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Abstract:
화합물 반도체 나노 구조는 광학적, 전기적 특성을 기반으로 하는 단전자 트랜지스터, 적외선 검출기, 레이저, 태양전지 같은 다양한 분야에 활용하기 위한 연구로써 진행되고 있다. 그 중에서도 0차원 구형태의 구조를 가지는 양자점(Quantum dots)은 3 차원적으로 구속되어 있는 상태 밀도를 가지고 있어 레이저 응용 시 낮은 문턱 전류밀도, 높은 이득, 높은 열적 안정성을 기대되고 있지만 양자점의 운반자 수집과 열적 안정성의 한계가 여전히 존재한다. 이러한 문제를 해결하기 위해 다양한 방법이 연구되고 있으며, 그 중 두 양자점이 결합된 이중 양자점 구조가 관심을 갖게 되었다. II-VI 족 화합물 반도체 양자점 중에서도 CdTe 양자점은 높은 엑시톤 결합에너지와 녹색 스펙트럼 영역을 필요로 하는 광학적 장치들에 대한 응용 가능성을 높게 평가 받고 있다. 또한 Si 기판을 이용한 연구에서는 Si이 가지는 고유 격자 상수로 인하여 박막 형성 시 발생하게 되는 격자 부정합 때문에 GaAs 기판 위 연구가 대부분이며, 이에 따라 Si 위에 성장한 양자점의 연구가 부족한 상태이다. 하지만, Si 기판은 GaAs 기판에 비해 가격이 저렴하다는 장점을 가지며, 이로 인해서 대량 생산이 가능하다는 이점을 가지고 있다. 본 연구에서는 분자 선속 에피 성장법(Molecular Beam Epitaxy; MBE)과 원자 층 교대 성장법(Atomic Layer Epitaxy; ALE)을 이용하여 크기가 다른 CdTe/ZnTe 이중 양자점을 ZnTe 장벽층 두께를 변화시켜 성장하여 광학적 특성을 연구하였다. 저온 광 루미네센스 측정(Photoluminescence; PL)의 측정 결과를 통하여 장벽층 두께가 작아짐에 따라 작은 양자점의 광 루미네센스의 세기가 감소하면서 큰 양자점의 세기가 증가하는 것을 확인 할 수 있었다. 이는 장벽층 두께가 작아짐에 따라 작은 양자점의 운반자들이 큰 양자점으로 이동되는 양이 많아지기 때문이다. 또한 장벽층 두께가 작아질수록 큰 양자점의 반치폭(Full Width at Half Maximum; FWHM)이 단층 양자점의 반치폭 보다 감소하는 것을 관찰 할 수 있었는데 이는 작은 양자점과 결합된 큰 양자점이 작은 양자점의 strain을 받아 크기의 균일함이 증가했기 때문이다. 또한 온도 의존 광 루미네센스 측정을 통해 장벽층 두께가 작아질수록 큰 양자점의 열적 활성화 에너지가 단층 양자점의 열적 활성화 에너지 보다 더 커지는 것을 관찰 할 수 있었는데 이는 장벽층 두께가 작아질수록 작은 양자점의 운반자들이 큰 양자점으로 이동되는 양이 많아지기 때문이다. 이와 같은 결과는 이중 양자점 구조가 단층 양자점의 한계인 운반자 수집과 열적 안정성을 향상할 수 있는 좋은 구조임을 제시하고 있다.

Keywords:
CdTe, 양자점,Si 기판, 적층 구조, 열적 활성화 에너지

단일층 WSe_2에서 valley polarized exciton에 의한 굴절률과 흡수율 변화 측정

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Abstract:
WSe_2는 벌집모양 구조를 가지고 있는 TMDC물질중 하나로 단일층에서 K vector와 K' vector의 엑시톤 state가 같은 에너지를 가지며 spin 방향이 다른 특징을 가지고 있다. 빛은 원편광 방향에 따라 -1과 +1의 스핀을 가지고 있어 입사하는 빛의 스핀에 따라 엑시톤이 만들어지는 wave vector가 달라지게 된다. 본 실험은 박리법을 통해 만든 WSe_2 단일층에 Ti:sapphire을 매질로 하는 펄스레이저를 여기 광과 탐침 광으로 사용하는 여기-탐침 실험을 하였다. 여기광과 탐침광을 원편광 시켜 WSe_2 단일층에서 탐침광의 투과량 변화를 측정하였으며 여기광의 스핀방향을 바꿔가며 여기광의 스핀방향에 따른 탐침광의 투과량 변화를 측정하였다, 또한 탐침 광을 선편광 시켜 WSe_2 단일층을 투과 한 후 탐침 광의 선편광 각도가 돌아가는 것을 측정하였으며 두 실험 모두 10nm 간격으로 band pass filter를 바꿔가며 10nm파장 간격별로 파장에 따른 차이를 측정하였다. 측정결과 원편광 되어 있는 여기광으로 인하여 WSe_2 의 K와 K'에 만들어지는 엑시톤의 양이 달라지게 되고 그로인해 탐침광의 스핀 방향에 따른 굴절률과 흡수율이 달라지게 되는데 원편광 되어 있는 탐침 광을 사용한 경우 원편광 된 여기 광에 따른 투과량 변화의 차이를 통해 흡수율 변화의 차이를 확인하였고, 선편광 되어 있는 탐침 광을 사용한 경우 선편광 각도가 돌아가는 것을 확인 하여 굴절율 변화의 차이를 확인하였다. 또한 band pass filter를 바꿔가며 측정한 결과 exciton state에서 흡수율 변화 차이와 굴절률 변화 차이가 가장 크게 나타나는 것을 확인하였다.

Keywords:
TMDC, Exciton, WSe_2, Pump-probe experiment, Valley polarized exciton

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Facile Method for Synthesis of Various Transition Metal Dichalcogenide Thin Films by Chemical Vapor Deposition

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Abstract:
Transition Metal Dichalcogenides (TMdCs) have been interested due to the several applications including solar cell, thermoelectric device, and field-effect transistor. However, to obtain the large-area TMdC films are still challenge. Here, we report the facile method to synthesize the centimeter-scale thin film by using chemical vapor deposition. The thin film of transition metal with a thickness of ~ 100 nm was prepared by using sputtering, and then chalcogenization under chalcogen atmosphere was carried out at elevated temperature. From the measurement of X-ray diffraction and Raman spectroscopy, it was confirmed that layered TMdCs were formed with maintaining high quality under the appropriate growth conditions. The amount of chalcogen source and the temperature of transition metal film were found to be important parameters to determine the crystal structure. For their application, we also report the useful transfer method from as-grown substrate to other target substrate.

Keywords:
TMDCs, Chemical vapor deposition, 2D semiconductor

Large area vapor phase growth and characterization of molybdenum disulfide atomic layer

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Abstract:

Monolayers of semiconducting transition metal dichalcogendes (TMDs) hold significant promise in electronics and optoelectronics due to their unusual electrostatic coupling, large carrier mobility, high current carrying capacity, and strong absorption in the visible frequencies with the their chemical and mechanical robustness. There are semiconducting TMDs that can be produced by combining the metals Mo with chalcogens S in the form MX_2. Interestingly as the number of layers is decreased their electronic properties change, with the monolayer exhibiting a direct band gap. In mineral form, MoS_2 is the most abundant TMD and therefore has been extensively studied. While monolayer of MoS_2 can be readily obtained by micromechanical cleavage of synthesis or natural bulk crystals, large area, high quality and continuous thin film are needed for practical devices application. Therefore, obtaining high crystal quality thin films over a large area remains a challenge. In this work, we report the structural and optical properties of large area electronic grade single crystal MoS_2 thin films grown by chemical vapor deposition (CVD) and the demonstration of photodetectors based on large scale two-dimensional and high quality MoS_2. MoS_2 films grown under optimal conditions were found to be of high structural quality from high-resolution X-ray diffraction, transmission electron microscopy, and Raman measurements. The behaviors of the photoresponse of the large area and high crystal quality MoS_2 sample will be presented.

Keywords:
MoS_2, molybdenum disulfide, Chemical vapor deposition, transition metal dichalcogendes, TMD

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Investigation of thermoelectric properties of ntype $SnSe_2$ single crystals

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Abstract:

Thermoelectric are perhaps the simplest technology for direct thermal to electric energy conversion. The conversion efficiency of a thermoelectric material is related to the dimensionless figure of merit ZT. High ZT is a counterindicated property of matter. The tin diselenide ($SnSe_2$) layered crystals are potential candidates for thermoelectric applications because of their high Seebeck coefficient and electrical conductivity. In this work, bulk $SnSe_2$ single crystals were synthesized by gradient temperature method. The confirmation of single crystalline and composition determination of the grown crystals have been made by using Xray diffraction and EPMA Quantitative Analysis techniques, respectively. The layered structure was observed via FESEM images. Thermoelectric response including electrical conductivity, Seebeck coefficients has been investigated in wide temperature range of 20 - 700K by using transport properties measurement system. Carrier concentration was evaluated by the Hall effect measurement with the van der Pauw method. The power factor value showed obvious temperature dependences. Specific results will be discussed.

Keywords:
tin diselenide,single crystal, thermoelectric,layered crystal

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Generation of exciton-polariton condensates in resonant pumping regime toward exploring quantum fluid

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Abstract:

New quasiparticle, “exciton-polariton (polariton)” behaves like boson with strong light-matter coupling in semiconductor microcavities. When populated above threshold density, macroscopic number of exciton-polariton occupies the ground state forming the quasi Bose-Einstein Condensation with quantum coherence. In this study, we concentrate on the generation of exciton-polariton condensate and its excitation, a quantized vortex. First, we observed exciton-polariton condensate with a resonant pumping method. We characterize energy-momentum dispersion, coherence, phase, density and momentum distribution of polariton condensates using the basic techniques of photoluminescence, interferometry and Fourier optics. We were able to exploit the exciton-polariton relaxation towards the ground state based on non-linear polariton-polariton interaction. Then we successfully observed superfluidity by creating a quantized vortex with a resonant pump scheme.

Keywords:
Exciton-polariton, Bose-Einstein Condensation, Vortex

On the Effect of Vacuum Annealing on the Electrical Properties of Monolayer MoS_2

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Abstract:

Although it was believed that vacuum-annealing-induced defects act as compensating p-type dopants in n-type monolayer MoS_2 based on optical photoluminescence (PL) intensity enhancement, this 'p-doping effect' on the n-type MoS_2 has never been confirmed by electrical or other measurements. On the contrary, the fermi level of monolayer MoS_2 was found to move closer to the conduction band minimum by ~ 0.1eV after vacuum annealing. In addition, field effect transistor also showed more n-type conductivity after vacuum annealing. The field effect mobility was dramatically decreased also, indicating that a high density of defects was generated after vacuum annealing. Among the generated defects, we believe that S-vacancies, which act as an n-type dopant, are mainly responsible for the observed fermi level shift. We also observed PL enhancement for nearly-intrinsic monolayer MoSe2 after vacuum annealing, which indicates that the vacuum-annealing induced PL enhancement should be explained not by the trionic 'p-doping effect', but by a mechanism directly involving annealing-generated defects.

Keywords:

MoS2. vacuum annealing, defects, photoluminescence

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Nanostructured NiMoO4 thin films for electrochemical supercapacitor applications

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Abstract:

Nanostructured $NiMoO_4$ thin films are fabricated using hydrothermal method on to stainless steel substrates. During the film growth the temperature of the teflon autoclave is maintained at 180^0C for 12 hrs, and then it is naturally cooled to room temperature. The as-grown $NiMoO_4$ film shows a uniformly distributed needle like morphology. It exhibits a polycrystalline monoclinic phase of a $NiMoO_4$ crystal structure. The electrochemical supercapacitor properties of the $NiMoO_4$ thin films are examined using cyclic voltammetry (CV), galvanostatic charge-discharge (CD) and impedance measurements in a 2M KOH electrolyte. A maximum specific capacitance of the $NiMoO_4$ thin film is found to be ~327 Fg^{-1}. It also exhibits good electrochemical stability for more than 2500 charge discharge cycles.

Keywords:
Nanostructured,hydrothermal,polycrystalline monoclinic phase,supercapacitor.etc

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온도 변화에 따른 단일층 WSe_2 의 엑시톤 신호 변화

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Abstract:
2차원 층상 구조를 가진 전이금속 칼코겐 화합물 WSe_2 는 단일층에서 Direct 밴드갭 (Bandgap) 구조를 가지는 특성을 보인다. 이 실험에서는 화학증착 (CVD) 방법으로 제작된 WSe_2 단일층의 온도 변화에 대한 광학적 특성 분석을 위하여 광발광 (Photoluminescence) 실험과 반사율 (Optical contrast) 실험을 수행하였다. 80 K부터 470 K까지 온도 변화에 따른 광발광 신호와 반사율 스펙트럼을 얻고자 두 실험을 연속적으로 실험 가능하도록 실험 구성을 하였다. 80K 부근에서는 반사율 스펙트럼에서 A 엑시톤 (A exciton) 신호가 1.710 eV 부근에서 발견되었으나 광발광 신호는 1.719eV 로 10meV 정도의 차이를 보였다. 광발광 실험에서는 A 엑시톤 신호보다 100 meV 낮은 영역에서 더 세기가 강한 또 다른 신호 X 가 측정되었는데 이 신호 X 는 온도가 증가하여 170 K 부근에서는 사라지는 것을 확인하였다. 반면 온도를 473 K까지 증가시켜도 A 엑시톤 의 광발광 신호가 사라지지 않았으며 이는 A 엑시톤의 결합에너지 (Binding Energy) 는 약 40 meV 이상임을 의미한다. 반면 온도가 증가하면서 광발광 신호의 적분면적 (Integrated area) 은 310 K 이상에서는 감소하는 경향을 보이지만 80 K부터 310 K 사이는 뚜렷한 경향성을 보이지 않고 증가 혹은 감소를 반복하였다. 온도에 따른 반사율 실험에서 나타나는 A 엑시톤 신호의 위치 변화는 반도체의 온도증가에 따른 밴드갭 감소를 설명하는 바시니 방정식 (Varshni's equation)과 경향성이 일치하며 A 엑시톤 신호의 반치폭 (FWHM)은 온도가 높아지면 증가하는 경향을 보이지만 선형 증가는 아닌 것을 확인하였다. 광학적인 특성을 분석하는 대표적인 실험 방법인 광발광과 반사율을 통하여 WSe_2 단일층의 온도 변화에 따른 밴드 구조의 변화를 보았으며 잘 알려진 다른 반도체들과 달리 상온 이상의 고온에서도 A 엑시톤 신호가 사라지지 않아 상대적으로 높은 결합에너지를 가지고 있음을 알 수 있었다.

Keywords:
Exciton, TMDC, WSe_2, Photoluminescence, Optical contrast

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나노복합체를 사용하여 제작한 memristor 소자의 동작 매커니즘 연구

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Abstract:
최근 memristor에 대한 연구가 제 4의 수동소자로서의 가능성 때문에 활발하게 이루어 지고 있다. Memristor는 특정 Threshold Voltage를 기준으로 같은 전압을 반복하여 걸어주면 특정 방향으로 전류의 특성이 방향성을 띠며 변하는 메모리 소자이다. 전류의 방향성은 loop의 형태로 나타나는데 이것을 hysteresis loop라고 부른다. 때문에 다양한 재료로 memristor를 만들려는 시도가 이루어 지고 있다. 이번 연구에서는 Poly - methyl methacrylate (PMMA)를 이용하여 memristor의 특징인 hysteresis loop가 나타나는 소자를 만들어 보았다. PMMA는 무 독성, 무색투명, 경량, 강성, 내후성, 내수성 등에서 큰 강점을 보이고 윤활류에 잘 견디는 성질을 가지고 있어 전자 소자에 사용하기에 큰 장점을 가지고 있다. 유리 기판 위에 ITO(Indium Tin Oxide) 전극 층을 쌓고 PMMA에 Graphene Quantum Dot(GQD)를 포함한 층을 쌓아 Glass/ITO/PMMA with GQD 구조를 spin-coating 방법으로 memristor 소자를 제작 하였다. PMMA층 윗부분에는 Al를 사용하여 전극을 붙여 전원을 공급하였다. 제작한 소자의 전기적 특성이 hysteresis loop를 나타내는지 알아보기 위해 I-V 실험으로 관측하였다. 관측한 I-V 특성을 통해 이 소자가 memristor의 특성을 보여주었다. Memristor 소자의 동작 메커니즘을 I-V 결과를 수행하여 설명하였다. PMMA를 이용한 소자의 응용성을 논의한다.

Keywords:
memristor, memory device, PMMA

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FinFET의 gate side angle 변화에 따른 전기적 특성 변화

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Abstract:
사물인터넷 장치의 경우 전력소모가 낮고 효율성이 좋은 MOSFET 사용이 필요하다. MOSFET 전기적 특성 효율을 향상하기 위해 MOSFET의 크기를 지속적으로 감소하였지만, 케이트의 크기가 10 nm 이하에서는 단채널 효과와 게이트 누설전류 문제가 있다. 단채널 효과와 게이트 누설전류 문제를 해결하기 위하여 나노크기의 FinFET에 대한 연구가 진행되고 있다 [1]. FinFET 소자는 MOSFET에 비하여 구조적 특징으로 누설전류의 감소와 높은 효율성 및 스위칭 속도가 빠르며 소비전력이 더 낮은 장점이 있다. 그러나 FinFET 소자의 경우 MOSFET에 비하여 전자이동도가 낮아지고 게이트의 두께가 얇아질수록 공정이 어려워지는 단점을 가지고 있다. 이 문제를 해결하기 위하여 Fin 모양에 따른 소자의 전기적 특성 변화에 대한 연구를 하였다. 본 연구에서는 FinFET 소자의 gate side angle 변화에 따른 전기적 특성 변화를 multi-orientation mobility model을 포함한 TCAD 시뮬레이션을 사용하여 관찰하였다. Fin side wall의 각도를 변화시키면서 sub-threshold swing, 채널에서의 전자이동도 및 누설전류를 관찰하였다. 시뮬레이션 결과는 Fin과 게이트 접촉면의 모양에 따라 채널영역의 모양의 변화에 따른 전기적 특성이 변하는 것을 보여주었다. Gate side angle이 증가함에 따라 sub-threshold swing과 게이트 누설전류가 감소하였고 20 nm 채널영역에서의 전자이동도가 200% 증가함을 시뮬레이션 결과로 확인하였다. 이와 더불어 gate side angle의 변화가 FinFET 소자의 효율성에 미치는 영향을 조사하였다.

Keywords:
FinFET, gate side angle, 전기적특성

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플래시 메모리의 금속층 삽입에 따른 셀간 간섭 현상

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Abstract:
휴대용 전자기기에 대한 플래시 메모리의 수요가 갈수록 증가에 따라 더 큰 저장공간, 빠른 동작속도, 낮은 소비전력, 높은 신뢰도의 소자가 요구 되고 있다 [1]. 플래시 메모리의 크기가 나노크기로 작아짐에 따라 셀 간의 간섭이 발생한다. 셀 간 간섭에 따른 누설전류 증가와 문턱전압의 마진이 줄어 드는 소자 성능 저하 및 소자의 신뢰성 문제가 발생한다. 본 연구에서는 플래시 메모리의 전기적 특성 향상을 위해 플래시 메모리 소자의 셀 간 간섭을 억제하는 방법에 대해 연구하였다. 플래시 메모리에서 인접한 셀의 절연 층 중간에 금속 층을 삽입하여 셀 간 간섭을 관찰하였다. 제안한 금속층을 삽입한 플래시 메모리 소자의 전기적 특성을 TCAD (3-Dimensional Technology Computer-Aided Design) 시뮬레이션 툴을 이용하여 계산하였다. 인접한 셀간의 전계 분포를 프로그램을 통해 시뮬레이션 한 결과, 기존 구조의 플래시 메모리에 비해 제안한 플래시 메모리 소자의 인접 셀간 간섭이 크게 감소한 것을 확인하였다. 제안한 플래시 메모리 소자는 삽입된 금속 층으로 인해 증가된 게이트 커플링 비율이 터널링 산화막에 적용되는 실질 전계 값에 영향을 주어 기존의 소자에 비해 증가된 실질 전계 값을 확인하였다.

Keywords:
플래시, 전기적 특성, 간섭, 게이트 커플링

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Comparative studies on the physical and electronic properties of ZnO and ZnON semiconductors by reactive RF magnetron sputtering

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Abstract:

High speed thin film transistors (TFTs) are in great need for next generation display industry. For realizing ultra-definition, large area and other future display technology in the future, the mobility need to be further increased over 50 cm2/V·s . Among the candidates, oxide thin film transistors (OxTFTs) are one of most promising device due to their high performance. Here, the oxide thin film transistors were fabricated using ZnO and ZnON semiconductors grown by reactive RF magnetron sputtering using Zn target. After air annealing at 300℃, ZnON devices exhibit superior electrical performance (μsat=86.9cm2/V·s, Vth= -0.77 and SS= 0.43 V/dec) in comparison with ZnO devices (μsat=0.05cm2/V·s, Vth= 3.23 and SS= 1.08 V/dec). We investigated the origins of electrical properties of ZnO and ZnON, in terms of the electronic structure including chemical bonding states, band alignment and band edge states below the conduction band.

Keywords:
ZnON, Band alignment, Oxide thin film transistor

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Effect of structural distortion on phase-change properties in Sb doped Ge-Sb-Te

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Abstract:
Ge-Sb-Te pseudo-binary chalcogenide compounds show reversible phase-change phenomenon between amorphous and crystalline phase. Most of these chalcogenide compounds are suitable as candidate for next-generation memory application called phase-change random access memory (PCRAM) device. Using the difference in electrical resistivity difference between amorphous and crystalline phase for PCRAM, The relationship of phase change process with the structural characteristics is most important part to understand the origin of phase change process and to apply the material to PCRAM. In this study, in order to evaluate the phase-change property, the extended X-ray absorption fine structure (EXAFS) and terahertz pump-probe method were introduced. It is known that Sb doping in Ge-Sb-Te increases the speed of phase change. By analyzing the bond length and phonon behaviors of Sb doped Ge-Sb-Te, structural change induced by Sb doping could be determined. Combining this result with Raman analysis and sheet resistance measurement, the resonant bonding on anharmonicity significantly affects the set temperature. This study based on metrology evaluating the phase-change materials (PCM) can provide new insights on better choice of PCM for PCRAM applications.

Keywords:
Phase-change, PCRAM, chalcogenide, resonant bonding, Peirls-like distortion

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Growth and thermoelectric transport properties of InSe single crystal

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Abstract:

InSe is a member of the III-VI layered semiconductor group, which are possessed a layered structure with strong covalent bonding between In and Se in a stacking sequence Se-In-In-Se and the layers linked each other only by weak interlayer Van der Waals interactions. Therefore, InSe usually present anisotropic characteristics. In this study, InSe single crystal was successfully grown by using the temperature gradient method. We have experimentally studied the crystal structure, optical properties and transport properties of the InSe single crystal. The layered crystal structure of InSe was determined by XRD and FE-SEM measurements. The Raman spectroscopy of InSe single crystal with high crystallinity could be characterized by three principal bands. Measurement of the electrical conductivity and Seebeck coefficient were performed in two crystallographic directions (parallel and perpendicular to the layers) in the range of 20 K to 400 K. Power factor of n-type InSe increased with temperature, about 0.06 $\mu Wcm^{-1}K^{-2}$ at 400 K. We expect higher power factor at a high-temperature range.

Keywords:
InSe, single crystal, thermoelectric transport properties

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산화그래핀과 유기폴리머 나노복합체 기반 비휘발성 메모리의 전하 수송 메커니즘 규명

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Abstract:
나노복합체 기반 비휘발성 메모리 소자는 기존의 메모리 소자에 비해 제작 공정이 단순하여 저가에 소자 제작이 가능하며 유연성을 지닌 소자를 제작할 수 있기 때문에 연구가 활발히 진행되고 있다. 나노입자를 포함한 유기물층을 활성층으로 사용한 비휘발성 메모리 소자에 대한 제작과 전기적 특성에 대한 연구는 많이 진행되었으나 산화그래핀을 사용하여 형성한 활성층을 기반으로 한 비휘발성 메모리 소자의 전하수송 메커니즘에 대한 연구는 상대적으로 적게 진행되었다. 본 연구에서는 유기 폴리머 물질 안에 산화그래핀을 삽입하여 전하 트랩 영역으로 사용하였고, 그 활성층의 두께를 다양하게 조절하여 스핀코팅 방법으로 제작한 소자의 전기적 특성 및 전하 수송 메커니즘에 대해 연구하였다. 제작된 소자의 구조적 특성을 주사전자현미경을 사용하여 관측하였다. 전류-전압 특성 결과는 소자가 동일 전압에서 전기적인 쌍안정성을 보여주었으며, 산화그래핀이 없는 소자에서는 전기적 쌍안정성이 나타나지 않았다. 또한 제작된 소자의 안정성을 조사하였다. 실험 결과와 에너지 밴드 개략도를 기반으로 소자의 전하 수송 메커니즘을 설명하였다. Acknowledgement This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2016R1A2A1A05005502).

Keywords:
유기메모리, 비휘발성메모리, 산화그래핀, 유기폴리머, 나노복합체, 쌍안정성

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Scavenging of galvinoxyl spin 1/2 radicals in annealed galvinoxyl-doped P3HT films

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Abstract:
It is a very challenging subject to manipulate spin states of organic semiconductors by doping of spin 1/2 radicals. Galvinoxyl (Gx) radical is known to be a stable organic radical. The efficiency of organic solar cells was reportedly improved after Gx doping due to a change of spin ensembles; Gx was also used in organic radical battery as active-electrode materials. We report the disappearance of galvinoxyl radicals in galvinoxyl-doped P3HT films as the sample was heated up to ~150 ℃. The melting point of Gx is known 156~160 ℃. We suggest that the losing of Gx paramagnetic signals in the thermal processing of organic device is related to the melting of Gx, and consequently following the radical scavenging of Gx spins.

Keywords:
galvinoxyl

Doublet of quintets from spin 1/2 radicals in galvinoxyl liquid samples

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Abstract:

We report the losing of paramagnetic spins of galvinoxyl radicals in galvinoxyl samples dissolved in 1,2-Dichlorobenzene, or orthodichlorobenzene (ODCB). We found doublet of quintets electron spin resonance (ESR) hyperfine signals from galvinoxyl (Gx) spin 1/2 radicals in the liquid samples. The Gx-(ODCB) liquid samples were prepared using 2.1 mg of Gx powder dissolved into 2 ml of ODCB. One set of samples was stirred in N2 atmosphere at 50℃; and then was sealed into quartz tubes in N2 atmosphere; while the other set of samples were prepared in the same way except that the samples were stirred in air. The doublet of quintets was regarded to originate from four equivalent hydrogens situated on aromatic ring and from the hydrogen of C-H group joining the aromatic ring. The as-purchased Gx powder samples showed one-resonance type ESR spectra at low temperatures (4 K- 50 K). The g-value was ~2.0045. With time in Air, the ESR intensity starts to decrease at ~30 min and then totally disappeared after ~4 h. The color of the sample was found to change from dark blue to yellow as well. However, in N2, the ESR intensity of the sample persisted for over 4 h; the color has not been changed. The decrease of Gx signal was attributed to galvinoxyl "radical scavenging". The related mechanisms will be discussed.

Keywords:
galvinoxyl, ESR

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신규 고분자를 이용한 유기 태양전지의 광전류 향상 연구

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Abstract:
본 연구에서는 강한 전자 결핍을 갖는 Thieno thiophene (TT)을 이용한 신규 전자주개 P(BDT-DPPD-FTTE) (RP2) 고분자를 이용하여 태양전지를 제조하고 그 특성을 분석하였다. RP2 고분자 태양전지는 전자받개 물질인 [6,6]-penyl-C71-butyric-acid-methyl-ester (PC71BM)과의 혼합을 통해 제조되었고, 두께조절 및 다양한 첨가제의 활용을 통해 최적화 되었다. 그 결과, 전자 수용체를 포함한 RP2 태양전지는 전자 수용체를 삽입하지 않은 기존 고분자에 비해 넓어진 흡수 스펙트럼을 보였으며, 이는 엑시톤 생성의 증가로 이어져 전자와 정공의 생성량을 증가시키고, 이로 인해 약 25% 향상된 12.99 mA/cm2의 광전류를 보였다.

Keywords:
신규 고분자, 유기 태양전지

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용매첨가제를 이용한 고분자 태양전지에 광학 스페이서 도입을 통한 광전류 향상연구

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Abstract:
고분자 태양전지에서 옵티컬 스페이서와 용액 첨가제는 광전류의 증가와 같은 다양한 이점을 제공하지만, 하나의 소자 안에 두 가지 기법이 모두 구현된 경우는 아직 알려지지 않았다. 실제로, 옵티컬 스페이서는 태양 전지 내에서 첨가제의 사용과 병립하지 않는다. 우리는 본 연구를 통해 성공적으로 옵티컬 스페이서인 타이타늄 아산화물(TiOx)과 첨가제를 동시에 태양전지 소자에 도입하였고, 소자로에서 광전류의 현저한 증가를 관측하였다. TiOx 박막을 형성하기 이전에, 쉽게 적용가능하며, 물질에 의존하지 않으면서도, 유효한 저진공 처리를 통해 옵티컬 스페이서와 첨가제 사이의 문제가 해결되었으며, fill factor(FF)와 개방전류 전압(VOC)의 손실 없이 광전류의 주목할 만한 증가가 이루어졌다. TiOx가 1,8-diiodooctane(DIO) 첨가제와 함께 도입되었을 때 효율이 PBDTTT-EFT:PC70BM 소자의 경우 7.63 %에서 9.33 %로, P(BDT-TDPPDT-TPD):PC70BM 소자의 경우 5.5 %에서 6.46 %로 크게 증가했다.

Keywords:
용액 첨가제, 고분자 태양전지, 금속산화물

Fabrication and study of Fe-N nanopowder prepared by DC thermal plasma

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Abstract:
During the past decades, iron nitrides have received considerable scientific and technological attentions due to their diverse phase structures and interesting magnetic properties. Iron nitride compounds are known to exist in varieties of phases having distinct crystal structure and magnetic properties. Among the different phases, the ferromagnetic iron nitride (α''-$Fe_{16}N_2$) with body centered tetragonal structure has been paid much attention as a new candidate for future permanent magnet material with rare earth free. It was reported that α''-$Fe_{16}N_2$ phase have saturation magnetization (M_s) is 240 emu/g and magnetocrystalline anisotropy constant (K_u), is about $1x10^7$ erg/cm^3 at room temperature. Attempts to fabricate α''-$Fe_{16}N_2$ by using dc plasma arc discharge method have been employed in this work. Keeping the experimental conditions constant of ~10 kW power and ~4 kPa pressure of chamber filled with different compositions of nitrogen-based gases, the synthesized Fe-N powders were analyzed structurally and morphologically by x-ray diffraction and scanning electron microscopy respectively. The Fe nano-particles are spherical and connected rods in shape having particle size in the range of 20-100 nm. The magnetic properties of fabricated nano-powders have been studied by PPMS and the approach to fabricate the $Fe_{16}N_2$ phase will be discussed.

Keywords:
Fe-N, magnetic properties, nano-powder, thermal plasma

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신자성재료 개발을 위한 High-throughput 자성재료 제조 및 특성 평가

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Abstract:

신자성 소재 개발을 위한 High-throuput 자성 박막 제조 공정 및 연속측정장치를 개발하였다. High-throughput 박막제조 공정은 동시증발법을 이용하여 대면적 기판상에 증착하는 방법으로서 원소별 증발시키기 위한 가열기, 각 원소별 증착률을 측정하기 위한 Quartz Crystal Microbalance(QCM), 기판을 가열하기 위한 히터 등으로 구성되어 있다. 기판의 각 위치에서 각 원소 소스별 거리 및 기판 입사 각도가 다르므로 기판의 각 위치마다 자성물질의 조성비가 다르다. 따라서 1회의 실험으로 다양한 조성비를 가진 샘플을 얻을 수 있다. Hith-throughput 자성재료 특성 연속측정장치는 1.3 T 영구자석, 테이프형 샘플 연속이동장치, 3축 홀센서 등으로 구성되어 있다. 테이프를 일정한 간격으로 이동하면서 샘플에 영구자석을 이용하여 자기장을 가하고 각 위치에서 자기 이력곡선을 측정하는 장치이다. 이러한 high throughput 실험으로 얻을 수 있는 잇점은 1) 1회의 실험으로 다양한 조성비를 가진 화합물을 얻을 수 있고, 연속적인 측정방법을 통하여 신속하게 측정할 수 있으므로 실험결과 획득 속도가 상당히 빠르다. 2) 기판의 각 위치에서 조성비 외에 다른 증착변수들은 같은 경험을 거치므로 조성비 의존성에 대한 실험의 신뢰도가 높고 3) 조성비에 따른 연속적인 물성의 변화를 관찰할 수 있고, 연속적으로 변화를 관찰함으로써 최고의 물성을 가지는 조성비를 추적할 수 있다.

Keywords:
신자성소재, high-throuput, 동시증발법, 대면적 증착, 연속적인 자성재료 특성 측정방법

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Vanadium을 미량 치환한 $LiFePO_4$의 결정학적 및 자기적 특성 연구

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Abstract:
이차전지 양극 물질인 리튬인산철(lithium iron phosphate, $LiFePO_4$)에 Vanadium을 1% 치환한 시료를 직접합성법으로 제조하였다. 이 시료를 XRD(X-ray Diffractometer)를 사용하여 측정하였으며, Rietveld refinement method으로 분석하여 Pnma 공간 그룹의 orthorhombic 구조임을 확인하였다. 이 시료의 격자상수는 순수한 $LiFePO_4$보다 작아졌음을 확인하였고, 이는 V의 이온반경이 Fe의 이온반경보다 작기 때문이라고 해석된다. 거시적인 자기적 특성을 측정하기 위해 VSM(Vibrating Sample Magnetometer)을 사용하여 4.2 ~ 295 K까지 온도 변화에 따른 자화율을 측정하였다. 그 결과, 이 시료는 반강자성체의 거동을 보였으며, 상자성체로 변화하는 Néel 온도(T_N)를 확인하였다. 또한 4.2 ~ 295 K의 온도구간에서 Mössbauer 분광 실험을 실시하여 미시적인 자기적 특성을 확인하였다. 모든 온도에서 이성질체 이동치(δ)를 확인한 결과, Fe 이온이 Fe^{2+}로 존재함을 확인하였다. Néel 온도 이하에서 Mössbauer 스펙트럼은 비대칭적인 8개의 흡수선으로 분석하였고, Néel 온도이상에서는 대칭적인 2개의 흡수선으로 분석하였으며, 295 K에서 전기 4중극자 분열치 E_Q = 2.95 mm/s, 이성질체 이동치 δ = 1.11 mm/s로 분석하였다.

Keywords:
Mössbauerspectroscopy, Cathode material,$LiFePO_4$, Substitution

Dielectric and structural properties of $Hf_{1-x}Zr_xO_2$ thin film grwon by pulsed laser deposition for ferroelectric oxide

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Abstract:

Concerning the ferroelectricity embedded on CMOS technology, research attention has been paid to the potential application of HfO_2 as a non-perovskite ferroelectric material. HfO_2 has been considered the alternative for the standard gate dielectric. HfO_2 showed the typical capacitance-voltage hysteresis which is a characteristic of ferroelectric materials. In addition, the doped HfO_2 exhibited ferroelectric as well as antiferroelectric behavior. Both ferroelectric and antiferroelectric behavior of $Hf_{1-x}Zr_xO_2$ can be used the memory device and energy harvest materials, respectively. Strong electrode dependence of ferroelectricity of $Hf_{1-x}Zr_xO_2$ was observed in the device structure using Pt and TiN electrodes. The strong ferroelectric behavior was observed in $Hf_{1-x}Zr_xO_2$ thin film on TiN electrode. On the other hand, the ferroelectric behavior disappeared on Pt electrodes because of its (111) orientation. Also it is controversy whether the existence of top electrode during annealing affect the ferroelectricity property or not. In this study, $Hf_{1-x}Zr_xO_2$ thin films were fabricated on Pt(111) and Pt (poly) platinized Si substrate by pulsed laser deposition. The dielectric and structural properties of the $Hf_{1-x}Zr_xO_2$ thin films were investigated by conventional I-V measurement and GIXRD.

Keywords:
$Hf_{1-x}Zr_xO_2$, Ferroelectric

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이중 헬름홀츠 공명기를 사용한 연속적 유효 압축률 구현

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Abstract:
연속적으로 조정이 가능한 구성변수(constitutive parameters)는 메타물질을 이용한 장치 구현에 있어서 매우 중요하다. 연속적으로 변화하는 유효 밀도는 박막을 이용한 메타물질에 의해서 이미 구현이 되어있다. 본 발표에서는 이중 헬름홀츠 공명기(Double Helmholtz resonators)를 이용한 메타물질이 음의 극한값에서부터 양의 극한값까지의 유효 압축률을 연속적으로 구현할 수 있음을 증명한다. 실험적으로 유효 압축률은 공기대비 -10 부터 10까지 측정을 하였다. 이 연구결과는 음향 은폐(acoustic cloaking)에 연관이 있다.

Keywords:
음향 메타물질, 음향 은폐, acoustic metamaterials, acoustic cloaking

A strategy for developing phosphors with tunable white light-emitting properties: $ZnWO_4:Sm^{3+}$, Bi^{3+}, Li^{+}

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Abstract:

The color-tunable phosphor ZnWO4: Sm3+, Bi3+, Li+ has been prepared via a solid-state reaction method. The white light was attributed to the color mixture of blue-green and orange-red emission, which originated from the charge transfer transition of W-O and the transition emission of Sm3+ respectively. The obtained phosphors exhibited a strong traditional band at 305 nm and a new band at about 351 nm which comes from the 1S0-3P1 transition of Bi3+. White light with tunable color emission for ZnWO4: Sm3+, Bi3+, Li+ phosphors were demonstrated by simply controlling the ratio of Sm3+/Li+. The calculated chromaticity coordinates were varying from blue to white region. When excited at about 351 nm, these phosphors have a strong orange-red light. These results indicate that the phosphor of ZnWO4: Sm3+, Bi3+, Li+, which can generate tunable blue-white-red light, may be a promising element for cost-effective diodes with near ultraviolet white light emitting properties.

Keywords:

ZnWO4: Sm3+, Bi3+, Li+, White light emitting, Phosphors

Synthesis and Luminescence Properties of K2Ge4O9: Mn4+ Phosphors via solid-state reaction route

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Abstract:

For phosphor-converted warm white light-emitting diodes, it is essential to find highly efficient red phosphors, which are better chemically stable and benefit to environment and can be prepared in a much milder condition. Here, we report a red phosphor $K_2Ge_4O_9$:Mn^{4+} via the conventional solid-state reaction route. The X-ray diffraction (XRD), photoluminescence excitation, emission spectra, fluorescent decay curves were applied to characterize the samples. XRD reveals that the Mn^{4+}can be completely dissolved in the $K_2Ge_4O_9$ host lattice by substitution of the Ge^{4+}. Under the excitation of UV light, the doped phase show the characteristic emissions of Mn^{4+} and clear red-emission at room temperature. They are from the $^4A_2 \rightarrow {}^4T_1$ (partly Mn^{4+}-O^{2+}charge-transfer transition) and $^4A_2 \rightarrow {}^4T_2$ spin-allowed transitions of Mn^{4+} ions, respectively. The obtained $K_2Ge_4O_9$:Mn^{4+} phosphors have potential application in the areas of NUV white-light-emitting diodes and field emission display devices, etc.

Keywords:

K2Ge4O9:Mn4+, Phosphor, Luminescence

Luminescence properties of Dy^{3+} ions activated novel white-light emitting $K_2Gd(PO_4)(WO_4)$ phosphors

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Abstract:

Phosphor-converted light-emitting diodes (pc-LEDs) have gained abundant interest as future of solid-state lighting trades because of their numerous advantages starting from being energy efficient, economic, compact, long-lived, environmental friendly, etc. and having high luminous efficiencies for reducing the global electricity consumption. In this study, a serious of Dy^{3+}-activated novel phosphor-tungstate $K_2Gd(PO_4)(WO_4)$ phosphors were synthesized via a conventional high temperature solid-state reaction. The XRD results revealed that the phosphors possessed single-phase and the incorporation of small amount Dy^{3+} ions did not induce any significant changes in the crystal structure. The PL spectra show energy transfer from Gd^{3+} to Dy^{3+} with the excitation of 273 nm, and dysprosium ions exhibit three peaks at 483 nm, 573 nm, and 660 nm, corresponding to $^4F_{9/2}$–$^6H_{15/2}$, $^4F_{9/2}$–$^6H_{13/2}$, and $^4F_{9/2}$–$^6H_{11/2}$, respectively. The optimal concentration of Dy^{3+} ions is 0.03 mol. Energy transfer of Dy^{3+} centers were demonstrated from dipole-dipole interaction. All of the phosphors exhibited strong absorption bands in the near ultraviolet (near-UV) range, revealing the phosphor-silicate phosphor interesting for application in the output wavelength of the near-UV used phosphor-converted LED chips.

Keywords:
Light-emitting diodes,Phosphors, Dy^{3+} ions

유로퓸으로 도핑된 산화알루미늄의 열형광 및 포토루미네선스 특성 연구 유로퓸으로 도핑된 산화알루미늄의 열형광 및 포토루미네선스

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Abstract:
산화알루미늄은 열형광 특성이 나타나는데 이때 결정 내에 희토류 금속(Eu)을 도핑하면 열형광의 파장변화를 보인다. 연소법으로 제조한 Al2O3:Eu 파우더는 열처리에 따라 결정성이 달라지며 입방구종의 Eu2O3의 대칭인자(symmetry factor) 또한 열처리 온도에 따라 영향을 받는 것으로 확인되었다. PL(photoluminescence) 분석으로 흡수와 발광의 위치를 파악하였고 열형광 분석을 통해 가열 온도에 따라 발광 스펙트럼을 확인하였다. 이것은 PL에서 보이는 특성과 열형광에서 보이는 특성이 대체로 일치함을 보였다.

Keywords:
combustion, Al2O3, Europium, Photoluminescence

전기도금과 갈바니치환 방법으로 제작한 BiTe 박막의 특성

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Abstract:
열전소자로 많은 연구가 진행되고 있는 BiTe 박막을 전기도금방법과 갈바니치환 방법으로 제작하였다. 먼저 전기도금 방법으로 free-standing Co 박막을 제작하였고 이 Co 박막을 갈바니치환하여 BiTe 박막으로 변환하였다. 갈바니치환 전해액은 Bi 20 mM와 Te 10 mM을 혼합하여 제조하였다. 박막의 두께는 약 5 um로 고정하였고 Co 전해액의 유기첨가제 농도와 갈바니치환 반응시간을 조절하여 다양한 박막을 얻을 수 있었다. 대체적으로 BiTe 박막의 resistivity는 단결정 BiTe에 비해 약 100배 이상 크게 나타났다. 이는 갈바니치환 과정을 통해 형성되는 BiTe 박막의 다결정구조에 기인하는 큰 grain boundary scattering으로 설명할 수 있다.

Keywords:
열전, 열전소재, BiTe, 전기도금, 갈바니치환, 비저항, 결정성

Growth of VO_2 single crystalline nano- and microwires in atmosphere on various substrates

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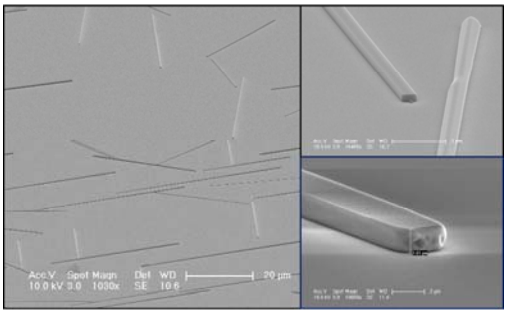

Abstract:
Single crystalline nano- and microwires(SCNMWs) of Vanadium dioxide(VO_2) were successfully fabricated by a vapor transport method at atmospheric pressure at variable temperature on Al_2O_3, Si and SiO_2/Si substrates. Suggested technology of growth of VO_2 SCNMWs is more simple and inexpensive compare with conventional growth method. To confirm the quality of SCNMWs, metal-insulator phase transition, the most important feature of VO_2, occurred at a critical temperature(T_c) of 340K, was observed by optical microscope on heating. The Raman spectra of VO_2 SCNMWs were measured at room temperature in order to check the properties of the insulating monoclinic VO2 phase.

Keywords:
VO_2;MIT;nanowire;

Synthesis of high crystalline and large area h-BN through electrochemical polishing(ECP) treatment

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Abstract:
절연특성, 산화방지막 등의 특성을 가진 Hexagonal Boron nitride(h-BN) 는 절연층, 전기적 소자의 기판, 부식 또는 산화 방지코팅, 2D 나노 물질 성장의 기판 등으로 응용되고 있다. h-BN 은 유연소자에 절연체로 적응 하기 위해서는 결정성이 좋고 균일하며 원자수준의 단일 층으로 합성 되어야 한다. 하지만 원자수준 단일 층으로 합성되는 h-BN 에서는 결함이나 도메인 사이에서 생기는 누설전류가 발생하여 응용에 한계성을 가지게 된다. 그래서 결함들은 줄이고 도메인크기를 증가시키는 것은 매우 중요하다. 우리는 h-BN 합성의 촉매가 되는 구리 포일을 Electro Chemical Polishing(ECP) 처리하여, 구리 포일에 표면 거칠기를 감소시키고 불순물을 제거하였다. 이에 따라, 도메인 크기가 증가하고 결함들은 적은 고품위 h-BN 을 합성하였다.

Keywords:
Hexagonal Boron nitride, Synthesis,ElectroChemical Polishing

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Temperature-Dependent Optical Properties of Organo-Metal Halide Perovskite Single Crystals

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Abstract:
Recently, in field of photovoltaic research, one of hot issues is the Organo-Metal Halide Perovskite (ABX_3 where A=CH3NH3, B=Lead, X = I, Br and Cl) solar cell due to its outstanding photovoltaic performance (up to 20.6 %). Also, these materials are leading low-cost energy conversion technology because they can be used for fabricating devices in a solution process. Due to such advantages, researchers in this field have been intensively investigating to reveal its remarkable photovoltaic properties and a lot of results have been reported. However, it is still in lack of basic optical properties. In this work we investigated the temperature dependent optical properties of Methyammonium Lead Iodide ($MAPbI_3$) and Bromide ($MAPbBr_3$) single crystals. We measured optical reflectance spectra and obtained optical constants such as optical conductivity, dielectric constant and refractive index by using a Kronig-Kramer (KK) relation. We report and discuss on the optical constants in this presentation.

Keywords:
Optical spectroscopy, $MAPbI_3$, $MAPbBr_3$, Perovskite Photovoltaic, Organo-metal halide

Field-Induced Strain and Ferroelectric Properties of $Bi(Mg_{0.5} Zr_{0.5})O_3$-Modified $BiFeO_3 - BaTiO_3$ Ceramics

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Abstract:
Lead-free piezoelectric ceramics, (1-x) ($0.67BiFeO_3$ - $0.33BaTiO_3$) - x $Bi(Mg_{0.5}Zr_{0.5})O_3$ abbreviated as BF-BT-BMZ (x = 0.00-0.030) were synthesized by a conventional solid state reaction method. BMZ addition does not change the crystal structure of BF-BT ceramics in the studied composition range. However, the microstructure changes with increasing amount of BMZ concentration. For composition x = 0.060, enhanced ferroelectric and field-induced strain properties were obtained. High Curie temperature T_c = 392° C and large dynamic piezoelectric constant $S_{max}/E_{max} = d^*_{33}$ = 440 pm/V at a relatively low field of 4kV/mm was observed in BF-BT-BMZ ceramics. The large field induced strain at low driving field and its high T_c makes this material suitable for high temperature piezoelectric applications. Keywords: Lead-free, Field-induced strain, Ferroelectricity, $BiFeO_3$,

Keywords:
Lead-free, Field-induced strain, Ferroelectricity, $BiFeO_3$,

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2016.10.19 - 2016.10.21

Direct Growth of High-Quality Large-Area Graphene/h-BN Heterostructure on Recyclable Pt Foil by Chemical Vapor Deposition

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Abstract:

High-quality large-area graphene was successfully grown on a single-layer h-BN/Pt foil by chemical vapor deposition (CVD). The high quality large-area graphene is confirmed by optical microscopy, Raman spectroscopy, scanning electron microscopy, atomic force microscopy and electrical characteristics. Moreover, Hall measurement indicates that the electrical mobility of graphene/h-BN film reaches up to 2,110 $cm^2 V^{-1} S^{-1}$ at room temperature, suggesting that the high-quality large-area graphene/h-BN heterostructure on recyclable Pt foil grown by CVD can be a promising approach suitable for high performance graphene based electronics.

Keywords:
graphene, h-BN/Pt, chemical vapor deposition, graphene electronics

Sr_2CeO_4:Er^{3+}/Tm^{3+}/Yb^{3+}: a potential color tunable phosphor for white LEDs

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Abstract:

Sr_2CeO_4 Ln^{3+} (Ln = Er, Tm, Yb) phosphors were synthesized via high-energy ball milling method. The structure of the synthesized phosphor is identified to be a pure orthorhombic structure. By varying the concentration of dopant ions, the obtained phosphors present tunable up-conversion emissions under 975 nm laser excitation. The white up-conversion light emitted from a 3mol%Er^{3+}/1mol%Tm^{3+}/10mol%Yb^{3+} ions tri-doped Sr_2CeO_4 phosphor was observed corresponding to the transitions from $^1G_4 \rightarrow {}^3H_6$ of Tm^{3+}, $^1G_4 \rightarrow {}^3F_4$ of Tm^{3+}, $^2H_{11/2} \rightarrow {}^4I_{15/2}$ of Er^{3+}, $^4S_{3/2} \rightarrow {}^4I_{15/2}$ of Er^{3+} and $^4F_{9/2} \rightarrow {}^4I_{15/2}$ of Er^{3+} transitions at 478, 652, 526, 552 and 664 nm, respectively. The efficient up-conversion emission is attributed to energy transfer between Yb^{3+} and Er^{3+} or Tm^{3+} ions. Moreover, there is a chance for an energy transfer from the $^4I_{15/2}$ level of the Er^{3+} to the $^3H_5$ level of the Tm^{3+} to enhance the blue emission. Tunable color emissions of phosphors could be achieved by controlling the concentrations of the Er^{3+} and Yb^{3+} ions, or by tuning the pump power of the laser. The results indicate that the synthesized phosphors can be potentially applied to many devices, such as optical displays, lighting sources for light emitting diodes and lasers.

Keywords:
Sr_2CeO_4; Er^{3+}/Tm^{3+}/Yb^{3+} tri-doped; Up-conversion luminescence; White-light

Influence of sintering temperature on white upconversion emission in Er3+/Yb3+/Tm3+ tri-doped Y2O3 nanophosphors

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Abstract:

The $Er^{3+}/Yb^{3+}/Tm^{3+}$ tri-doped Y_2O_3 nanophosphors were synthesized by a solvothermal method and the temperature dependence of their white upconversion emission has been studied using a 975 nm laser diode. The white light consists of the blue, green, and red upconversion radiations corresponding to the transitions $^1G_4 \rightarrow {}^3H_6$ of Tm^{3+}, $^2H_{11/2}$, $^4S_{3/2} \rightarrow {}^4I_{15/2}$ of Er^{3+}, and $^4F_{9/2} \rightarrow {}^4I_{15/2}$ of Er^{3+} ions, respectively. The Y_2O_3:$Er^{3+}/Yb^{3+}/Tm^{3+}$ nanophosphors show upconversion emission ranging from white to green at power of 600 mW/cm^2 as the sintering temperature was increased. Their upconversion processes were explained by obtaining the upconversion luminescence spectra and pump power dependence.

Keywords:

White upconversion emission, Energy transfer, Nanophosphors

EPR and Optical Absorption Studies around Cu2+ ions in BaO-B2O3-CuO Glasses

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Abstract:
xBaO - B2O3 - yCuO glasses (x=BaO mol%/ B2O3 mol% and y=CuO mol%/B2O3 mol%) mixed with different ratio of BaO content (x=0.1~ 0.7) at constant ratio of CuO content (y=0.01 and 0.03) were prepared by conventional melt-quenching method in the temperature range 1000~1100℃ depending on the glass composition. The local structure around Cu2+ ions in the samples has been observed by means of electron paramagnetic resonance (EPR) and optical absorption experiments. The values of spin Hamiltonian parameters (SHP) show that the Cu2+ ions in these glasses exist in octahedral sites with tetragonal distortion [1]. Bonding parameters such as α^2, β^2, $\beta^2{}_1$, $\Gamma\sigma$ and Γ_π have been evaluated using EPR and optical absorption data[2]. By correlating SHPs and molecular bonding parameters, the structural modification of Cu2+ ion environment due to increasing the ratio of BaO content at constant CuO ratio was explained[3]. References 1. B.Vas. Veepa, J. Non-cryst. Solids, 355, 1663 (2009). 2. G. Upender, Ch. Vevi, V. Kamaraker, V. Mouli, J. Alloys and Compounds, 509, 5887 (2011). 3. S. Bale and S. Rahman, Physica B, 418, 52 (2013).

Keywords:
EPR, CuOglasses, bonding parameters

Fabrication of K^+ ion source

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Abstract:

The K^+ ion source was fabricated for a filament type ion gun. The ion sources was coated on the filament and the obtained maximum K^+ ion current was about 100 uA when the ion extraction voltage at 500V and the filament temperature was 1000 K. When the K^+ ion was emitted from the filament, the pressure in the chamber was ~10^{-9} torr. The intensity of the ion current was stable for longer than two hours with the fluctuation less then 5%. This ion source is effective for the electrostatic energy analyser of the Ion Scattering Spectroscopy (ISS) because of lower neutralization probability than He^+ .

Keywords:
K^+ ion source, filament type ion gun, ISS

Photocatalyst properties of $ZnSn(OH)_6$ and $ZnSnO_3$ nanoparticles obtained by facile reflux method

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Abstract:

In this work, we report the preparation of $ZnSnO_3$ (ZTO) catalyst for photocatalytic degradation of a methyl orange (MO) aqueous solution. The catalysts were synthesized via a facile reflux method approach using Zn $(CH_3COO)_2 \cdot 2H_2O$ and $SnCl_2$ as precursors, without the use of any template. As-synthesized $ZnSn(OH)_6$ (ZHS) cube catalyst was changed to ZTO by annealing at 600 °C for 3h. The catalysts were characterized by X-ray diffraction, Raman spectroscopy, scanning electron microscopy, UV-vis spectrometer and photoluminescence spectroscopy. The size of cube catalyst was changed from 200 nm, 300 nm and 500 nm by changing the pH value to 12.8, 12.7 and 12.6, respectively. Photocatalytic degradation of MO solution under UV-light (254 nm, 40 W) irradiation was monitored for up to 4 h duration. The photocatalytic degradation of ZTO cube catalyst was superior to that of ZHS cube. It is concluded that a higher photocatalytic activity was attributed to the efficient separation of electron-hole pairs in ZTO.

Keywords:
photocatalyst, ZTO, zinc tin oxide, ZHS, zinc tin hydroxide, zinc stannate, zinc hydroxystannate

Pulsed Wire Evaporation법을 이용한 core-shell Fe 나노 분말의 결정 구조 및 자기적 특성

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Abstract:

Fe 분말이나 페라이트로 이루어진 연자성 금속 합성체 (soft magnetic composite=SMC)는 전자기 및 통신 어플리케이션에 널리 적용돼 왔다. 특히 이 합성체는 칩 파워 인덕터와 같은 자기소자의 주요 원료로 활용돼 오고 있다. 하지만 높은 주파수에서 합성체의 와전류 손실 증가로 인해 성능이 저하되는 단점을 가지고 있다. 이를 개선하기 위해 비정질의 Fe 분말이나 Fe 나노 분말을 적용한 SMC가 제조되었으나 와전류 손실과 함께 자화값 역시도 감소하는 것으로 보고 되었다. 최근 고주파수 대역에서의 높은 성능 (높은 포화 자화값과 낮은 코어 손실)을 가진 SMC를 구현 하기 위해 Core-shell 구조의 Fe 나노 분말이 큰 관심을 끌고 있다 [1]. Core-shell Fe 나노 분말의 여러 합성법 중에서 pulsed wire evaporation (PWE) 법은 다른 합성방법들에 비해 적은 공정 단계와 높은 생산 효율을 가진 합성방법으로 알려져 있다 [2]. 우리는 PWE 법으로 합성한 Core-shell Fe 나노 분말의 물리적 특성에 대해 연구하였다. Ar과 O_2의 혼합 가스 분위기에서 PWE 공정을 진행하였으며, 합성된 분말은 XRD, SEM, TEM, VSM 측정을 통해 미시결정구조와 자기적 특성을 연구하였다. XRD 측정 결과, Fe 단일상을 가지는 것을 확인하였으며, Debye Scherrer 방정식을 이용하여 산출한 분말의 평균입경은 약 50nm이었다. SEM 측정 결과, 합성된 분말의 형태는 구형으로서 입경 분포가 20~200nm인 것을 확인하였다. TEM과 EDS 측정 결과, 합성된 나노 분말 표면에 4~5nm 균일한 두께의 Fe_3O_4 층 형성되어 있는 것을 확인 하였으며, 상온에서의 MH측정 결과 약 160emu/g의 포화 자화값을 가진 강자성을 나타냈다. [1] H. K. Kim and S. Y. An, J. Magn. 20, 138 (2015). [2] H. M. Lee, Y. R. Uhm, and C. K. Rhee, J. Alloys and Comp., 461, 604 (2008).

Keywords:
Soft magnetic composite; Pulsed Wire Evaporation; Core-shell Fe/Fe_3O_4 nano particle

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NIR-to-Visible upconversion in Er3+ and Yb3+ codoped SrLaMgTaO6

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Abstract:
Er3+, Yb3+ co-doped SrLaMgTaO6 phosphors have been successfully synthesized by solid state reaction method and their optical properties and mechanism were investigated in detail. Under 975 nm excitation, the SrLaMgTaO6:Er3+/Yb3+ phosphors have been emitted strong green luminescence centered at 525 nm and 545 nm and relatively weak red anti-stokes luminescence centered at 660 nm corresponding to the intra 4f transitions of Er3+ (2H11/2,4S3/2,4F9/2 → 4I15/2). Emission from the 2F5/2 → 2F7/2 by Yb3+ transition was also observed under 975 nm excitation to presence the energy transfer process from Yb3+ to Er3+. An enhancement of the red emission is observed.

Keywords:
Upconversion, SrLaMgTaO6, Energy transfer

SHP Investigation of Cu^{2+} ions in $Li_2O-B_2O_3-CuO$ Glasses

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Abstract:

The glasses $xLi_2O-B_2O_3-yCuO$ with x=0.1 and y=0.01-0.2(x=Li_2Omol%/B_2O_3mol% and y=CuOmol%/B_2O_3mol%) were prepared via melt-quenching technique using reagent grade Li_2CO_3, H_3BO_3 and CuO in suitable proportion. The room temperature EPR(Electron Paramagnetic Resonance) spectra were recorded in the X-band frequency(≈9.425GHz)with a field modulation of 100kHz. The EPR spectra of Cu^{2+} ions of the samples were analyzed by using an axial spin Hamiltonian and the spin Hamiltonian parameters (SHP) were evaluated. The observed values of $g_{\parallel}$ and $g_{\perp}$ are characteristic of Cu^{2+} ions coordinated by six oxygen ligands which form an octahedron elongated along the z-axis[1]. As $g_{\parallel} > g_{\perp} > g_e$, we consider that the ground state of the paramagnetic electrons is d_{x2-y2} orbital ($2B_{1g}$ state) and the Cu^{2+} ion is located in the distorted octahedral site(D_{4h})[2]. Increasing the ratio of CuO content at constant ratio of Li_2O, we observed the variation of SHPs in the glasses and discussed the result in the structural changes around Cu^{2+} ions in $Li_2O-B_2O_3-CuO$ glasses. References. 1. J. L. Rao, G. Sivaramaiah and N. O. Gogal, Physica B, 349, 206 (2004). 2. Ch. Rajyasree, P. M. Teja, K. V. R. Murthy and D. K. Rao, Physica B, 406, 4366(2011).

Keywords:
EPR CuO glasses

Control of oxygen octahedral tilt in $BiFeO_3/SrRuO_3$ heterostructures

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Abstract:

Design of oxygen octahedral tilting in oxide perovskite films is a key challenge which can lead us to emergent phenomena. Here we demonstrate that the octahedral tilting angle of BFO films can be controlled using an interfacial octahedral coupling with SRO bottom electrodes at a constant strain state in BFO films. BFO/tetragonal-SRO and BFO/monoclinic-SRO heterostructures were fabricated to $SrTiO_3$(001) substrates at different oxygen pressures using a pulsed laser deposition technique. Scanning transmission electron microscope analyses and x-ray scattering experiments using synchrotron facilities were conducted to quantitatively investigate the octahedral tilting angle as well as direction of BFO/SRO films. We found that the crystallographic structure of BFO layers is equivalent to that of SRO layers. At the room temperature, the positive piezoresponse of tetragonal BFO film is 1.6 times larger by than that of monoclinic BFO film while the saturation magnetization of tetragonal BFO film is 2.5 times smaller by than that of monoclinic BFO film.

Keywords:

ferroelectricity,weak ferromagnetism,strontium ruthenate,bismuth ferrite

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RF 스퍼터링을 이용한 RuO_2 박막의 제작과 증착온도에 따른 특성 분석

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Abstract:
루세륨 산화물 RuO_2는 흔히 루타일(Rutile) 구조라 부르는 정방정계(Tetragonal) 구조(a = 4.49 Å, c = 3.11 Å)를 갖는다 [1]. 단위 세포(Unit cell)의 중심에 있는 Ru 이온을 6개의 산소 이온들이 둘러 싸고 있는 형태를 취한다. 특징으로는 벌크 상태에서 낮은 비저항(35)을 가지고 있으며, 온도에 대한 안정성이 좋고 화학적 부식에 강하다 [2]. 또한 5.1 eV의 일함수(work function)을 가진다 [3]. 이러한 특성들로 인해 전극이나, 축전지(capacitor)에 응용 가능성이 있다. 이 실험에서는 RuO_2 타겟을 라디오파(Radio Frequency: RF) 스퍼터링(sputtering) 방식으로 에픽탁셜(epitaxial)하게 제작하여 그 특성을 알아보기 위해 증착 온도와 기판의 결정방향에 따른 물리적 특성 변화를 연구하였다. C-plane 사파이어(Al_2O_3) 위에 RuO_2 박막을 온도를 증가시키며 제작하였다. 이때, AFM(Atomic Force Microscopy) 를 통하여 표면의 거칠기(Roughness)를 측정하였고 증착 온도가 증가함에 따라서 박막 표면의 RMS 값이 점점 커지며 800 ℃ 에서 다시 낮은 값을 보였다. 또한 XRD(X-ray Diffraction) 측정을 통하여 C-plane 사파이어 기판 위에 RuO_2 박막이 (100)의 방향성분을 가지며 성장함을 알 수 있었다. 또한 RuO_2 피크 위치는 400 ℃에서 39.06 근처였으나 온도가 증가할 수록 각도가 증가하는 방향으로 움직였으며, 500 ℃ 이상에서는 40 부근에서 관측되었고 피크의 세기가 조금씩 줄어들다가 800 ℃ 에서 피크가 사라짐을 확인하였다. 상온에서 4 단자 측정법으로 비저항을 측정하였는데, 증착 온도가 증가함에 따라 비저항이 점점 감소하다가 550~600 ℃ 구간에서 가장 낮은 값을 가지며 이후 비저항이 다시 증가하였고 800 ℃ 에서 비저항이 부도체와 같이 측정이 불가능 하였다. 끝으로, 사파이어 기판의 결정 방향에 따른 RuO_2 박막의 표면특성, 결정성, 비저항 도 분석하였다. [1] C. A. Chen, Y. M. Chen, K. Y. Chen, J. K. Chi, Y. S. Huang, and D. S. Tsai, J. Alloys Compd., vol. 485, no. 1–2, pp. 524–528, 2009. [2] X. Fang and T. Kobayashi, Appl. Phys. A Mater. Sci. Process., vol. 69, no. 7, pp. 587–590, 1999. [3] M. Ť, A. Rosová, E. Dobro, V. Štrbík, Š. Gaži, K. Fröhlich, P. Benko, L. Harmatha, C. Manke, and P. K. Baumann, vol. 073702, pp. 1–12, 2008.

Keywords:
RuO_2; thin film;

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Ultrafast transient-photocarrier-induced saturable absorption behavior of topological insulator $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$

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Abstract:
Using optical-pump terahertz-probe spectroscopy, we investigated ultrafast photocarrier-induced saturable absorption behavior in the $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ (BSTS) single crystal which is one of the most bulk-insulating topological insulators. Overall, a relaxation time of the transient transmission spectrum is several times longer than that of Bi_2Se_3. Moreover, optical-pump-induced saturable absorption behavior occurs at the much lower fluence for BSTS that for Bi_2Se_3. Whereas two materials have different doping concentrations, i.e., ~ 10^{18} cm^{-3} and ~ 10^{20} cm^{-3} for BSTS and Bi_2Se_3, respectively, we consider possible contributions of the interband relaxation between the bulk and surface states as well as an Auger recombination process to understand such distinct photoexcitation and relaxation processes.

Keywords:
Optical pump terahertz probe, topological insulator

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DC 스퍼터링을 이용해 증착한 버퍼 전극층에 따른 PTC 써미스터의 전기적 특성

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Abstract:
Ag는 일반적으로 $BaTiO_3$ (BT)가 적용된 PTC 써미스터의 전극으로 후막 공정을 사용하여 형성되고 있다. 그러나, 후막 전극의 고온 열처리 공정으로 인해서 BT 쪽으로 Ag의 migration이 발생 및 접촉 저항의 특성 저하등이 보고되고 있다. 본 연구에서는 기존의 문제점을 개선하기 위하여 이종 전극 구조를 도입하여 BT 써미스터와 기존 후막 전극 사이에 buffer 전극을 삽입하였다. Buffer 전극은 dc 마그네트론 스퍼터를 이용한 Cu, Al, Ag 등을 증착하였다. buffer 전극 적용으로 breakdown voltage가 향상되었으며, 95% 이상의 접촉저항의 감소를 확인하였다.

Keywords:
PTC, thermistor, buffer, electrode, thin film

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Electronic structure study of WO3 using various soft X-ray spectroscopy

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Abstract:
Electronic structures of WO3 thin film have been studied using x-ray photoelectron spectroscopy (XPS), x-ray absorption spectroscopy (XAS), and x-ray emission spectroscopy (XES) in an attempt to understand the influence of growth conditions on the electrical properties. The influence of growth oxygen pressure on the metal-insulator transition (MIT) was investigated. It found that the conductivity of WO3 films increases remarkably with the increase of the growth oxygen pressure. The decreased oxygen vacancies induced by lower growth oxygen pressure, verified by XPS, XAS and XES.

Keywords:
WO_3, XPS, XAS, XES

Physical properties of half-metallic CrO2 thin films by chemical vapor deposition

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Abstract:

Differently oriented CrO_2 thin films on (111) Pt/TiO_2/SiO_2/Si and (200) Pt/TiO_2/SiO_2/Si substrates were grown using a CVD method. The deposition rate was 1000 Å measured by cross-section of SEM images. The CrO_2 thin films show (200) oriented growth on the (111) Pt/TiO_2/SiO_2/Si substrate and (110) oriented growth on the (200) Pt/TiO_2/SiO_2/Si substrate. The highly crystallized rectangular grains were observed by atomic force microscope. The refractive index and the extinction coefficient were obtained by data fitting of the spectroscopic ellipsometry. The ferromagnetic domains were observed by MFM and they showed in-plane magnetic polarization resulting from the orientation of the easy axis along the in-plane film direction.

Keywords:
film CrO2 thin

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Structural and optical properties of nanostructured V_2O_5 films grown by electrodeposition method

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Abstract:
Nanostructured vanadium pentoxide (V_2O_5) was prepared by electrodeposition on FTO-coated glass substrate from an aqueous solution of NH_4VO_3. The grown films were annealed with different temperatures during time from 1h to 8h in air ambient. The structural, morphological properties of deposited V_2O_5 films were investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM) and Raman spectroscopy. Our results indicate that the annealing temperature and annealing time affect to the structure of films and V_2O_5 nanorods observed when annealed at 500°C for 3h. The photoluminescence (PL) intensity of the nanostructured V_2O_5 films also shows a dependence on annealing temperature.

Keywords:
Vanadium pentoxide, Electrodeposition, Photoluminescence. Nanorods and nanowires

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An in situ study of thermal oxidation process of vanadium thin films with ambient pressure X-ray photoelectron spectroscopy

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Abstract:

In this study, the thermal oxidation process of vanadium thin films is monitored with in situ ambient pressure X-ray photoemission spectroscopy (AP-XPS). As the surface temperature and oxygen pressure of vanadium thin films change, various oxidation states of vanadium, including VO_2, V_6O_{13}, and V_2O_5, are formed on the surface. AP-XPS spectra for 5 nm vanadium thin film show that VO_2 component grows maximally at 200 mTorr oxygen pressure. Especially, as the surface temperature increase from room temperature to 200 °C under oxygen pressure of 200 mTorr, V_6O_{13} is developed while V_2O_5 is reduced significantly. Also, as the oxygen pressure increases to 400 mTorr, the spectra of 20 nm vanadium thin film show the reduction of VO_2 and the formation of V_2O_5 at 250 °C. In addition, Raman spectroscopy measurement, a more bulk sensitive analytic tool than XPS, is conducted to confirm the static oxidation states of both films, consistent with the results of depth profiling measurement using in situ AP-XPS. The ex situ temperature-dependent resistivity measurements on the grown films exhibit very weak metal-insulator transition only for 20nm film, indicating the presence of metallic layer under the film. Our results give spectroscopic information about oxidation states of vanadium films for the study of intrinsic properties of vanadium oxides and their industrial applications.

Keywords:

Vanadium oxides, Ambient pressure X-ray photoelectron spectroscopy (AP-XPS), Raman spectroscopy

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단결정 구리 박막의 열처리를 통한 CuO, Cu_2O 제작 및 광촉매 응용

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Abstract:

RF sputtering 방식을 통해 박막을 제작할 때, 단결정 구리 타겟을 사용하면 기판에 성장되는 (111) 방향으로 성장되는 구리 박막의 결정성을 현격히 높이며 다양한 목적에 응용할 수 있다. [Ref.1, 2] 이러한 방식으로 제작된 Cu (111) 박막 표면에는 자연산화막인 CuO(111) 층이 최대 2nm 정도 존재하여 기존의 구리박막에서보다 산화에 대한 안정성이 높다. 대기와 유사한 분위기를 갖는 전기로의 온도를 150~170 ℃ 혹은 180~200 ℃로 조절하여 각각 단결정 구리박막을 열처리하면 Cu_2O 또는 CuO를 얻을 수 있다. 결함이 많은 구리박막을 위와 같은 조건에서 열처리를 할 경우, 많은 그래인들이 형성되고 박막의 품질이 나빠지며 기판과의 접착력이 감소함에 따라 더 이상 박막으로 존재하지 않게 되기도 한다. 열처리를 통하여 생성된 CuO는 (11-1), Cu_2O는 (111)의 방향성을 나타내고, 단결정 구리박막의 초기에 존재하던 CuO(111) 층은 그대로 존재한다. 본 연구를 통해 단결정 구리박막을 통해 제작한 Cu_2O, CuO 박막에 대한 특성을 분석하고, CO_2 를 CO로 환원시키기 위한 광촉매제에 대한 응용 가능성을 보이고자 한다.

Keywords:
단결정 구리박막, CuO,Cu_2O, 광촉매제

물 위를 구르는 물방울에 관한 연구

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Abstract:
물 위에 물방울을 떨어뜨리게 되면 물과 바로 합쳐지지 않고 때로 물방울이 물 표면을 따라 구르는 현상이 나타난다. 본 연구에서는 물 표면을 따라 물방울이 구르는 현상을 고속카메라로 촬영하였다. 이때 고속카메라는 물 표면의 상단과 측면에 각각 설치되었고, 조명장치는 물이 들어있는 수조 하단에 설치되었다. 고속 촬영된 이미지를 통해 물방울의 이동경로, 속도 및 크기변화를 시간의 함수로 분석하여 물과 물방울 사이의 운동 마찰력을 정밀하게 구하였다. 본 연구는 물방울이 물 위에서 구를 수 있는 운동을 해석하고 원인을 도출하기 위한 실험이다. 이를 위해 물에서 뿐만 아니라 기름, 에탄올, 글리세린 등 다양한 액체에서도 운동 마찰력을 구하는 실험을 계속할 계획이다.

Keywords:
물방울, 물 표면, 운동 마찰력

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Terahertz Detection of Coherent Spin Precession in $YMn_xFe_{1-x}O_3$

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Abstract:
We observed coherent spin precession in canted antiferromagnetic $YMn_xFe_{1-x}O_3$ (x=0 - 0.45) by using terahertz time-domain spectroscopy. Both the quasi-ferromagnetic resonance mode (qFMR) and the quasi-antiferromagnetic resonance mode (qAFMR) were detected at 0.299 and 0.527 THz, respectively, in $YFeO_3$. In $YMn_{0.1}Fe_{0.9}O_3$, the spin precession signal of the weak ferromagnetic moment of along the c axis disappears below 100K, signaling the spin reorientation transition from the Γ_4 weak ferromagnetic phase to the Γ_2 antiferromagnetic phase.

Keywords:
Terhertz, spin precession, antiferromagnetic, $YFeO_3$, spin reorientation transition

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Direct measurement of the Dzyaloshinskii-Moriya interaction in orthorferrite $YFeO_3$ using terahertz time domain spectroscopy

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Abstract:

Dzyaloshinskii-Moriya (DM) interaction energy in orthorferrite $YFeO_3$ has been measured by using terahertz time domain spectroscopy. Here, two resonant modes (quasi-antiferromagnetic mode and quasi-ferromagnetic, QFMR mode) are described as symmetric and asymmetric precessional motion of sub-lattices, s_1 and s_2. The latter is shown as the elliptical precession of the weak magnetization, m= $(s_1+s_2)/2$, which is ascribed to DM torque. Thus, by measuring the trajectories of m, we succeeded in estimating DM interaction energy. Finally, we deduced the sub-lattice dynamics from m, together with exchange and anisotropy energies. Analytical calculation for QFMR agrees well with experimental results.

Keywords:

Dzyaloshinskii-Moriya orthorferrite YFeO3

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2016.10.19 - 2016.10.21

Tuning Optical Band-gap by Electrochemical Reduction in TiO_2 Nanorods for Improving Photocatalytic Activities

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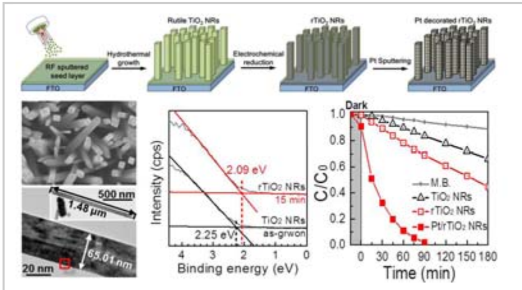

Abstract:

We investigate an electrochemical method to tune optical band gap of TiO_2 nanorods (TiO_2 NRs) to be narrow for improving its photocatalytic activities. A seed layer prepared by RF-sputtering method is employed to increase the adhesion between TiO_2 NRs and substrate to prevent the peel-off of TiO_2 NRs from substrate during electrochemical reduction process. The morphological study shows TiO_2 NRs structure is stable reduction process. The amount of Ti^{3+} (a reduced state of Ti^{4+}) and oxygen vacancy after electrochemical reduction process are found to be increased to 9.4 % and 24.3 %, respectively. Also, the optical band gap is tuned from 3.0 eV (rutile TiO_2 NRs) to 2.84 eV (after reduction) due to the shift-up of valence band to Fermi level. The tuning optical band gap of TiO_2 NRs to be narrow give strongly effect to increase photocatalytic activities of sample due to the longer range of photon absorbance for more easily separate photo-excited electron-hole pairs

Keywords:
TiO_2 Nanotube, Electrochemical Reduction, Photocatalytic

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Femtosecond laser-induced confined ablation on SiO_2/Si interface with embedded Au – Ag nanoparticles

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Abstract:

We present the plasmonic laser ablation of crystalline silicon (c-Si) in a confined medium using single 40 femtosecond laser pulses. A composite material consists of 10 μm thick layer of SiO_2 capping c-Si and embedded with gold (Au) and silver (Ag) nanoparticles on the interface was used a target. A mixture of Au-Ag nanoparticles was used as doping material to benefit from plasmonic effect by enhancement of field intensity. The near field properties for the system consisting of Au-Ag nanoparticle deposited on the silicon substrates and irradiated by 800 nm wavelength of interest, were also investigated using Finite Difference Time Domain Simulation (FDTD) technique. The results reveal that the field on the substrate surface is enhanced dramatically. The theoretical prediction of the field enhancement on the substrate is confirmed experimentally. Micro-Raman spectroscopy, micro-photolumiouscence spectroscopy along with transmission electron microscopy (TEM) were used to investigate structural modification at the sites of laser induced damage. Analysis revealed presence of laser-modified volume at the interface with dramatically different feature if compared to pristine region. In addition, similar irradiation condition results for SiO_2/Si without Au-Ag nanoparticles was also used as a reference.

Keywords:

SiO2/Si, embedded Au-Ag NPs, femtosecond laser, confined ablation

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Synthesis and photoluminescence properties of yellow-emitting $Ca_5(Zn_{1-x}Mg_x)_4(VO_4)_6$ self-activated phosphors

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Abstract:
Over the past few years, vanadate based materials have received a great deal of attention in developing the novel solid-state lighting based devices due to their ease of availability, low-cost, enhanced chromaticity, and lower sintering temperatures. Additionally, these compounds exhibit a broadband emission spectrum that covers the entire visible region between 400 and 700 nm, which is useful to obtain a high color-rendering index compared with the conventional phosphors. Therefore, a self-activated vanadate material with a proper composition is essential for synthesizing the white-light emitting phosphors and their utilization in the fabrication of WLEDs. Some of the available vanadate phosphors are $Sr_2V_2O_7{:}Eu^{3+}$, $Ba_3V_2O_8$, $K_3Y(VO_4)_2$, $Ca_5Zn_{3.92}In_{0.08}(V_{0.09}Ta_{0.01}O_4)_6$. Herein, A novel yellow-emitting $Ca_5(Zn_{1-x}Mg_x)_4(VO_4)_6$ self-activated phosphors were prepared by a citrate sol-gel method. The x-ray diffraction patterns confirmed their cubic garnet structure. The photoluminescence excitation spectra of $Ca_5(Zn_{1-x}Mg_x)_4(VO_4)_6$ phosphors exhibited a broadband excitation ranging from 250 to 430 nm, which is due to the charge transfer transition of $[VO_4]^{3-}$ group. The photoluminescence emission spectra of $Ca_5Zn_4(VO_4)_6$ and $Ca_5Mg_4(VO_4)$ phosphors exhibited the characteristic broadband emissions from 420 to 750 nm with the band maxima at 538 and 533 nm, respectively. The calculated CIE chromaticities were found to be in the greenish-yellow region with the coordinates (0.331, 0.476) and (0.318, 0.463) for $Ca_5Zn_4(VO_4)_6$ and $Ca_5Mg_4(VO_4)_6$ yellow phosphors, respectively. The obtained results suggested that these luminescent powders might be good candidates for their potential applications in the development of rare-earth free WLEDs.

Keywords:
$Ca_5(Zn_{1-x}Mg_x)_4(VO_4)_6$Self-activated phosphorsWhite LED

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Demonstration of intraband optical signal-to-noise ratio monitor with freedom from the simultaneous impacts of polarization mode dispersion and polarization extinction ratio of polarization beam splitter

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Abstract:
An intraband optical signal-to-noise ratio (OSNR) monitoring method free from the influences of both polarization mode dispersion (PMD) and polarization extinction ratio of polarization beam splitter based on improved principal-states-of-polarization (PSP) tracking is proposed and demonstrated theoretically and experimentally. The future dynamically reconfigurable wavelength-division-multiplexed optical network needs per-channel OSNR monitors because different wavelength signals experience different paths that may consist of different number of optical amplifiers. The previous OSNR methods have shown disadvantages in dealing with effects of PMD and polarization extinction ratio of a polarization beam splitter. To solve this problem, a per-channel OSNR monitoring method assisted by enhanced PSP tracking is proposed and demonstrated to suppress those deleterious impacts. The experimental results show that regardless of polarization extinction ratio of a polarization beam splitter and differential group delay, the OSNR measured by the proposed method, within an error of less than 1 dB, shows good agreement with the reference OSNR by an optical spectrum analyzer, while the previous method shows large errors.

Keywords:
optical signal-to-noise ratio, polarization mode dispersion, polarization extinction ratio

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Investigation of Influence of optical fiber amplifier noise on principal-states-of-polarization tracing in optical fiber link and its mitigation

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Abstract:
It is demonstrated through theoretical simulation and experiment that tracking and separation of principal states of polarization, induced in optical fiber link due to polarization mode dispersion, via polarization beam splitter are affected by amplified spontaneous emission noise generated by optical fiber amplifier, thus leading to incomplete separation of principal states of polarization and resulting in incomplete compensation and degradation of signal quality when applied to polarization mode dispersion compensator which is required in high-speed optical transmission systems. The results show that as the optical amplifier noise becomes larger, extent of separation of principal states of polarization becomes worse. In order to mitigate the injurious effect, a method of using two polarization beam splitter outputs is proposed and its operating principle is demonstrated. The results show that the method provides exact tracing and separation of principal states of polarization irrespective of noise of optical fiber amplifier.

Keywords:
principal states of polarization, optical fiber amplifier noise, polarization mode dispersion

Analysis of optical properties of Al wire grid polarizers using oblique angle deposition.

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Abstract:

Wire Grid Polarizers (WGPs) have 1D subwavelength nanostructures, which transmit transverse magnetic (TM) waves and reflect transverse electric (TE) waves [1]. WGPs as polarization separation devices are widely used in a broad range of optical system, such as flat panel display, micro display, and optical networking [2]. WGPs require high polarization efficiency (it is indicated as polarization extinction ratio (PER = T_TM/T_TE)), wide viewing angle, and long-term stability [2, 3]. It is well-known that it is difficult to make WGPs in large size and the fabrication processes (e.g. E-beam lithography) are expensive [2]. Nanoimprint lithography (NIL) and oblique angle deposition (OAD) have been employed for large area Al nanoWGPs [2,3,4,5]. The OAD method can control nanostructures of a film into tilted pillars, zigzag pillars, or helical structures due to a self-shadowing effect and surface diffusion during the deposition process. When a subwavelength nano pattern of polymer from NIL is coated with Al by OAD as shown Fig. 1, the vapor direction of Al can determine the distribution of Al coating: the width (w), height (h), and thickness (t) of Al coating can be changed and then the optical properties of WGPs can be varied. In this study, we investigate the relationship of the distribution of Al coating with the optical properties of WGPs. We simulate various Al structures deposited on polymer ridges using the finite-difference time-domain (FDTD) method and analyze the optical properties in visible wavelength regime (380 - 780 nm). The results show that the highest PER of 400,000 is obtained at w=50nm, h=150nm, and t=0: Al is coated only on top of the ridge. The analysis method and results in this study will be helpful to fabricate high-quality of OAD nanoWGPs in large size. (1) Kuo H L, et al, "A novel wire grid polarizer", SID 04 Digest 732–5 (2004) (2) Lei Chen. et al, "Large flexible nanowire grid visible polarizer made by nanoimprint lithography ", Applied Physics Letters (90) (2007) (3) Ahn S.W, et al, "Fabricationofa50nmhalf-pitchwiregrid polarizer using nanoimprint lithography" Nanotechnology 16, 1874-1877 (2005) (4) M. P. C. Watts ; M. Little ; E. Egan ; A. Hochbaum ; C. Johns, et al. " Wire grid polarizers fabricated by low angle deposition ", Advanced Fabrication Technologies for Micro/Nano Optics and Photonics VI, 86130E (2013) (5) Wang J J, et al, "High-performance nanowire-grid polarizers" Optics Letters. (30) 195 (1995) (6) K.M.A. Sobahan et al. 'Nanostructured porous SiO2 films for antireflection coatings ', Optics Communications(284) 873–876, (2011)

Keywords:
WGP, polarizer, nano pattern, grating, oblique angle deposition,

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IEC 60627 3rd Edition에 기반한 산란 X선 제거용 그리드의 성능 예측 연구

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Abstract:

산란 X선 제거용 그리드(Anti-scatter Grid, 이하 그리드)는 X선 영상 장비의 주요 구성품으로, X선 영상 검사에서 환자 또는 물체를 투과하며 발생하는 산란 X선을 제거해 화질을 향상시키는 역할을 한다. 일반적으로 X선 촬영 조건, 촬영 거리, 검출기의 화소크기, 피사체의 두께 등 촬영 환경에 따라 각기 다른 그리드를 사용한다. 그러나 제작 및 실험을 통해 다양한 X선 영상 장비에 적합한 그리드를 선정하여 사용하는 것은 많은 시간, 비용, 공간을 필요로 한다. 따라서 다양한 사양의 그리드의 성능을 선행하여 예측하고 이를 바탕으로 각각의 X선 영상 장비에 적합한 그리드를 사용하는 것이 효율적이다. 본 연구에서는 IEC 60627 3rd Edition 기반으로 그리드의 성능을 측정할 수 있는 IEC Test Fixture를 제작하였으며, Monte Calro 기법을 이용하여 그리드와 사용 환경을 전산모사해 성능을 예측하는 프로그램을 제작하였다. 또한 제작한 IEC Test Fixture와 개발한 프로그램을 통하여 그리드 성능 중 Transmission of primary radiation (Tp), Transmission of total radiation(Tt), Transmission of scatter radiation (Ts), Grid exposure factor(B), Grid Selectivity(Σ), Contrast improvement ratio(K), Image improvement factor (Q) 성능값을 측정 또는 예측하였으며 이를 비교하여 개발 프로그램의 유효성을 검증하였다.

Keywords:
산란 X선 제거용 그리드, IEC 60627 3rd Edition, Monte Carlo, 그리드 성능

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Wide-Range Complex Conductivity of Free-Standing DNA Slab Obtained via Kramers-Kronig Analysis

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Abstract:
We obtained the phase information of a free-standing DNA slab by Kramers-Kronig analysis from the far infrared transmission. We determined a linear compensation to match the terahertz phase and extracted the complex transmission ranging from 0.5 meV to 6 eV. We also analyzed the complex conductivity through non-linear fitting. Consequently, even when the finite-range phase information is given, we can retrieve the complex conductivity from the experimental transmission alone via Kramers-Kronig analysis.

Keywords:
conductivity, DNA, Kramers-Kronig

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Study of microbial battery on carbon nanomaterials for high efficient organic semiconductor devices

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Abstract:
In this study, we are developing a new type self-sustainable, large area and flexible organic semiconductor device through bio and material electronics for applying organic semiconductors. It is capable of extracting a highly efficient microbial energy using carbon nanotube and graphene materials. firstly, we prepare graphene layer and carbon nanotube integrated hydrogel cell patch for harvesting microbial energy. Using the carbon nano material, we study the electron transport for development of high efficient microbial energy device to use it as high efficient organic semiconductor devices

Keywords:
Microbial energy, Carbon Nano Tube, Graphene, Energy harvesting, orgranic semiconductor device,

멜라닌 나노 입자로 구현한 구조 색

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Abstract:
까치 깃털을 자세히 보면 보는 방향에 따라 검정 색, 푸른 색, 녹색 등 여러 가지 색을 띠는 것을 관찰할 수 있다. 이는 멜라닌 입자들이 균일하게 배열되어 나타나는 현상으로, 자연에서 존재하는 나노구조에 의한 구조색의 하나의 예이다. 까치의 꼬리에 존재하는 균일한 크기를 가진 멜라닌 나노 입자들이 주기적으로 배열 되어 있어 빛을 받을 때 마다 회절, 간섭, 산란의 현상을 일으켜 그 결과 멜라닌 나노 입자가 가지고 있는 구조 색을 띠는 것이라 할 수 있다. 본 연구에서는 여기에서 영감을 얻어 화학적 방법으로 멜라닌 나노입자를 합성하고 이를 주기적으로 배열함으로써 전술한 까치날개의 구조색을 재현하였다. 이 구조의 물리적 특성은 반사율 측정과 같은 광학적 방법으로 확인하였다.

Keywords:
구조색, 광자결정, 멜라닌

유연성을 지닌 실크 단백질 기반 3차원 광자결정

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Abstract:
나노광학 구조는 빛을 나노수준에서 컨트롤할 수 있다는 장점으로 바이오 분야에서도 널리 적용되고 있다. 특히 최근 인체에 집적한 바이오 센서의 개발이 각광을 받고 있으며, 이는 소재 측면에서 실크 단백질과 같은 바이오 고분자의 활용을 요구한다. 또한 굴곡진 인체조직 환경에서 안정적으로 구동이 가능하기 위해서는 소자의 유연성을 필요로 한다. 본 연구에서는 실크단백질을 photo-crosslinking 시키면 유연성이 증가된다는 사실을 바탕으로 유연성을 지닌 실크단백질 기반의 3차원 광자결정 구조를 제작하였다. 실크 3차원 광자결정의 구조를 전자현미경과 FT-IR 분석을 통해 확인하였고, 이들 구조에 백색광원을 입사시켜 샘플에 의해 반사된 신호를 분광학적으로 분석하여 반사율 스펙트럼을 얻었으며 3차원 광자결정의 밴드갭에 의한 특정 파장에서의 강한 반사효과를 측정으로 확인하였다. 이들 구조는 물에 넣었을 때 물을 흡수하여 수화젤 형태가 되며, 부피의 팽창과 물의 굴절률로 인해 밴드갭의 위치가 장파장으로 이동하게 된다. 이 수화젤 형태의 실크 광자 결정은 유연성을 보이며, 외부의 늘림에 따라 밴드갭 대응 파장이 단파장으로 이동하는 것을 확인하였다. 또한 이 구조에 레이저 빛을 입사시켰을 때 반사되는 빛을 직접 확인할 수 있으며 반사효과를 간접적으로 측정하여 정량화할 수 있었고, 이 소자가 좋은 반사체가 될 수 있음을 증명하였다.

Keywords:
실크 단백질, 광자결정, 유연성

임피던스 분석을 통한 유기 발광 소자의 전기적 광학적 특성 연구

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Abstract:
유기 발광 소자(OLED)는 직류 구동하에 동작하는 것으로 알려져 있다. 최근에는 소자 내부 전하의 분포를 확인하기 위해 교류 구동 OLED에 관한 연구가 진행 중이다. OLED의 발광 현상을 정확히 분석하기 위해서는 내부 전하의 거동에 대한 정확한 이해가 필요하다. OLED의 구동 과정에서의 특성 시간은 네 개의 종류로 정의된다. 그것은 수송 시간, 재결합 시간, trapping 시간, 그리고 AC(alternating current) 특성 시간이다. 본 연구에서는 네 종류의 소자를 Impedance spectroscopy를 사용하여 발광 및 임피던스 특성을 관찰하였다. 네 종류의 소자는 ITO(170 nm)/ TPD(40 nm)/Alq_3(60 nm)/Al(100 nm)를 기본 구조로 제작하였다. 여기서 ITO와 Al은 Anode와 Cathode로, TPD와 Alq_3는 HTL(Hole-Transport Layer)과 EML(Emission Layer)로 사용된다. 이 기본 구조의 소자를 포함하여 MoO_3(1 nm)를 EBL(Electron-Blocking Layer)로, MoO_3(15 nm)를 HIL(Hole-Injection Layer)로, Liq(2 nm)를 EIL(Electron Injection Layer)로 각각 추가하여 소자를 제작하였다. Impedance Spectroscopy로 측정한 Impedance와 Capacitance를 통해 각 소자의 특성 시간을 확인하고 전자와 양공의 거동을 분석하였다. 또한 DC 구동하의 I-V-L 특성을 통하여 각 소자의 특성을 비교하였다.

Keywords:
Impedance Spectroscopy, AC characteristic time, OLEDs.

F-SAM 물질의 알킬 체인 길이 변화에 따른 유기 발광 소자의 전기적 광학적 효율 향상에 관한 연구

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Abstract:
유기 발광 소자는 양전극, 음전극 사이에 다층의 유기층 구조로 제작된 발광 소자이다. 백라이트유닛 없이 자체 발광이 가능하고 빠른 응답속도와 넓은 시야각 등의 장점으로 차세대 디스플레이 기술로 주목받고 있다. 유기 발광 소자의 여러 장점 때문에 디스플레이 산업에서 다양한 응용이 가능함에 따라 주요 기술로 발전하고 있다. 하지만 효율이 낮은 단점 때문에 다양한 개선 방법이 연구되고 있다. 이에 대한 방안 중 하나는 전기 쌍극자 모멘트가 큰 물질을 사용하여 유기 발광 소자의 효율 개선을 들 수 있다. 본 실험에서는 플루오린(F)과 결합한 분자를 작용기로 갖는 물질을 ITO/Glass 기판 위에 플루오린-자가 조립 단막층 (Fluorinated-self assembled monolayer ; F-SAM)을 형성하였다. 분자의 작용기는 $-CF_3$ 로서 탄소(C)와 플루오린(F) 간의 전기 음성도 차이가 크기 때문에 $-CF_3$ 는 매우 큰 쌍극자 모멘트를 갖는다. F-SAM을 양공 주입층에 적용하게 될 때 ITO와 양공 수송층 사이의 에너지 장벽 높이를 조절하여 향상된 전류 밀도와 휘도 그리고 낮아진 구동 전압을 확인하였다. F-SAM 박막은 전기 오븐에 148℃에서 2시간 동안 가수 분해와 탈수 분해를 통해 박막을 제작하였다. SAM 방법은 복잡하지 않고 물리적 결합 없이 박막을 형성할 수 있기 때문에 매우 간단하고 효율적인 박막 형성 방법이다. 알킬 체인 길이가 다른 F-SAM 물질을 이용하여 쌍극자 모멘트가 큰 물질이 소자에 미치는 영향과 물질간의 알킬 체인 길이 변화에 따른 소자 특성 변화를 확인하였다.

Keywords:
Self Assembled Monolayer, Dipole moment, -CF3

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Full Color Chemiluminescence Performance using Functional Organic Materials

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Abstract:
기능성 유기물 기반으로 다양한 색과 효율을 보이는 화학발광 (Chemiluminescence)의 특성을 연구하였다. 다양한 유기반도체의 반응 조건 및 성분 비율에 따라서 Chemiluminescence의 발광 시간 및 색의 변화를 관찰하였다, 또한, Chemiluminescence의 반응 속도를 조절하여 빛이 나오기 시작한 후 발광 시간을 호기기적으로 조절하여 상당히 긴 시간동안 발광이 유지되도록 하였다. 이 때, 색 및 발광 효율과 반응 속도에 따라 발광 Life time의 변화를 연구하였다. 정밀한 실험 조건을 변경 함으로써 반응 속도를 천천히 만들어 Life time을 최대 100배 증가 시킬 수 있음을 확인하였다. 최종적으로 기능성 유기물의 비율과 효율을 조절하여 일정한 비율에 따라 백색광의 Chemiluminescence가 가능함을 확인하였다.

Keywords:
chemiluminescence, full color, functional organic materials, white color emission

Optical Property of Water based Salmon Double Strand and single strand DNA thin film

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Abstract:

This study is designed to present the optical property difference in UV-Visble and Mid Infrared between Double strand DNA and single strand DNA in terms of thin film. There are a several known DNA denaturation methods such as heating, Mixing chemical substance, Sonication. Salmon DNA solution is prepared by melting its Solid DNA and NaoH is used for denaturation. DNA denaturation can be proved by DNA absorption peak increase in 260nm. Prepared DNA solution denaturation is checked by 260nm absorption. Single strand thin film is made by evaporation DNA liquid in Teflon beaker in heater and spin coating on wafer such as quartz. This study will compare UV-Visble absorption spectrum, refractive index and Mid-infrared absorption spectrum for Double-single strand DNA thin film.

Keywords:
DNA denaturation

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Interfacial electronic structure study of CuPc/C_{60}/potassium-doped MoO_3 using x-ray and ultraviolet photoemission spectroscopy.

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Abstract:

The interfacial electronic structure of a bilayer of copper phthalocyanine (CuPc) and fullerene (C_60) grown on potassium-doped MoO_3 substrates has been evaluated by X-ray and ultraviolet photoemission spectroscopy. The work function was measured as a function of potassium-doping rate and the energy difference between the highest occupied molecular orbital (HOMO) level of the CuPc layer and the lowest unoccupied molecular orbital (LUMO) level of the C_{60} layer ($E^{D}_{HOMO} - E^{A}_{LUMO}$) was determined and compared to that grown on undoped MoO_3 substrate. This result is discussed in terms of the differences of the work function and resistivity of each substrate. We also obtained complete energy level diagrams of them.

Keywords:
MoO_3, CuPc, C_{60}, Band diagram, XPS, UPS

Simple model based kinetic study of G quadruplex formation using fluorescence correalation spectroscopy

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Abstract:
The dynamics of G-quadruplex formation, including diffusional properties, are of interest owing to their roles in telomere protection and gene expression regulation. Translational diffusion times of single-stranded DNA (ssDNA) and G-quadruplexes were studied to determine the persistence length and cooperativity of G-quadruplex formation using a wormlike chain (WLC)-based Monte Carlo simulation implemented in HYDRO. In KCl, the telomeric sequence HT72 underwent 27 intermediate states, which can be classified as ssDNA, single-G-quadruplex, double-G-quadruplex, and three consecutive G-quadruplexes. Each state type was modeled using a series of beads and appropriate bond lengths, which were obtained from the WLC model. Using the HYDRO program, we calculated diffusion times for each species, and these were used to calculate simulated HT72 diffusion times for mixtures of species in arbitrary KCl concentrations. We obtained a positive cooperativity of C=200 in the comparison between simulated and experimental diffusion times

Keywords:
fluorescence correlation spectroscopy, Wormlike chain model, MonteCarlo simulation

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형광 비드를 이용한 형광의 편광 상태에 따른 형광상관함수의 분석

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Abstract:
형광상관분광법은 형광입자가 방출하는 형광 신호의 시간 경과에 따른 변화 상태를 분석하는 기술로 고정 또는 유동 형광 입자에 대해서 방출되는 형광의 세기를 상관함수 형태로 변환함으로써 수 마이크로 미터 이하의 크기를 가지는 입자들의 물리적인 특성을 분석하는 데 활용되고 있다. 본 연구에서는 형광상관분광법을 통해 형광비드에서 방출되는 형광을 서로 수직한 두 편광상태로 분리하여 분석함으로써 입자의 역학적·광화학적 특성들을 확인하였다. 광원으로는 532 nm인 DPSS 레이저와 632.8 nm인 He-Ne 레이저를 사용하였고, 크기가 20 nm이고 두 광원에 대해 독립적으로 여기되는 Invitrogen 사의 형광 비드 F8782와 F8784들의 형광에 대한 상관함수를 분석하였다. 파장 차이로 인해 입자들에 적용되는 관측 영역이 차이를 가졌지만, 수십 나노미터 수준에서 측정되는 상관함수를 비교한 결과 동일한 회전확산 시간을 가지는 것이 확인되었다. 본 결과를 통해 편광을 활용한 형광상관분광법이 광원의 파장에 무관하게 입자의 특성을 분석하는데 활용될 수 있음을 확인하였다.

Keywords:
형광상관분광법, 편광분석, 형광비드

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Analysis of interaction of G-quadruplex using Fluoresceon Correlation Spectroscopy

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Abstract:

Human telomeric DNA sequence의 경우 높은 이온농도, molecular crowding condition 등의 환경 하에서 G-quadruplex structure를 형성한다는 것이 알려져 왔다. 세포분열 도중 실제로 세포 내부에 G-quadruplex structure가 존재한다는 것이 확인 된 이후 세포 수명 조절 및 암세포 진단 등의 응용을 위한 G-quadruplex의 성질에 대한 연구에 박차를 가하게 되었다. 본 연구에서는 FCS system을 이용하여 solution 상에서 G-quadruplex와 결합하는 물질들과의 상호작용에 대해 분석하였다. Human telomeric DNA sequence에 tetramethylrhodamine (TAMRA) dye를 tagging 하여 non fluorescence molecule 과 G-quadruplex의 결합여부에 따른 diffusion 및 photochemical properties의 변화를 관측하였으며, TAMRA가 tagging 되지 않은 DNA 와 prove fluorophore와의 반응성을 확인하기 위해 DNA 유무에 따른 fluorophore의 diffusion 및 광화학적 성질변화를 확인하였다.

Keywords:
human telomeric DNA, fluorescence correlation spectroscopy

Variation of clearance limits in Gamma Knife treatment planning

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Abstract:
In Gamma Knife treatment planning, defining the coordinate frame configuration allows treatment position to be extended. The clearance can be calculated with geometry of skull, coordinate frame, posts and screws. The Gamma Knife treatment planning application limits two clearances composed of that from coordinate frame assembly and from patient's head. Although the height of the four corner posts of Leksell coordinate frame is defined as the perpendicular distance along the Z-axis, the posts are in practice tilted to exterior of stereotactic space. The clearance limits should be modulated in consideration of tilted post for extreme shot position.

Keywords:
GK treatment planning

Resonance Modal Analysis for Cylindrical Shells with an Obliquely Incident Ultrasonic Wave

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Abstract:
The resonance scattering of a shell by obliquely incident plane wave is studied. Scattering matrix elements for a cylindrical shell immersed in a fluid are calculated, and the inherent background coefficient is introduced to isolate resonance. To make investigate the relation between helical and meridional waves, resonance spectra as a function of frequency and aspect angle is researched theoretically. For the verification of numerical results, the backscattered spectral magnitude according to the incident angle is measured using the quasi-harmonic MIIR to improve the frequency resolution.

Keywords:
Resonance

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Selective detection of Escherichia coli and Salmonella through immobilizing aptamers on capacitance sensor.

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Abstract:
Capacitance is one of indicators which can inform amount of biotic object in real-time detection. However, it is difficult to procure selective and sensitive detecting. Here we report capacitance-based bacterial sensor being able to detect specific bacteria in high sensitivity. Covalently immobilized anti-E.coli or anti-salmonella aptamers on SiO_2 surface between 30 μm inter-digited gold electrodes, we assured selective and sensitive performance of the sensor. When salmonella added into a sensor with anti-E.coli aptamer, the change of capacitance was relatively small. It is because salmonella showed difficulty to proliferate. On the other hand, when E.coli added into the same sensor, we could observe the change of capacitance. Due to specific binding of anti-E.coli aptamers with E.coli, E.coli could proliferate and this made the change in dielectric constant which induced the change of capacitance. This novel capacitance biosensor can apply to water-quality monitoring and clinical diagnosis with high selectivity as low as 10^2 CFU/ml of target bacteria.

Keywords:
Capacitance-based bacterial sensor, Escherichia coli, Salmonella

Vertical capacitance sensor for monitoring bacterial growth and detecting antibiotic susceptivility

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Abstract:

We have developed vertical capacitance sensor to monitor bacterial growth in blood. Bacteria may be regarded as dielectric particles, so bacterial growth is expected to be monitored in real-time by measuring the capacitance change. However, in the case of horizontal capacitance sensor, electrodes are usually covered by various proteins and biomolecules in blood. To solve the problem that electrodes are covered by various biomolecules, vertical capacitance sensor are fabricated. Indeed, the growth of e.coli. and straphyloccoccus in blood can be monitored in real-time using vertical capacitance sensors. In addition, when antibiotics are added, different capacitance changes are measured, suggesting that antibiotic susceptibility is able to be measured in real-time.

Keywords:

Capacitive biosensor, e.coli, staphylococcus, Antibiotics Susceptibilty Test(AST), Real-time monitoring

Analysis of neuronal signals of neurons cultured on multi-wall carbon nanotube multi-electrode array

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Abstract:
We have investigated a propagation of neural signals by measuring temporal-spatial changes of neural signals. As multi-electrode arrays (MEAs), vertically grown multi-walled carbon nanotubes (MWCNTs) were used since the contact impedance between MWCNTs and neurons were low, increasing a signal-to-noise ratio. To achieve spatial resolution, primary dissociated brain neurons were patterned on the MEA using poly-L-lysine (PLL) that can guide neurite outgrowth. After electrical firing, neural signals were measured as a function of time and space and analyzed. Possible propagation paths and behaviors are discussed.

Keywords:
Multi-electrode arrays, Neuron, Multi-walled carbon nanotube, Neuron patterning, Biosensor

레이저 스페클 이미지 상관 관계를 활용한 음식 속 미생물 측정 방법

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Abstract:
식품 산업이 분업화된 현대 사회에 있어, 음식 위생은 매우 중요한 문제이다. 세계보건기구(WHO)의 2015년 보고서에 따르면, 전 세계적으로 연간 약 6억 명의 사람들이 오염된 식품으로 식중독을 앓고, 42만 명의 사람들이 목숨을 잃는다. 식중독 예방과 식품 안전은 현대 사회의 주요 이슈 중 하나로서 식중독의 원인이 되는 유해 박테리아를 판별하기 위한 다양한 방법들이 연구되어왔다. 그 예로 질량 분광계, 적외선 분광법, 중합효소연쇄반응, 액체 크로마토그래피, 라만 분광법 등이 사용되었으나, 이러한 방법들은 많은 예산, 복잡한 장치, 높은 숙련도를 필요로 하는 경우가 많아 전문적인 실험실이 아닌 실제 현장에 적용되기에는 제한점이 많았다. 우리는 이러한 실용적인 한계를 극복하기 위하여 다중 산란으로 생성되는 레이저 스페클을 활용, 간단하고 빠르며 동시에 저렴한 식품 위생 판별법을 새롭게 개발하였다. 하얀색 페인트나 종이와 같이 불투명한 매질에 빛을 쏘이면, 매질 내부에서 수많은 산란 현상이 일어나게 된다. 이 때 간섭성이 좋은 빛을 사용하면 이러한 무작위적인 산란의 결과로 스페클 패턴이라 하는 매우 무질서한 패턴이 나타나게 된다. 이 스페클 패턴은 매질의 광학적 형태나 구조에 극도로 민감하게 반응하는데, 매질 속에서 아주 작은 (수백 나노미터 크기의) 움직임만 있다 하더라도 패턴이 크게 바뀌게 된다. 이러한 민감도에 착안하여, 우리는 닭가슴살 내부에서 움직이는 박테리아를 스페클 패턴 분석을 통해 감지하는 데 성공하였다. 본 연구에서는 닭가슴살 속 대장균(Escherichia coli)과 바실러스 세레우스(Bacillus cereus) 2종의 식중독 유발 박테리아를 측정해내는 실험을 수행하였다. 닭고기 자체를 다중 산란체로 활용하여 스페클 패턴을 형성시켰고, 카메라로 초당 30장의 속도로 얻은 스페클 이미지들의 움직임을 관측하였다. 그 결과 박테리아에 의해 오염된 닭가슴살의 경우 내부의 유해한 박테리아의 움직임으로 인해 신선한 닭가슴살보다 스페클 이미지가 크게 요동치는 것을 확인할 수 있었으며, 나아가 스페클 이미지의 시간에 따른 상관관계를 계산하여 이러한 움직임을 정량화 하였다. 이로써 신선한 음식과 그렇지 않은 음식이 쉽고 빠르게 구별 가능하였다. 제안된 기술은 닭가슴살 자체에서의 다중 산란을 활용하여 단순한 추가 설비 (레이저와 카메라) 만으로 의미 있는 결과를 얻을 수 있어, 실제 산업 현장에서 쉽게 식중독 위험 음식을 판별해내는 강력한 도구가 될 수 있을 것이다. 예컨대 식당이나 가정의 냉장고에 장치를 설치하여 누구나 간편하게 음식의 위험 여부를 알도록 할 수 있다.

Keywords:
레이저 스페클, 다중 산란, 박테리아, 식품 위생, 닭가슴살, 이미지 상관관계

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Single Molecule Study on the Saccharomyces cerevisiae Modifier of Transcription 1

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Abstract:

Saccharomyces cerevisiae(brewer's yeast) is an eukaryotic unicellular organism, which has an elaborated transcription mechanism. Before transcription, transcriptional complex with RNA polymerase should find its initiation site with the assistance of TATA-binding protein(TBP), which is a part of a transcription factor II D (TFIID) protein. TBP has well-known capability of finding proper initiation site, generally has a series of bases as TATAAAA, which is the origin of the protein's name. The affinity of TBP to various binding site is inhomogeneous. Some TATA-rich site can show high affinity, but the other initiating sites perform low affinity, which induces unwanted gradation of transcription. There are some groups of proteins redistribute this TBP to control transcription process. Modifier of Transcription 1(Mot1) is a member of these proteins, which regulate TBP in the vicinity of the protein. We imported single molecule FRET(smFRET) techniques to measure the dynamics of this TBP-Mot1-DNA complex at nanometer scale, which will help to understand the mechanism of transcription regulation, and beside the whole transcriptional process.

Keywords:

single-molecule FRET, Mot1, Transcriptional complexes, Swi/Snf2, TATA-binding protein, ATPase

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국제우주정거장에서의 고에너지 우주선 관측을 위한 실리콘 전하 검출기의 pedestal 값과 온도의 상관 관계

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Abstract:
ISS-CREAM실험은 국제우주정거장에서 고에너지 우주선을 관측하는 과학 탑재체로서, 모든 우주 인증시험을 마치고 현재 발사 장소인 Kennedy Space Center에서 2017년 4월 국제우주정거장으로의 발사 및 설치를 기다리고 있다. ISS-CREAM 탑재체의 주요 기기의 하나인 실리콘 전하 검출기는 총 4개의 층으로 총 11,644개의 채널로 이루져 있으며 우주선 성분을 정밀하게 검출할 수 있다. 본 연구에서는 실리콘 전하 검출기의 아날로그 신호처리 장치당 측정한 온도와 각 채널의 pedestal 값의 관계를 1차 함수로 예측하였다. 모든 채널에 대하여 온도와 pedestal 값의 1차 상관 관계를 알고 있으므로 매 10초 단위로 측정되는 온도를 기반으로 pedestal 값을 예측할 수 있다. 실제 우주정거장에서 고에너지 우주선 데이터 획득 시 각 채널 별로 온도로 예측한 이 pedestal 값의 응용 가능성에 대하여도 논의한다.

Keywords:
ISS-CREAM , 실리콘 전하 검출기 , 우주선

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Novel Camera System to Study Antarctic Ice Properties for Extensions to IceCube

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Abstract:
The IceCube Neutrino Observatory is the world's largest neutrino detector located at the geographic South Pole. It utilizes more than 5000 optical sensor modules on the 86 strings, which were deployed at a depth of 1500m to 2500m by a hot water drill used to melt holes within the ultra-pure Antarctic ice, to observe Cherenkov light from neutrino interactions. The Antarctic Ice is extremely clean and ideally suited as a medium for neutrino detector. However, Ice properties, including the refrozen ice from the optical sensor deployment, represent a major source of uncertainty for event reconstruction in IceCube until now because of our imperfect interpretations for the Antarctic Ice and effects from detector geometry. Extensions to the IceCube Neutrino Observatory are under active consideration, and a novel camera system integrated with optical sensor modules could be tremendously beneficial for the interpretation of calibration measurements and to better understand ice properties. We describe a prototype design and preliminary simulation works of an on-board camera system, and show its impact on ice property measurements and geometry calibration.

Keywords:
IceCube, Ice Properties, Camera, Detector Calibration

Asymmetry magnetic hysteresis arising from Dzyaloshinskii-Moriya interaction in lateral symmetry broken structure

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Abstract:
The interfacial Dzyaloshinskii-Moriya interaction (iDMI) has been highly interest because it has a crucial role for creating new-type spin texture such as skyrmion[1] which is candidate for future information storage devices with ultra-fast and high energy efficiency. Recently, it has been heavily studied for observation of iDMI by using many experimental techniques such as Brillouin light scattering (BLS) [2,3], asymmetric domain-wall expansion.[4] In this report, we introduce unique method to straightforwardly observe iDMI from asymmetric magnetic hysteresis loop manifested by iDMI in laterally asymmetric microstructures. Especially, we prepared triangular-shaped ultrathin magnetic films pattern to make laterally asymmetric structure which is expected hysteresis shift by applying biased magnetic field direction ($+H_x$, $-H_x$). Figure 1. indicates magnetic hysteresis loop shift in the lateral symmetric breaking in Pt/Co/Ir and AlO_x/Co/Pt micro-structure. Consequently, we establish a unique, simple, and reliable approach to quantify the iDMI in thin film structures and successfully observe a shift in magnetic hysteresis loops arising from the DMI, by introducing a lateral asymmetry in microstructures and applying in-plane bias field.

Keywords:
Dzyaloshinskii-Moriya interaction, Asymmetric magnetic hysteresis, Lateral symmetry broken structure

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$Sr_3Co_2Fe_{24}O_{41}$의 결정학적 및 자기적 특성 연구

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Abstract:

Z-type hexaferrite 중의 하나인 $Sr_3Co_2Fe_{24}O_{41}$는 Ba이 들어간 Z-type hexaferrite보다 좁은 상형성 온도구간에 의해 직접합성법을 통한 단일상 형성에 어려운 점이 있다. 따라서, 유기-금속 복합체로 1차적인 상형성 후, 낮은 온도에서 소결 할 수 있는 polymerizable complex method를 통해 $Sr_3Co_2Fe_{24}O_{41}$의 시료를 제조하였다. 출발물질로 $SrCl_2\cdot6H_2O$, $CoCl_2\cdot6H_2O$, $FeCl_3\cdot6H_2O$를 이용하여 Z-type hexaferrite의 당량비로 증류수에 용해시킨 다음 citric acid를 첨가하여 metal-citrate를 제조하였다. 제조 된 citrate 용액에 ammonia 수와 ethylene glycol를 적가한 후, 이를 건조 시켜 유기-금속 복합체를 제조하였다. 최종적으로, 만들어진 유기-금속 복합체를 1190도에 소결하여 단일 상의 $Sr_3Co_2Fe_{24}O_{41}$ 시료를 합성하였다. 합성 된 $Sr_3Co_2Fe_{24}O_{41}$ 시료를 x-선 회절기 (XRD), 진동시료형 자화율측정기 (VSM), 그리고 Mössbauer 분광기를 통해 결정구조 및 자기적 특성을 연구하였다. 295 K에서 XRD 실험을 수행하였으며, 이를 Rietveld 정련법을 이용하여 분석하였다. 그 결과 $P6_3/mmc$ 공간군을 가지는 hexagonal의 결정구조로 확인되었으며, 격자 상수 상수 a_0와 c_0는 각각 5.86, 51.91 Å으로 분석되었다. 거시적인 자기적 특성을 확인하기위해, 4.2부터 295 K까지 다양한 온도 구간에서 15 kOe까지 자기이력곡선을 측정하였으며, 준강자성의 거동을 보였다. 또한, 온도가 증가함에 따라 포화자화와 보자력은 감소하였다. 4.2부터 295 K까지 Mössbauer 분광 실험을 통해 초미세상호작용 및 부격자 내의 철이온 분포에 대해 연구하였다. Z-type hexaferrite는 10개의 부격자가 존재하여, 중첩된 10개의 Mössbauer 스펙트럼을 퀴리온도 이하에서 6-sextets 형태로 분석하였다. 온도가 증가함에 따라, 초미세자기장의 크기는 감소하였으며, 모든 부격자내의 철이온의 이온가는 3+임을 확인하였다.

Keywords:
Mössbauer분광학, Z-type hexaferrite, $Sr_3Co_2Fe_{24}O_{41}$

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Zn가 치환된 $LiFePO_4$ 양극물질의 결정구조 및 자기특성변화연구

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Abstract:
$LiFe_{0.9}Zn_{0.1}PO_4$ 양극물질은 직접합성법(Solid state method)으로 제조하였다. x-선 회절 실험을 통하여 측정하였으며 Rietveld 정련법으로 분석한 결과, $LiFe_{0.9}Zn_{0.1}PO_4$의 결정구조는 orthorhombic 구조로서 Pnma 공간그룹을 가지는 것으로 확인되었다. 온도에 따른 자기적 특성을 확인하기 위해서 진동 시료형 자화율 측정기를 이용하여 1000 Oe 자장 하에 zero-field cooled (ZFC)와 field-cooled (FC) 실험을 진행하였다. $LiFe_{0.9}Zn_{0.1}PO_4$ 양극물질의 닐온도 (Néel temperature; T_N)는 48 K 이며, 14 K 부근에서 spin-reorientation 현상을 확인하였다. 초미세 상호작용 발현을 확인하기 위하여, 4.2 K에서 295 K까지 뫼스바우어 분광 실험을 진행하였다. 모든 온도 구간에서 Fe 이온은 Fe^{2+} 상태로 존재함을 확인하였다. 닐 온도 이하에서는 자기 2중극자 상호작용과 전기 4중극자 상호작용이 동시에 발현됨에 따라 8라인의 흡수선을 보였다. $LiFePO_4$ 양극물질에 Zn가 치환됨에 따라 Fe 이온 사이의 초교환 상호작용이 약해지므로 $LiFePO_4$의 닐 온도인 51 K보다 낮은 온도인 48 K에서 닐 온도를 보임을 알 수 있다.

Keywords:
뫼스바우어, 양극물질, 스핀 재배열

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Non-equilibrium dynamic reversal of nanoscale magnetized elements

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Abstract:

The ultrafast switching mechanism of in-plane magnetized single magnetic elements by applying dynamic out-of-plane magnetic field pulses is numerically investigated by performing micromagnetic simulations. For in-plane magnetized nanostructures, an out-of-plane magnetic field is able to rotate the direction of the magnetization when the precession torque overcomes the shape anisotropy of the system. Due to the magnetic damping of the systems, a single domain reversal is governed by a non-equilibrium dynamic in a certain transition time. By controlling the rise / fall times of dynamic out-of-plane field pulses, the transition time can be also successively tuned and then an ultrafast switching of an elliptical magnetic nano-element is clearly achieved by controlling the precessional torque. As another reversal mechanism, sinusoidal magnetic fields (AC fields) in gigahertz range are applied to the system. Consequently, the threshold switching fields are drastically decreased since the precession torque exerts to rotate the single domain element effectively.

Keywords:
spintronics, magnetization reversal, precession torque, non-equilibrium dynamics

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Non-collinear magnetic ground state of $GaMo_4Se_8$ and $GaTa_4Se_8$

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Abstract:

In order to understand the magnetic ground state of $GaMo_4Se_8$ and $GaTa_4Se_8$, we performed first principles density functional theory calculation within the non-collinear spin and orbital space. The detailed examination of the intra-cluster and inter-cluster couplings shows a clear difference between the ferromagnetic ($GaMo_4Se_8$) and frustrated magnetic ($GaTa_4Se_8$) material. There are ferromagnetic intra-cluster coupling in $GaMo_4Se_8$ and anti-ferromagnetic intra-cluster and inter-cluster couplings in $GaTa_4Se_8$. The detailed electronic structure analysis and comparision wth experiments will be presented.

Keywords:
Spin-orbit coupling, Cluster magnetism, Density functional theory, Non-collinear magnetism

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망간이온의 결핍에 따른 $LaMn_{0.92}O_{3+\delta}$의 스핀글라스, 초상자성, 방해 온도 분포에 대한 연구

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Abstract:

페브스카이트 산화물 $LaMnO_3$ 는 닐 온도가 약 140 K 인 반강자성(anti-ferromagnetic) 물질이다.[1] 기존 연구에 따르면 망간 이온이 물질 내에서 3가의 상태로 존재하며 반강자성을 띠게 된다. 하지만 자연상태에서 망간 이온이 4가로 존재하려는 성질이 있어 산소를 더 끌어 당기게 되어 $LaMnO_{3+\delta}$ 의 상태가 되며 Mn(Ⅲ) 과 Mn(Ⅳ) 들간의 이중상호작용에 의해 강자성 물질이 된다는 사실이 많은 연구를 통해 보고가 되었다.[2] 또한 앞선 연구결과에 따르면 시료 합성 시 산소 환경하에서 200 bar 이상의 압력을 가해줄 경우 스핀글라스 성질이 나타난다고 보고되고 있다.[3] 연구를 위해 solid state reaction 방식으로 $LaMnO_{3+\delta}$ 및 $LaMn_{0.92}O_{3+\delta}$ 두 시료를 제작하였다. X-선 회절 분광법(X-ray Diffraction Spectroscopy), 전자 스핀 공명(electron spin resonance: ESR)을 이용하여 구조 및 기초 물성을 측정하였고, 초전도 양자 간섭소자(Superconducting Quantum Interference Device: SQUID), X-선 흡수 분광법 (soft x-ray absorption spectroscopy: XAS) 을 이용하여 강자성, 초상자성, 스핀글라스 특성과 방해온도 분포에 관한 연구를 수행하였다. 본 연구에 의하면 공기 중에서 충분한 시간을 합성한 $LaMnO_{3+\delta}$ 시료의 경우 예상대로 $T_c \approx 150$ K 인 전형적인 강자성체인 반면 합성단계에서 의도적으로 망간을 8% 부족하게 하여 제작한 $LaMn_{0.92}O_{3+\delta}$ 시료에서는 스핀글라스, 초상자성 현상 및 방해온도 분포에 따른 자기 메모리효과(memory effect) 등이 관측되었다. 이는 시료 합성 단계에서 망간을 부족하게 했을 때 망간 사이의 long range 형태의 강자성 상호작용 연결고리가 끊어져 자기 클러스터가 형성되기 때문인 것으로 이해된다. [1] C. Ritter et al., Phys. Rev. B 56, 8902 (1997). [2] J. A. Alonso et al., Solid State Commun., 102, (1997) [3] L. Ghivelder et al., Phys. ReV. B 1999, 60, 12184 (1999)

Keywords:
스핀글라스, 초상자성, 방해온도 분포, 메모리 효과

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Epitaxy film growth and magnetic tunnel junctions based on magnetism at LaAlO3/SrTiO3 heterointerface.

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Abstract:
$LaAlO_3/SrTiO_3$ heterostructure have attracted considerable attention because of their captivating properties, including the magnetic ordering at the conducting interface. Here, we report the magnitude and sign of tunneling magnetoresistance(TMR) that was changed by direction of rotational magnetic field parallel to the $LaAlO_3/SrTiO_3$ plane and thermal cycling. We have fabricated magnetic tunnel junctions consisting of $La_{0.7}Sr_{0.3}MnO_3$ and $LaAlO_3/SrTiO_3$. The sample was grown by Pulsed Laser Deposition(PLD) and $La_{0.7}Sr_{0.3}MnO_3$ was etched by wet etching method. We have confirmed that film was epitaxy using the X-Ray Diffractometer(XRD) and measured magnetoresistance using the Physical Property Measurement system (PPMS). Our research show existence of the ferromagnetism at $LaAlO_3/SrTiO_3$ heterointerface and provides a further support for development of spintronics devices.

Keywords:
Magnetic tunnel junction/tunneling magnetoresistance/oxide heterointerface

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Cation redistribution of piezoelectric ferromagnetic $Ga_{0.6}Fe_{1.4}O_3$ (010) films by Co-doping

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Abstract:
We have studied how Ga and Fe atoms distribute in the four different cation sites of GFO films by measuring X-ray absorption spectra and X-ray magnetic circular dichroism spectra and comparing them with theoretical models. The spectra were taken at Fe $L_{3,2}$ and Co $L_{3,2}$ edges of the $Ga_{0.6}Fe_{1.4}O_3$ and 1.2 % Co-doped $Ga_{0.6}Fe_{1.4}O_3$ films. The X-ray absorption spectra on Co $L_{3,2}$ edges reveal that doped Co-ions favor Oh sites. The X-ray magnetic circular dichroism spectra on Fe $L_{3,2}$ edges before and after Co-doping are different by far and they show that the Td site occupation of Fe ions increases considerably after Co-doping, which implicates that the Co-doping leads to the overall redistribution of the cation atoms. The Fe occupation ratio of T_d and O_h sites are estimated by fitting the X-ray magnetic circular dichroism spectra with a cluster calculation. Finally the cation distribution of these films were obtained by implementing Gilleo's classical model which considers the presence of magnetically dead sites. We found that the cation atoms redistribute entirely after small amount of Co-doping and the total magnetization values of both films were well reproduced from the obtained distributions.

Keywords:
$GaFeO_3$, multiferroic, XMCD,Superexchange, site disorder

제일원리 계산에 의한 $CrPt_3$ 합금의 덩치와 (001) 박막의 자성

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Abstract:

제일원리 계산방법을 이용하여 계산한 $CrPt_3$의 자성에 대해 보고한다. 계산방법으로는 Vienna Ab-initio Simulation Package (VASP)을 이용하였고 교환-상관 전위는 일반화 물매 근사 (GGA: generalized gradient approximation)로 표현하였다. CrPt3 합금의 결정구조는 $L1_2$인 것으로 알려져 있는데 $L1_2$의 정방변형인 $D0_{22}$ 결정구조에 대해서도 총에너지를 계산하였는데 $L1_2$ 구조가 $D0_{22}$ 구조에 비해 에너지 차 0.324 eV 안정하였다. $L1_2$ 구조의 격자 상수는 3.925 Å (실험치 3.877 Å 보다 0.048 Å 컸다)이다. 자성 상태에서는 FM 상태일 때가 가장 안정하였는데 A-AF, C-AF, G-AF의 에너지는 FM 상태에 비해 각각 0.517 eV, 0.591 eV, 0.183 eV 높았다. 덩치 CrPt3 합금의 Cr의 자기모멘트는 FM 2.807 μ_B, A-AF 2.805 μ_B, C-AF 2.794 μ_B, G-AF 2.869 μ_B으로 계산되었다. 박막 자성에 대해서도 계산을 하였는데 박막의 표면은 (001) 면으로 택하였고 CrPt으로 끝나는 표면의 박막과 Pt로 끝나는 표면의 박막에 대해 계산을 수행하였다. CrPt 표면 9층, 7층, 5층 박막은 FM 상태일 때 가장 안정하였으나, 3층 박막에서는 C-AF 상태가 안정할 수 있음을 알았다. Pt 표면 9층, 7층 박막에서는 FM 상태일 때 가장 안정하였고 5, 3층 박막에서는 G-AF 상태일 때 안정하였다. 그리고 덩치 및 박막의 자기이방성에 대해서도 논의할 예정이다.

Keywords:
자성, 박막, $CrPt_3$

$CoFe_2O_4$@$AlFe_2O_4$ 코어/쉘 나노 페라이트의 결정학적 및 자기적 특성 연구

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Abstract:
바이오-메디컬 분야에서는 수 나노 크기에서 발현되는 스피넬 페라이트 특성을 이용하여 암세포 사멸을 위한 온열치료 (Hyperthermia) 연구가 활발히 진행되고 있다. 본 연구에서는 강자성의 Co 페라이트를 core로 비자성 이온인 Al 페라이트를 shell로 갖는 core/shell 구조의 $CoFe_2O_4$@$AlFe_2O_4$ 나노 자성입자를 고온열분해법으로 제조하여 자기적 및 발열 특성을 통하여 온열치료의 응용가능성을 확인하고자 한다. 제조된 나노 자성입자의 결정구조는 Fd-3m 공간군을 갖는 cubic spinel 구조로 확인되었으며, Scherrer 방정식을 통하여 10~14 nm 크기의 입자 사이즈를 계산하였다. $CoFe_2O_4$@$AlFe_2O_4$ 자성 입자는 Al 페라이트보다 높은 자화값을, Co 페라이트보다 낮은 보자력값을 가지는 것으로 측정되었다. 제조된 나노 페라이트의 Blocking 온도는 Co 페라이트가 250 K, Al 페라이트가 50 K, Co@Al 페라이트가 225 K, 50 K 부근의 두 곳으로 확인되었다. 나노 자성입자의 발열 온도는 Co 페라이트, Co@Al 페라이트, Al 페라이트 순으로 낮아지는 것을 확인하였다. 또한, 미시적인 자기적 특성 확인하기 위하여 상온에서 뫼스바우어를 측정하였으며, Co 페라이트는 2-set의 6라인, Al 페라이트는 1-set의 6라인과 doublet, Co@Al 페라이트는 2-set의 6라인과 doublet으로 분석되었다. 이러한 뫼스바우어 분석과 blocking 온도를 통하여 코어/쉘 구조임을 확인할 수 있었으며, 온열치료용 물질로서의 그 적합성이 높음을 판단할 수 있었다.

Keywords:
온열효과, 코어/쉘, 뫼스바우어, 나노입자

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Magnetic interactions of A-site deficient spinel Ir_2O_2 emerging from trigonal distirtion

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Abstract:
We predict an unusual magnetic ground state of A-site deficient spinel Ir2O4 based on first principles calculations with LDA+U+SOC method as implemented in the OpenMX code. The A-site deficient spinel Ir2O4 is a Mott-Hubbard insulator driven by the formation of the J=1/2 band due to strong spin-orbit coupling, where the effective on-site Coulomb interaction U of 2.4 eV Ir 5d orbitals is used to give a direct band gap of about 0.5 eV in agreement with experimental observation. The magnetic ground state of the system is shown to have a non-collinear spin structure with competing ground states of so-called XY pyrochlore configurations. We show that the origin of this ground state can be explained by inspecting the trigonal distortion of oxygen atoms.

Keywords:
frustrated magnetism

제일 원리 계산을 이용한 CoPt3(111) 합금의 자성과 촉매반응성

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Abstract:
연료전지의 전극에는 Pt가 촉매로 널리 사용되고 있다. 특히, 연료전지 환원극 내 산소 환원반응 속도는 산화극에서 수소 산화반응 속도에 비해 5배 이상 느리므로, 환원극의 활성화 에너지를 낮추기 위해 고가의 백금촉매가 많이 사용된다. 따라서 저가의 고활성 산소 환원 반응 촉매를 개발할 필요가 있고, 수소 연료전지로부터 안정적인 전력을 생산하기 위해, 높은 전기화학적 활성뿐 아니라 내구성도 동시에 갖춘 촉매 물질도 요구되고 있다. 본 연구에서는 Pt 저감 촉매 물질 탐색을 하고자 3d 전이금속중 하나인 Pt-Co 합금의 촉매 반응성을 연구하였다. L12 구조의 덩치 CoPt3의 격자상수를 총에너지 계산을 통해 구한 다음, CoPt3(111) 합금 표면의 전자구조를 제일원리계산 방법을 이용하여 계산하였다. 또한, 산소분자의 흡착위치, 해리된 산소원자의 흡착위치, 해리 과정에서의 장벽의 높이를 계산하여 Pt(111) 표면의 그것들과 비교, 분석하고, CoPt3의 자성과 촉매성 사이의 상관관계에 대해서도 논의할 예정이다.

Keywords:
제일원리계산, 자성, 촉매

Scattering model for large damping-like torque in TI/FM bilayer

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Abstract:
Recently, a strong spin-transfer torque induced by charge current is observed in three-dimensional topological band insulator(TI)/ferromagnet metal(FM) bilayer[1-4]. Unlike field-like torque, existing theories could not explain the origin of this large damping-like torque clearly. We compute the spin torque ratio from a scattering state between TI and FM. Finally, we find that damping-like torque could be large at certain conditions and its origin is related with band matching between TI surface state and FM bulk states.

Keywords:
Spin torque, Topological Insulator

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Hydrogen-vacancy complex related ferromagnetism in single-walled carbon nanotubes

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Abstract:
Magnetic properties of hydrothermally treated single-walled carbon nanotubes (SWNTs) were investigated in this work. The saturation magnetization was increased after hydrothermal treatment and the magnetic moment appears to arise from a spin-3/2 species. The spin-3/2 may be attributed to a hydrogen-carbon vacancy complex as the infrared spectroscopic measurements indicated hydrogen incorporation after hydrothermal treatment. On the other hand, the magnetic moment in pristine SWNTs appears to arise from a spin-1 species of the adsorbed oxygen molecules as detected from the XPS measurements. Acknowledgments This work was supported by the National Research Foundation of Korea (Project No. 2016005659).

Keywords:
Carbon naotubes, magetism, hydrogen related defect

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Large-size crystal growth of inorganic-organic hybrid material of $(CH_3)_2NH_2CuCl_3$ for neutron scattering

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Abstract:
$(CH_3)_2NH_2CuCl_3$ (Cu-DMA, dimethylamonium copperchloride) belongs to an inorganic-organic hybrid materials and shows ferromagnetic-antiferromagnetic chains. There are many debates about the magnetic properties of the Cu-DMA from FM-AFM chain system to quasi-one dimensional S = 1/2 alternating FM-AFM chain system [1, 2, 3, 4, 5]. To investigate the relation between the dimensionality and the magnetic behavior, it is crucial to have an adequate crystal structure. But, to the neutron scattering experiments requires a good quality large-size crystal. Here, we report the results on the single-crystal growth of Cu-DMA through a solvent evaporation method using the mixed solvents of methanol and isopropanol at different temperatures. For this, we performed powder X-ray diffraction (XRD) and single-crystal neutron diffraction experiments. Also thermal analyses and X-ray single-crystal measurements at 300K and 175K are carried out to study the structural phase transition. Reference [1] Willet., J. Chem. Phys. Vol. 44, 39 (1966) [2] Willet et al., Inorg. Chem. Vol. 45, 7689 (2006) [3] Inagaki et al., J. Phys. Soc. Jpn. Vol. 74, 2683 (2005) [4] Yoshida et al., J. Phys. Soc. Jpn. Vol. 74, 2917 (2005) [5] Stone et al., PRL, Vol. 99, 087204 (2007)

Keywords:
single crystal growth, recrystallization, solvent, growth from solutions, magnetic materials, neutron scattering

Ultrafast THz spectroscopy on a $Ba_{0.6}K_{0.4}BiO_3$ superconducting thin film

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Abstract:
The superconductivity of $Ba_{1-x}K_xBiO_3$ is realized when a long range charge density waves order in $BaBiO_3$ is suppressed by K doping. The interplay of the CDW and superconductivity is still in controversy. We investigate the superconducting response of the $Ba_{0.6}K_{0.4}BiO_3$ superconductor by time domain spectroscopy over 0.5-3 THz. A superconducting thin film of $Ba_{0.6}K_{0.4}BiO_3$ of Tc 18 K was grown on MgO substrate. We observe clear superconducting response in the transmission spectra at equilibrium as temperature decreases. We are currently performing NIR-pump/THz probe experiment to better understand the nature of the superconductivity and phase competition/coexisting behavior.

Keywords:
$BaBiO_3Ba_{0.6}K_{0.4}BiO_3$Optical-Pump THz-Probe Spectroscopy

Ferromagnetic quantum criticality in $Sm_{1-x}La_xNiC_2$ (x=0.85, 0.92 and 0.96)

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Abstract:
We report muon spin rotation/relaxation (μSR) experiments on the ternary compounds $Sm_{1-x}La_xNiC_2$ (x=0.85, 0.92, and 0.96), having a non-centrosymmetric orthorhombic $CeNiC_2$ structure (Amm2). These compounds host a variety of magnetic and electronic phases including the ferromagnetic and charge-density-wave states at x=0 and the superconducting state at x=1, and thus enable us to address a ferromagnetic quantum criticality occurring around x=0.92. ZF-μSR measurements give no apparent indication of magnetic ordering in the x=0.85 ferromagnetic compound down to 2 K and in the x=0.96 superconducting and the x=0.92 quantum-criticality compound down to 30 mK. Rather, both the x=0.85 and x=0.92 samples show a steep increase of the muon relaxation rate, suggesting a short-range and disordered nature of the magnetic state. The superconducting sample exhibits a temperature-independent muon relaxation rate, excluding the possibility of the coexisting ferromagnetic and superconducting phases.

Keywords:
Quantum criticality, muon spin rotation, superconductivity

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Selective detection of AC transport current distributions of GdBCO coated conductor using Low Temperature Scanning Hall probe Microscopy

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Abstract:

In this study, we applied AC current to GdBCO coated conductors and measured local magnetic field distributions by using SHPM (Low Temperature Scanning Hall probe Microscopy). We selectively measured magnetic field profiles from AC current signal by Lock-in technique and calculated local current distributions by inversion calculation. In order to compare AC and DC measurement results, we applied DC current corresponding to peak and RMS value of AC current and compared AC and DC current distributions. We carried out the same measurements at various external DC magnetic fields, and investigated redistribution of AC current.

Keywords:
Superconductivity, SHPM, AC transport current

Superconducting films of BaFe2As2 by Cobalt ion injections

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Abstract:
The reel to reel coated conductor fabrication is widely used to make long length of superconducting tapes having several steps. If a doping procedure can be operated independently of mother compound deposition, we can control the extent of doping in one manufacture line or make superconductor circuits. We present a possibility of an ex-situ fabrication method by using an ion injection which is widely used in the process of manufacturing semiconductor. Cobalt ions are injected into a BaFe2As2 epitaxial film and make superconductivity. We found the structure transition below 150 K coexist with the superconducting phase, while the structure transition disappears in the in-situ fabricated superconducting films. Regardless of a dose level of cobalt ion beam, the resistance decreases at the transition temperature of an optimal doped films.

Keywords:
iron based superconductor, ion injection, ex-situdoping

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금속 절연 및 병렬저항 부착 2세대 고온초전도 코일의 제작과 특성

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Abstract:

오늘날 전기저항 “0”의 성질을 이용한 고효율 고온초전도 전력 및 산업응용 기기들의 개발이 진행 중이다. 코일의 형태로 응용이 되는 초전도 응용기기에서는 높은 자기장 속에서도 임계전류 특성이 가장 우수한 2세대 고온초전도 선재를 이용한다. 최근 몇 년 동안 절연이 되지 않은(No Insulation) 2세대 고온초전도 선재를 사용하여 매우 안전성이 높은 코일 제작이 가능하다는 발표들이 있었다. 2세대 고온초전도 선재만으로도 26.4 T의 고자장을 발생 시킨 보고도 있다. 그러나 No Insulation의 경우 전류를 인가할 때 전류분류가 발생하기 때문에 전류인가 속도를 매우 느리게 해야만 한다. 본 연구진은 2세대 고온초전도 선재를 스테인레스 스틸과 같은 금속 테이프를 2세대 고온초전도 선재와 공동으로 권선한 2세대 고온초전도 코일(Metal Insulation)을 제작하여 성능평가를 한 결과들을 봄 학술대회에서 보고했었다. 이 코일의 경우 No Insulation 코일 보다 전류인가 속도를 빠르게 할 수 있으며 임계전류 이상에서이나 히터에 의한 퀜치 발생 시에 안정성은 NI 보다는 떨어지지만, Insulation의 경우에 비해서는 매우 높았다. 본 연구에서는 Indium sheet를 층간 접촉저항을 줄일 목적으로 코일의 측면에 병렬저항 (Parallel Resistor, PR))으로 부착한 MI&PR 더블팬케이크 코일을 제작하고 그 특성을 분석하였다. 사용한 2세대 고온초전도 선재는 ㈜서남에서 제작한 것으로 폭이 4.1 mm이다. 코일 내경은 80 mm, 턴수는 각 single pancake 당 100 턴이다. 2세대 고온초전도 코일의 히터에 의한 퀜치 거동에 대해 액체질소 속에서 그리고 전도냉각 방식으로 이루어 졌으며, 그 결과들을 소개하고자 한다. "본 연구는 2016년도 정부(미래창조과학부)의 재원으로 국가과학기술연구회의 지원을 받아 수행된 한국전기연구원 주요사업임 (No. 16-12-N0101-25) "

Keywords:
2G HTS coil, high temperature superconductor, critical current, metal insulation, no insulation, parallel resistor

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Measurement of reflectance spectrum of a gold film coated on a sample in FIR region

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Abstract:
Gold can be used as a reference material in FIR (5 ~ 600) range for reflectance measurement due to its good reflectivity (~ 99%) in this range. Some optical spectroscopy groups are using an in-situ gold evaporation method to obtain accurate reflectance spectra of samples with rough surfaces. After getting reflectance with respect to the gold through this method one needs to correct the measured reflectance with the absolute gold reflectance for getting the absolute reflectance of the sample. However, the reflectance of the coated gold film on a sample may not be the same as the absolute gold reflectance due to the different measurement conditions. Therefore, one needs to know the reflectance of the coated gold film produced under their experimental conditions for getting reliable data. In this presentation we introduce a way how one can get the reflectance of the coated gold film under his/her experimental conditions.

Keywords:
Absolute reflectancein-situ evaporationFTIROptical spectroscopy

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The Effect of laser fluence on superconductivity of $Ba_{1-x}K_xBiO_3$ films in pulsed laser deposition

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Abstract:

Cation stoichiometry of the films were controlled significantly by varying laser fluence. Especially, we found that the dependence of T_c and laser fluence was consistent with previous bulk reports, which indicates the correlation between laser fluence and potassium concentration in BKBO films. As a result, T_c of BKBO films was altered from zero (insulating) to ~24.5 ± 0.5 K at optimal stoichiometry. It should be emphasized that this is the first report of T_c control of any PLD-grown oxide superconductor via lase fluence control. These results give not only a useful guideline for the synthesis of high-quality superconducting BKBO films, but also additional insight into the general growth strategy of complex oxide thin films containing volatile elements.

Keywords:
Pulsed laser deposition (PLD), Ba-K-Bi-O (BKBO), Thin film, Superconductivity, Growth parameters

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Critical characteristics and performance in REBCO high T_c superconducting wires investigated by optical methods

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Abstract:
본 연구에서는 분광학 방법을 이용하여 높은 임계전류를 가지는 여러 고온 초전도 선재의 특성과 성능에 대해 조사하였다. 선재는 $GdBa_2Cu_3O_{7-x}$ (GdBCO)를 사용하였고, 선재는 77K에서 210-370 A/4mm-w의 임계전류 값을 보이고 있다. 임계전류 값은 1 μV/cm를 기준으로 결정하였다. 선재의 기본적인 특성을 알아보기 위해 주사 전자 현미경을 통하여 표면과 측면의 결정의 크기 및 조성 등을 확인하였다. 라만 분광법을 이용하여 선재 결함 특성을 분석하였고, 라만 이미징을 통해 선재의 국소적 부분의 조성 특성에 대해서 확인하였다. Ic-B 측정을 통하여 각 선재의 조성과 고자기장 하에서 보이는 성질의 관계를 파악하고자 하였다. 또한 본 연구에서는 현재 연구원에서 진행하고 있는 선재의 접합에 대한 내용도 간략하게 소개하고자 한다.

Keywords:
GdBCO, HTS wires, Optical methods

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Superconducting properties of the misfit compound $(SnSe)_{1.16}(TaSe_2)$

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Abstract:
Misfit layer 구조 화합물은 $(MX)_{n+\delta}(TX_2)_m$ (M = p-type metalloid, T= 전이금속, X = 칼코겐 원소) 조합을 갖는 2차원 층상구조 화합물로써, MX층과 TX_2층이 교차적으로 (n, m)의 정수 배로 쌓인 자연 초격자 구조 물질이다. Misfit layer 구조 화합물로써 $(SnSe)_{1.16}(TaSe_2)$ 물질에서 초전도 상전이를 관찰하였다. X-ray diffraction을 통하여 얻어진 결정구조는 SnSe와 $TaSe_2$ 상이 초격자 형태로 형성된 것을 확인하였다. 이 물질은 시료 합성 시 고온 가압소결 조건에 따라 초전도 전이온도가 달라졌는데, 고온 가압소결 온도가 550 °C였을 때 초전도 전이온도 Tc = 3.8 K였고, 600 °C였을 때 초전도 전이온도는 Tc = 4.8 K였다. 이는 이 초전도가 intrinsic 초전도라고 하기보다는 소결조건에 따른 구조적 변화 및 조성변화가 초전도 전이온도에 영향을 미쳤을 것이라 생각된다. 전기저항과 자기화 측정 결과를 Ginzburg-Landau 이론과 Werthamer-Helfand-Hohenberg (WHH) 공식에 적용하여 upper critical field $H_{C2}(0)$ 와 coherence length ξ 를 구하였고 이를 통하여 anisotropic parameter γ_{HC2}를 구하였다. 이 시료는 다결정 화합물임에도 불구하고 위 실험을 통해 이방성이 존재함을 확인 할 수 있다. 또한 비열 측정을 통하여 specific heat jump $\Delta C/\gamma T_C$ 와 electron – phonon coupling constant λ_{e-ph}를 구하였는데 이를 통해 이 시료가 weak-coupling BCS 초전도라고 이해할 수 있다.

Keywords:
superconductivity, misfit layercompound

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Temperature dependent strain properties of lead-free Sn-doped $Bi_{1/2}(Na_{0.82}K_{0.18})_{1/2}TiO_3$ relaxor ceramics

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Abstract:

Incipient lead-free piezoceramics such as $(Bi_{1/2}Na_{1/2})TiO_3$ (BNT)-based or BNT-$(Bi_{1/2}K_{1/2})TiO_3$ (BNKT) compounds have exceptionally large electromechanical strain of ~ 0.40%. Although the electrical performance of these materials is sufficient for electromechanical applications, there are still several problems that should be solved. One is high electric field required for activating large strains and another problem is substantial hysteresis. The other is the strong temperature dependence of strain properties, e.g., S_{max}/E_{max}, which decreases significantly up to ~ 150 °C for the reported materials. For many applications, higher operating temperature is needed. Thus, the temperature stability of the properties is one of the most important issues for the development of lead-free relaxor ceramics. For this reason, the temperature-dependent phase stability of lead-free relaxor ceramics should be well-understood. Therefore, this study investigated the thermal evolution of an electric-field-induced ferroelectric phase in BNKT-based lead-free relaxor materials by temperature-dependent dielectric, ferroelectric, and strain characterizations in relation to temperature dependent X-ray deflection studies.

Keywords:
Lead-free piezoelectric; Relaxor ferroelectric; Depolarization

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Fabrication and Comparison of Nd-doped $Bi_4Ti_3O_{12}$ as Bulk Ceramic and Thin Film

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Abstract:

Recently, the deleterious environmental impact of the lead used in many ferroelectric and piezoelectric materials has stimulated research into lead-free alternatives with comparable properties. We investigated the lead-free perovskite $Bi_{3.1}Nd_{0.9}Ti_3O_{12}$ (BNdT) as a bulk ceramic fabricated by conventional solid state reaction method and as thin films fabricated by Pulsed Laser Deposition (PLD), which is a relatively easy method for fabrication of thin films. The samples were grown on $Pt/SiO_2/Si$ substrates using a KrF laser (248nm). We varied the PLD deposition conditions, including the substrate temperature, oxygen gas pressure, repetition frequency, target-substrate distance, pulse energy and determined the optimal conditions of these parameters for fabrication of high quality BNdT thin films. The BNdT crystal structure was measured by high resolution x-ray diffraction (HR-XRD) while the thickness was obtained low angle x-ray reflectivity (XRR). The surface structure and d_{33} value were checked by field effect-scanning electron microscope (FE-SEM) and Sawyer-tower Circuit, respectively. Ferroelectric characterization was investigated by piezoresponse force microscopy (PFM). The structural and electrical properties of the films were systematically compared with those of the bulk material as a function of the growth variables.

Keywords:

Pulsed Laser Deposition, $Bi_{3.1}Nd_{0.9}Ti_3O_{12}$, Ceramics, Ferroelectrics

Impedance spectroscopy of hydrogen plasma-treated zinc oxide

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Abstract:
Effects of hydrogen plasma treatment on the electrical properties of zinc oxide(ZnO) have been studied by employing the impedance spectroscopy. Hydrogen plasma treatment increased the frequency range of the constant values of the real part of the complex impedance. The complex impedance data were analyzed by employing the equivalent circuits. The electrical conductivity was found to increase with reduced activation energy as a result of the plasma treatment. The dielectric constant increased as well following the plasma treatment.

Keywords:
Impedance spectroscopy, ZnO, Interstitial hydrogen dynamics, Hydrogen plasma treatment

리튬이온전지 고체전해질 $xLi_2O-SiO_2-B_2O_3$ 유리의 열, 전기, 광학 특성 연구

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Abstract:
현재 상용화 중인 리튬이온전지의 전해질은 대부분 액체로써, 전극 부식, 누액, 폭발의 위험이 있어 고체전해질 개발을 통한 전지 안정성 확보가 필요하다. 고체전해질에 사용 가능한 리튬 산화물 유리는 열적·화학적으로 안정하고 시료 제조 시 구성 원소의 혼합비를 다양화할 수 있는 장점이 있다. 최근에 유리 형성제 SiO_2, B_2O_3, P_2O_5를 사용한 고체전해질 유리의 물성 연구가 활발하게 이루어지고 있다. 본 연구에서는 $xLi_2O-SiO_2-B_2O_3$ (x = 0.5, 1, 2, 3, 4) 유리를 용융 급랭법으로 제조하고 리튬 양 변화에 따른 열, 전기, 광학 특성을 분석하였다. 유리상에서 온도 및 주파수 변화에 따른 전기적 특성을 전기전도도, 복소임피던스, 전기모듈러스 모델을 적용하여 설명하였다. 리튬 양이 증가할수록 상온에의 dc 전기전도도는 $\sim10^{-9}$ S/cm에서 $\sim10^{-6}$ S/cm로 향상되었다. Raman 분광법으로 유리상에서의 국소 진동모드를 분석하였다. 망목 수식제 (network modifier)인 리튬 산화물 양이 증가할수록 3차원의 Si-O, B-O의 진동모드 수는 감소하고 1차원의 진동모드 수가 증가하는 것으로부터 유리 구조의 국부적 변화를 미시적으로 분석하였다.

Keywords:
리튬이온 전지, 고체 전해질, 유리, 전기 전도도, 라만 분광법

브릴루앙 및 유전 분광법을 이용한 비납계 $(Na_{0.5}Bi_{0.5})TiO_3-BaTiO_3$ 단결정의 상전이 거동에 대한 전기장 인가 효과 연구

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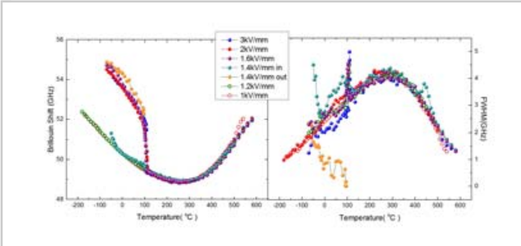

Abstract:
비납계 압전소재는 일반적으로 PZT로 대표되는 납기반의 압전체와 비교해서 압전성능이 떨어진다는 사실에도 불구하고 환경친화적 측면 때문에 주목 받고있다. 비납계 압천체의 상전이 특성에 대한 이해를 통해 우리는 비납계 압전소자의 압전성능을 향상시킬 수 있는 방법을 찾을 수도 있다. 이 연구에서는 95%$(Na_{0.5}Bi_{0.5})TiO_3$-5% $BaTiO_3$ (NBT-5%BT) 단결정에 대한 음향특성과 유전율 특성에 전기장이 미치는 효과를 조사하였다. NBT-5%BT는 PMN과 같은 전형적인 relaxor의 특징을 보인다. NBT-5%BT의 [100]방향으로 상온에서 20분 동안 전기장을 가한뒤, -196°C부터 600°C까지 온도를 올리면서 측정하면 1.4kV/mm 이상의 전기장에서 폴링된 경우에는 약 110°C에서 불연속적인 구조상전이가 관찰되었다. 특히 1.4kV/mm로 폴링한 시료의 경우 릴랙서와 강유전상의 공존현상이 확인되었다.

Keywords:
비납계, NBT-BT, 강유전체, 압전체, 브릴루앙 산란

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Raman mapping study of pigment distribution in wood decoration of Korean cultural heritages

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Abstract:

We observed several color pigments taken from Korean cultural heritage by Raman spectroscopy. In this study, Raman mapping is used for investigating the detailed distribution of particular pigments found in the wood decoration of Bongjeongsa temple in Andong and Sunglimsa temple in Iksan. We could find that the yellow pigment in the specimen had several components of crocoite, lazurite and rutile by the fingerprints of the Raman spectra from various spots. We also detected lazurite and minium components in the red pigment by Raman mapping. The pigment distribution of the specimen from the Raman mapping matched with the microscopic image of the color distribution of the specimen. However, Raman mapping gives more details regarding the components distribution of the pigments in the specimen. Our Raman mapping results would be useful in conservation and restoration of cultural heritages.

Keywords:

Raman mapping, pigment, Korean cultural heritage

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A Study on Temperature-Dependent Optical Properties of $GaFeO_3$ by Spectroscopic Ellipsometry

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Abstract:

Multiferroics have been of interest for applications in microelectronics, spintronics and data storage, including computer hardware industry since the spontaneous magnetic and electric ordering in the same phase. Among the ferrite-based materials, $GaFeO_3$ is one of prominent candidates of multiferroic materials due to the featured properties of large magnetoelectric effect, magneto-optic, and piezoelectric. In order to understand the underlying physics, to design more efficient devices, and to provide an experimental basis for band calculations, the information on the complex dielectric functions $\varepsilon = \varepsilon_1 + i\varepsilon_2$ and critical point (CP) energies is strongly required. In this work, we diagnose the dielectric dependence of dielectric functions of $GaFeO_3$ from 39 to 350 K in the energy range from 0.74 to 6.42 eV by using spectroscopic ellipsometry. Our bulk $GaFeO_3$ sample is single crystal with orthorhombic structure (010) which is confirmed by the X-ray diffraction. A multilayer version of the B-splines method was performed to extract the optical properties of $GaFeO_3$ and the CP energies are determined by standard lineshape analysis using numerically calculated second derivatives of ε with respect to energy. At low temperature, the blue shifts of the dielectric functions and CPs can be observed. These changes can be interpreted by the reductions of the electron-phonon interactions and the lattice constants at low temperatures. The temperature dependences of the CPs were obtained by fitting data to a phenomenological expression that contains a Bose-Einstein statistical factor and a temperature coefficient. These parameters allow the CPs of GaFeO3 to be calculated analytically for any given temperature. This result will be useful in understanding the optical properties of $GaFeO_3$ and in a number of other contexts, including the design of multiferroic devices.

Keywords:
$GaFeO_3$, Ellipsometry, Dielectric function, Temperature dependence

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Optical investigation of the gamma-ray irradiation effects on Pb(Zr,Ti) O_3 thin films

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Abstract:

We investigated the visible emission property of the gammy-ray (g-ray) irradiated Pb(Zr,Ti)O_3 (PZT) thin films with the various total doses up to 1000 kGy. The PZT thin films were prepared on the Pt/Ti/SiO_2/Si substrates by using a sol-gel method with a spin-coating process. It was found that the visible emission emerges near 550 nm with the g-ray irradiation. The intensity of the emission increased with the increasing dose amount. The spectral feature of the g-ray induced emission was quite narrow, which was distinguished from that formed by normal defects such as oxygen vacancy. It could be suggested that the g-ray irradiation should generate a specific type of defect state inside the PZT films, which could be detected by the low temperature photoluminescence spectroscopy. For more understanding, these results were compared with the emission spectra of several ferroelectric polycrystalline samples with the g-ray irradiation.

Keywords:
ferroelectics, photoluminescence

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Interdigital-electrodes-based triboelectric generator for harvesting ocean wave energy

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Abstract:

The ocean energy harvesting technology convert the tidal, wave, current, energy of sea into electricity. The ocean energies have attracted a great deal of attention due to the sea covers more than 70% of the total earth surface. Among the ocean energies, ocean wave energy, which is sustainable and environmental friendly, has been estimated to have the potential to produce 1~10 TW. It is quite important to develop low-cost and high efficiency compatible techniques, due to low efficiency of converting wave energy. In this work, we present a flexible interdigital-electrodes based triboelectric generator for harvesting vibrating mechanical energy. To effectively obtain wave energy through speed and height of wave, interdigital-electrodes are useful. By inserting the aluminum interdigital-electrodes covered with the PTFE tape and water into acrylic tube, we fabricated a triboelectric generator. In shaking mode, the maximum open-circuit voltage and short-circuit current were 20 V and 2.5 uA at 3.8 Hz with 30 ml water, respectively. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2015R1A2A1A16074922).

Keywords:

Inter-digitalled electrode, triboelectricity

파도의 역학적 에너지 수확을 위한 마찰 전기 디바이스

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Abstract:
바다에 존재하는 다양한 역학적 에너지원 중에서, 파도의 역학적 에너지를 수확하기 위한 많은 노력이 있어왔다. 파도의 역학적 에너지를 효과적으로 수확하기 위해서는 역학적 안정성, 항부식성 등 많은 해결하여할 점이 존재한다. 본 연구에서는, 마찰전기현상을 이용하여 파도에 의한 작은 역학적 변형을 이용하여 전기를 발생할 수 있는 디바이스를 구성하였다. 출력을 증가시키기 위해 테플론 폴리머와 알루미늄 전극을 사용하였으며, 아크 형태가 유지 될 수 있도록 PET 기판을 이용하였다. 1 N의 힘을 이용하여, 20 V의 전압, 500nA의 전류 값을 얻을 수 있었다. 실제 바다 환경에 사용하기 위해, 디바이스를 모듈화하였다. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2015R1A2A1A16074922).

Keywords:
마찰전기디비아스

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원통형 마찰 전기 디바이스를 이용한 해양 에너지 수집

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Abstract:
해양의 역학적 에너지를 수확하기 위한 다양한 종류의 마찰 전기 디바이스들이 제시되었다. 이러한 디바이스는 거의 대부분 폴리머와 전극이 평면형태로 되어, 해양 에너지 수확을 위해 다양한 제약이 있어왔다. 본 연구에서는 그물망에 적용가능한 원통형의 마찰 전기 디바이스를 구현하였다. 원통형 관에, 테플론막대와 구리전극을 이용하여 디바이스를 구성하였고, 파도에 의한 원통형 디바이스의 진동에 의해 테플론 막대와 구리 전극의 마찰을 유도하였다. 10 Hz의 주기를 갖는 역학적 진동에 약 20 V의 전압, 2 mA의 전류를 얻을 수 있었다. 이 논문은 2016년 해양수산부 재원으로 한국해양과학기술진흥원의 지원을 받아 수행된 연구임(경기씨그랜트사업)"

Keywords:
해양 에너지 수집, 마찰전기 디바이스

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강유전체 PVDF 폴리머를 이용한 마찰 전기 디바이스의 효율 증대

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Abstract:
천연 자원의 고갈로 인한 에너지 부족 문제를 해결하기 위하여 다양한 방법들이 연구되고 있으며, 마찰 전기를 이용하여 역학적 에너지를 전기 에너지로 전환하여 사용하는 방법이 활발히 연구되고 있다. 기존의 풍력발전이나 수력발전등의 발전은 거대한 구조물과 막대한 초기 투자비용이 문제가 되며, 마찰 전기를 이용한 방법은 이러한 저렴한 가격과 소형화에 장점이 있다. 마찰 전기를 이용한 에너지 하베스팅은 접촉하는 물질의 종류와 표면적 등에 의해 효율을 향상할 수 있지만, 지속적인 접촉으로 인하여 내구성이 감소하는 문제점이 있다. 기존 연구에서는 표면이 스스로 복구되거나, 깊숙한 내부까지 물리, 화학적 처리를 하여 해결하려고 하였다. 이번 연구에서는 미리 폴링된 PVDF 필름을 사용하여 표면에 대전되는 전하의 양을 늘리고, 대전되는 시간을 감소시키며, 방전되는 시간은 지연하는 효과를 보았으며, 내구성 감소의 근본적인 원인인 마모 문제를 비접촉 방법을 이용한 발전으로 해결하였다. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2015R1A2A1A16074922).

Keywords:
PVDF, 마찰전기

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비정질 $Li_2B_4O_7$-$BiFeO_3$의 결정화 동역학 연구

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Abstract:
서로 다른 성질 또는 유사 특성을 나타내는 물질을 혼합한 복합재료에 대한 연구가 활발하다. $Li_2B_4O_7$는 압전, 탄성 표면파, 비선형광학 물질이며, $BiFeO_3$는 상온 이상에서 강유전성과 강자성을 나타내는 대표적 다강체 물질이다. 이러한 유사 특성의 $Li_2B_4O_7$와 $BiFeO_3$를 혼합하여 유리로 제조하고, 결정화 과정에 대한 정보를 획득함으로써 나노, 유리-세라믹에서 나타나는 강유전성 및 압전성에 대한 전단계 연구를 수행하였다. $BiFeO_3$와 $Li_2B_4O_7$를 1:1의 몰 비율로 혼합하고, 용융 급랭법으로 유리를 제조하였다. 열분석 장비를 이용한 유리의 결정화 과정에서는 두 개의 발열 봉우리가 나타났으며 첫 번째는 $Li_2B_4O_7$, 두 번째는 $BiFeO_3$ 결정상 형성에 기인함을 밝혔다. 승온율 변화에 따른 비등온 실험으로부터 Avrami 지수 및 결정화에 필요한 활성화 에너지를 구하였으며, 이를 통해 결정 핵 생성 및 성장 방식을 해석하였다.

Keywords:
유리, 복합재료, 강유전체, 결정화 동역학

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등온법을 이용한 고전압 커패시터 $BaO-Na_2O-Nb_2O_5-SiO_2-B_2O_3$ 유리의 결정화기구 연구

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Abstract:
고전압 커패시터를 구현하기 위해 유전 상수가 큰 물질에 유리 형성제를 첨가한 유리-세라믹 소재 활용에 대한 관심이 높으며 이 중 하나가 $Ba_2NaNb_5O_{15}$ (BNN)이고, 유전 상수 ε ~240, T_c=560 ℃이다. 고전압 커패시터의 절연파괴 강도는 유리, 유리-세라믹, 결정크기에 따라 상이하며 이에 대한 연구가 진행 중이다. 본 연구에서는 유리형성제가 첨가된 BNN 유리 (($25.6BaO-6.4Na_2O-32Nb_2O_5$)$-24SiO_2-12B_2O_3$ (BNNSB))를 고온 용융 급냉법으로 제조하였다. BNNSB 유리의 결정화 과정에 따른 열, 구조, 표면 특성을 DTA, XRD, AFM을 이용하여 실험하였다. 온도가 증가함에 따라 BNNSB 유리는 orthorhombic BNN 결정상과 SiO_2와 B_2O_3 유리상이 공존하는 복합상으로 상전이하고 결정크기는 온도에 무관하게 ~50 nm로 일정하게 나타남을 알 수 있었다. Johnson-Mehl-Avrami-Kolmogorov 모델을 적용하여 결정화에 대한 활성화 에너지 및 Avrami 지수를 구하고 결정화기구를 밝혔다.

Keywords:
유리-세라믹, 결정화기구, Johnson-Mehl-Avrami-Kolmogorov 모델

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Topological evolution of the ground state property of the Floquet insulator based on Black Phosphorene

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Abstract:

Initiated by the outstanding performance of graphene as a bona fide Dirac material, various two-dimensional materials have been experimentally developed, which can serve as new building blocks to realize van der Waals heterostructure with distinct functionality. Among them, black phosphorus has drawn special attention due to its finite gap and anisotropic band structure. At the same time, new materials exhibiting non-trivial topological order have appeared and there have been tremendous research activities to observe the phase and to investigate their properties in the past decades. In our work, we have studied topological properties of black phosphorene monolayer under AC electric fields by using the Floquet method. For black phosphorene monolayer, the band structure can be described by tight-binding Hamiltonian with two-atoms in unit cell and pseudo spin can be defined. We have found that when the AC field induces a resonance between quasi-energy levels at certain intensity, meron and anti-meron pair of pseudo spin configurations can emerge at two band minima leading to non-trivial Chern number. We have also shown that for the phase with nonzero Chern number, gapless edge states in the quasi-energy band are formed in the nanoribbon structures. For experimentally observing the topological evolution of the Floquet insulator with varying AC field, we have calculated the transverse current, which clearly demonstrates the expected behavior. *This work is partially supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2016R1D1A1B01013756).

Keywords:

Floquet Insulator, Black Phosphorene

Low temperature STM and STS study of single crystalline GeTe (111) surface and its annealing effect

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Abstract:
As one of prototype materials used to data storage or disk optics application, GeTe can help to understand archetypal displacive ferroelectric system related Ge- and Te- based alloy. Despite various interests, a more accurate atom-resolved research of single crystalline GeTe surface still hardly has been studied. Here, we investigated as-cleaved and annealed surfaces of single crystalline GeTe (111) surface using low-temperature scanning tunneling microscopy and spectroscopy. After cleavage sample at 120 K, we found that as cleaved GeTe (111) surface reveal at least two types of terraces at 78 K. Origin of each terraces are able to distinguish as not only distinctive I-V curve but also scan stability conditions, with each being attributed to Ge-terminated, and Te-terminated surfaces. Also, we can compare to two cases of annealing temperature. Surface moderately elevated temperature to 350 K induces and extended defect network structures while annealing GeTe surfaces to high temperature introduces new transformation of surface morphology. We will present these data and discuss the mechanism in the formation of these structures.

Keywords:
STM, STS,Single crystalline GeTe

First-principles study of selectively adsorption of rhodamine B on graphene surface

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Abstract:
Graphene grain boundary (GGB) has been known to affect an electrical properties and mechanical strength of graphene. Therefore, it is important to observe the GGBs in polycrystalline graphene using specific tool for controlling the fundamental properties of graphene. Experimentally, a new method of observing GGBs using fluorescence microscopy (FM) was presented [1]. Rhodamine B (RB) is usually used as fluorescence molecules. It was found that RB selectively adsorbed on GGBs on oxidized Cu substrate is easily visualized by FM. In this point of view, we have performed density functional theory calculations using Vienna ab initio simulation package (VASP) to investigate the effect of oxidized Cu substrate on binding of RB on graphene. We consider RB on graphene on several types of oxidized Cu substrate. We find that RB is more strongly adsorbed on oxidized copper surface than clean copper surface. Then, we discuss the difference in binding behaviors between RB and graphene on various oxidized copper surfaces. Furthermore, we calculate the binding energies of RB on pristine graphene and defected one with Stone-Wales defect. [1] D.-W. Shin et al., Observation of graphene grain boundaries through selective adsorption of rhodamine B using fluorescence microscopy, Carbon, 108, 72 (2016)

Keywords:
First-principles, Graphene, Rhodamine B, Copper oxide

First-principles study of ferromagnetic contact between Ni and MoX_2 (X = S, Se, or Te)

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Abstract:

Two-dimensional layered materials have drawn much attention for application in various electronic devices. Among them, transition metal dichalcogenides (TMDs) are being actively investigated for the use of its unique atomic and electronic characteristics in electronic devices such as field effect transistors (FETs). For device applications of TMDs, we need to understand various contact behaviors between metal and TMDs. In this study, we have performed density functional theory (DFT) calculations to investigate the contact behavior between metal and several TMDs. Especially, we consider the ferromagnetic contact between Ni and MoX_2 (X = S, Se, or Te). Our calculations show that Fermi level is not simply aligned by work function difference between Ni(111) and MoX_2, representing the Fermi level pinning (FLP). Additionally, spin splitting occurs at conduction band offset (CBO) or valence band offset (VBO) with magnetic moment in MoX_2 induced by Ni. Details in electronic structure are analyzed in terms of partial density of states (PDOS), projected band structures and charge density difference.

Keywords:

Ferromagnetic contact, Ni-TMD interfaces, Fermi level pinning, First-principles study

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Short and Ballistic Josephson Coupling in lateral Graphene Junctions

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Abstract:

Much efforts have been made to reach the short and ballistic limit of Josephson coupling, but they were often hindered by poor interfacial characteristics between superconducting electrodes and the normal-conducting insert or by the weak superconducting coherence. Recent breakthrough in enhancing the carrier mobility, employing the graphene structure encapsulated by hexa-boron-nitride (BGB) layers, allows reaching the truly ballistic regime in graphene. Closely edge-contacted BGB structure with two superconducting electrodes seems to provide a promising scheme to realize the ballistic Josephson coupling. Here, we report on realizing lateral graphene Josephson coupling, in which Al superconducting electrodes with the long superconducting coherence range, is made a one-dimensional contact to the edges of the BGB structure. Our device shows exceptionally high transmission probability and Fabry-Perot oscillations, demonstrating its ballistic nature. The superconducting gap energy 2Δ of Al electrodes was about 200 meV at 10 mK, determined by multiple Andreev reflection. We observed that the critical currents oscillate for sweeping the gate voltage along with the normal conductance oscillation, which is a direct evidence of ballistic Josephson coupling. The I_cR_N product (I_c and R_N are the critical current and the normal resistance, respectively), a parameter representing the Josephson coupling strength, was estimated to be ~$2\Delta/e$, the largest value in lateral graphene Josephson junctions ever reported. We also observed the convex shape of decreasing critical currents with increasing temperature, canonical properties of short Josephson junction.

Keywords:
ballistic Josephson coupling, graphene Josephson junction

Observation of domain switching dynamics in epitaxial $BiFeO_3$ thin films using modified piezoresponse force microscopy

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Abstract:
Ferroelectric thin films have attracted considerable attention because they are used for non-volatile ferroelectric random access memories (FERAM). In particular, nanoscale non-volatile domains can be applied to ultrahigh density (above 10 TbBit inch^{-2}) data storage. Therefore, it is necessary to understand the domain dynamics during ferroelectric switching. Switching current measurements can be used to extract information about the switched charge, switching time, and activation field. We report the domain nucleation and growth in the polarization switching process of epitaxial $BiFeO_3$ (BFO) thin films using piezoresponse force microscopy. To fabricate epitaxial BFO thin films, we deposited BFO/$SrRuO_3$ epitaxial layers in situ on $SrTiO_3$ (001) substrate using pulsed laser deposition. The x-ray diffraction analysis show that the films are exclusively characterized by [001] growth. To investigate the nanoscale domain dynamics during the switching process in BFO thin films, we used the step-by-step switching method suggested by Gruverman et al. The results, visually confirmed that nanoscale domain behavior varied according to the switching time. Based on these results, nanoscale domain switching dynamics in BFO thin films will be discussed.

Keywords:
Epitaxial $BiFeO_3$, Domain switching dynamics, Piezoresponse force microscopy

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Van-der-Waals-gap tunneling spectroscopy for carbon nanotubes with asymmetric contact electrodes

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Abstract:
We report the new type tunneling spectroscopy technique for low dimensional nanostructures by using the natural Van-der-Waals (vdW) gap interface, by adopting indium (In) as an electrode metal on nanostructures, in our case, carbon nanotubes. Indium metal is known to form a physisorption interface with a vdW gap, which causes little disruption to the density of states of the low dimensional nanostructure near the metal interface and allows the optimum tunneling gap for spectroscopy without making an artificial tunnel barrier. To secure the single tunneling barrier for spectroscopy between In and carbon nanotube, we fabricated the devices with different contact materials, In and Pd. One (In) is for tunnel barrier, the other (Pd) is for ohmic barrier. We show that observed multiple differential conductance peaks for varying bias voltages up to ~ 2 V as a function of gate voltages correspond to the sub-band structures representing the characteristic van Hove singularities in electronic density of states of one dimensional nanostructure.

Keywords:
Tunneing spectroscopy, low dimensional nanostructures, carbon nanotube

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Quantized conductance in bilayer graphene constrictions

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Abstract:
Transport across top-gated short constrictions of bilayer graphene is investigated in zero magnetic field. Realizing a quasi-one-dimensional (1D) channel along a physically tailored bilayer graphene turns out to be extremely challenging due to scattering by the edge disorder and charged puddles. In this study, to minimize the edge scattering and obtain the ballistic quasi-1D channel in bilayer graphene, we adopted short constrictions of bilayer graphene encapsulated between a pair of hexagonal boron nitride (hBN) layers. Lateral confinement of charge carriers in physically tailored (~130 nm wide and ~50 nm long) hBN-encapsulated bilayer graphene leads to the formation of quasi-1D channels showing quantized conductance steps close to $2e^2/h$ for varying the Fermi wavelength. Voltage bias spectroscopy reveals an energy spacing of ~7 meV between subbands formed by laterally bound carrier states.

Keywords:
bilayer graphene, conductance quantization

Superconducting proximity effect via quantum-Hall edge states in graphene hybrid devices

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Abstract:
Andreev reflection (AR), a retro-reflection of an incident electron as a hole or vice versa at a superconductor-normal metal interface, leads to the formation of an Andreev edge state that consists of a coherent pair of an electron and a hole in a strong magnetic field [1]. The coexistence of AR and quantum Hall (QH) effect in semiconducting two-dimensional electron systems has been confirmed in two-terminal conductance measurement configurations where bulk and longitudinal contributions are bound to be contained. Here, we report signature of the Andreev edge state formed in mono- and bi-layer graphene devices with three-terminal measurement configuration. A high-mobility graphene layer, encapsulated by hexagonal boron nitride crystals [2], was in proximity contact with a Nb electrode having a high critical magnetic field (H_{c2} ~ 3.5 T at T = 160 mK). The high carrier mobility of our graphene layers allowed the formation of QH edge states in perpendicular magnetic fields as low as ~1 T. The signature of AR was clearly visible along with Landau-level modulating signals in the bias dependence of both upstream and downstream sides of QH edge states corresponding to high filling factors ($\nu \geq 28$). [1] H. Hoppe et al., Phys. Rev. Lett. 84, 1804 (2000). [2] L. Wang et al., Science 342, 614 (2013).

Keywords:
graphene, quantum Hall effect, Andreev reflection

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Raman Measurements of SnS_2 and $SnSe_2$ with Various Excitation Sources

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Abstract:

Atomically layered 2-dimensional (2D) materials such as graphene, MoS_2, WS_2, WSe_2, GaS, GaSe, SnS_2 and $SnSe_2$, and black phosphorous, have attracted much interest due to their potential optoelectronic applications, which result from their unique atomic structures. Among these 2D materials, SnS_2 and $SnSe_2$, which are earth abundant and environmentally friendly and exhibit many promising properties including high carrier mobility and remarkable performance photodetector [1, 2], are less explored. In this work, we investigate the properties of mechanically exfoliated SnS_2 and $SnSe_2$ using micro-Raman spectroscopy with different excitation energies. The thickness of the studied materials are identified by optical microscope, and then confirmed with atomic force microscopy (AFM). The intra-layer Raman modes and low-frequency shear and breathing modes are analyzed and their dependence on the excitation energy is investigated. References: [1] Xing Zhou, Lin Gan, Wenming Tian, Qi Zhang et al., Adv. Mater., 27, 8035-8041 (2015). [2] Y.-B. Yang, J. K. Dash, A. J. Littlejohn, Y. Xiang et al., Cryst. Grwoth Des. 16, 961-973, (2015).

Keywords:
Raman spectroscopy, 2D materials, SnS2, SnSe2

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External electric field effects on Raman and photoluminescence spectra of few-layer MoS_2

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Abstract:
We conducted Raman and photoluminescence (PL) measurements on few-layer MoS_2 under an external electric field (E-field) by using ion-gel top-gating technique. In the Raman spectra of few-layer MoS_2 with the 1.96 eV excitation energy, which is close to the A and B exciton energies of MoS_2, anomalous resonant Raman behaviors were observed due to the exciton-phonon coupling.[1] These resonance effects are changed under the external E-field, because the exciton energies of MoS_2 are tuned by an external E-field.[2] We generated a controllable E-field in the MoS_2 device by applying a topgate voltage (V_{TG}) through ion-gel. For the PL measurements, we observed redshifts of the A, B exciton and the indirect bandgap PL when V_{TG} was increased. In the Raman spectrum excited by the 1.96 eV, the resonance effects, such as peak enhancements and appearance of second-order modes, were stronger for negative V_{TG}. Therefore, we conclude that the resonance behaviors, which are observed in the resonance Raman spectrum with the 1.96 eV excitation energy, are related with the A exciton. References [1] J.-U. Lee et al., Nanoscale 7, 3229 (2015). [2] A. Chernikov et al., Phys. Rev. Lett. 115, 126802 (2015).

Keywords:
MoS_2, Raman, photoluminescence, E-field

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박막형 $LiT_xMn_{2-x}O_4$ (T = Ti, Cr) 이차전지 양극의 구조적 변화 및 충·방전 특성 탐구

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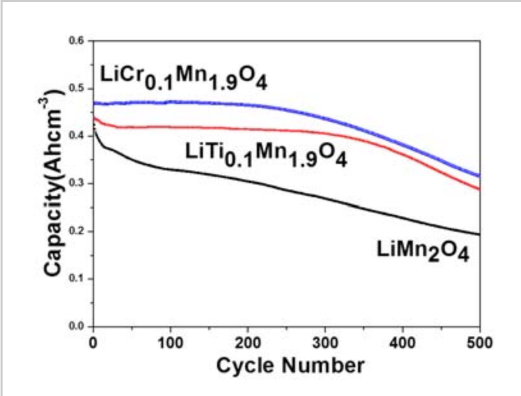

Abstract:

리튬(lithium) 스피넬(spinel) 산화물 $LiMn_2O_4$를 기반 물질로 하여 주기율표 상에서 Mn과 인접한 전이금속 원소(T = Ti, Cr)를 소량 치환시킨 $LiT_xMn_{2-x}O_4$ ($x \le 0.3$) 화합물 박막 시료들을 졸-겔(sol-gel) 방법 및 동일한 후열처리 조건하에서 제작하였다. X-ray diffraction(XRD), X-ray photoelectron spectroscopy(XPS), 전기화학적 실험 등을 이용하여 전이금속 치환에 따르는 화합물의 구조적 성질, 양이온 분포, 이차전지 양극 특성 변화 등을 조사하였다. XRD 분석 결과 제작된 화합물 시료 모두 Fd3m 정스피넬(normal spinel) 구조를 유지하며 어떠한 2차상도 나타나지 않았으며, $LiTi_xMn_{2-x}O_4$ 경우 Ti 치환량의 증가에 따라 격자상수가 증가, $LiCr_xMn_{2-x}O_4$ 경우 Cr 치환량의 증가에 따라 격자상수가 감소됨을 확인하였다. XPS 분석 결과 Ti 이온들은 대부분 +4의 이온수를 가지지만 Cr 이온들은 +3 및 +4를 가짐이 나타났다. 제작한 화합물 시료들을 비커셀 형태의 반전지로 조립하여 전기화학적 조사를 수행한 결과, 전이금속 치환된 화합물 양극에서 기반 물질 $LiMn_2O_4$ 보다 향상된 충·방전 싸이클 특성(charchar/discharge cyclability)을 얻었으며 그 원인에 대하여 고찰하였다. 우측의 그림에서는 충·방전 횟수가 증가함에 따르는 반전지들의 방전 용량 변화를 관측한 결과를 비교하였으며, Cr 및 Ti 적정량 치환에 의하여 방전 용량이 증가하였음을 보여주어 이차전지 응용 시 더 우수한 성능을 나타낼 수 있을 것으로 예측된다.

Keywords:
$LiMn_2O_4$; 전이금속 치환 ; 스피넬 구조 ; 이차전지 특성

Synthesis and characterization of $Ni_{0.65}Zn_{0.35}Fe_2O_4$ ferrite nanoparticles for hyperthermia applications

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Abstract:

Magnetic hyperthermia treatment is one of the cancer therapies to eliminate cancer tissues by increasing their temperature above 42 °C. In this process, magnetic nanoparticles are injected into the tissue area and subjected to an oscillating magnetic field that causes the material to generate heat. Ni-Zn ferrite nanoparticles in powder form were synthesized via high temperature thermal decomposition method. Ni-Zn ferrite nanoparticles are potential candidates for hyperthermia applications because their Curie temperature can be tailored to lie between 42 - 46° C [1]. The morphology and phases of the sample were characterized by X-ray diffraction and transmission electron microscopy (TEM). The nanoparticles were found to be spherical in shape with average diameter of 10 nm. ICP measurements were carried out to confirm the chemical composition of the sample. Magnetic heating of aqueous suspensions of nanoparticles in the presence of RF magnetic field of 5.5 kA/m with frequency of 260 kHz was observed as shown in Fig.2 below. [1] Maria et al. International Nano Lett. 3:42. 2013. Figure 1: XRD patterns. Figure 2: Heating curve of aqueous solution of $Ni_{0.65}Zn_{0.35}Fe_2O_4$ nanoparticle.

Keywords:
Ni-Zn-ferrite nanoparticles, magnetic hyperthermia

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Electrical Probing of the Scanning Probe Microscopy by using Electrolyte-Cantilever

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Abstract:
We present a new method of the electrochemical and the mechanical analysis at the nanoscale level by developing new cantilever which has a built-in electrolyte. Freely to add, change, and control the liquid electrolyte to the cantilever is expected to significantly improve the application and functionality of the cantilever. The scheme of an electrolyte cantilever is the adsorption of electrolyte on the tip side. The cantilever can get a sponge-like characteristic by coating the organic compound. The organic coated cantilever is performed at both DFM and EFM. In the DFM measurements, the coated cantilever shows insensitive to phase shift, however, it does not disturbs imaging of topography i.e., the change of amplitude of the tip sample interaction. In the EFM measurement, the phase image shows plat phase which means insulating property of coated material. In addition, the EFM is performed before and after absorption of electrolyte. The effect of electrolyte is shown obviously in the phase images. The topography is not affected by the electrolyte absorption. The conductivity has been successfully adjusted without interference of topography. The electrostatic measurement shows a stable image comparing to the use of a general conductive non-contact cantilever.

Keywords:
electrolyte, cantilever, SPM, dophamine aqueous solution

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Observation of Mg-induced structural and electronic properties of graphene

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Abstract:

We report the formation of superstructures induced by Mg adatoms on a single layer graphene (SLG) formed on Ni(111) substrate, where a strong metallic parabolic band is found near the Fermi level at the Γ-point of the Brillouin zone. Our valence band and core level data obtained by using synchrotron photons indicate that Mg adatoms intercalate initially to lift the SLG from the Ni substrate to produce a well-defined π-band of SLG, and then the parabolic band appears upon adding extra Mg atoms on the Mg-intercalated SLG. Our scanning tunneling microscopy (STM) images from these systems show the presence of superstructures, a $2\sqrt{3}\times2\sqrt{3}$ phase for the intercalated Mg layer below the SLG and then a $\sqrt{7}\times\sqrt{7}$ phase for the Mg overlayer formed on the Mg-intercalated SLG. We discuss physical implications of these superstructures and the associated parabolic band in terms of a possible graphene-based two-dimensional superconductivity.

Keywords:
Graphene, Superconductivity, Superstructure, 2DEG (2-Dimensional Electron Gas)

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Visible light modulated phototransistors based on ZnO and CdSe/ZnS quantum dots

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Abstract:
Visible-light modulation of phototransistor based on ZnO and quantum-dots have been studied. The device have been fabricated using a solution processable ZnO thin film and CdSe/ZnS quantum-dots. Typically, ZnO film cannot absorb a visible light and generate a photocurrent with an illumination of visible light due to their wide band gap. However, by using the quantum-dots which can absorb the visible-light, our device showed an enhanced photocurrent according to the illumination of visible light with a wavelength of 635 nm. Moreover, a high photoresponsivity of 14,602 A/W and external quantum efficiency of 2.792×10^4 were obtained. We will discussed a detail in this presentation.

Keywords:
oxide semiconductor, phototransistor, quantum dots

Structural study of inorganic-organic hybrid thin films with two dimensional perovskite structure prepared by spin-coating method

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Abstract:
These days, perovskite type inorganic-organic hybrid materials are drawing attention because they have a lot of possible applications for s solar cells and thermoelectrics and spintronics. $(C_6H_5CH_2CH_2NH_3)_2MnCl_4$ (Mn-PEA) and $(C_6H_5CH_2CH_2NH_3)_2CuCl_4$ (Cu-PEA) are of the inorganic-organic hybrid material of two dimensional perovskite system and crystallize in the same space group (No. 61, P 2_1/b 2_1/c 2_1/a) at room temperature. Although the lattice parameters of these materials are almost same (a = 7.207Å, b = 7.301Å, c = 39.413Å for Mn-PEA, a = 7.187Å, b = 7.344Å, c = 38.549Å for Cu-PEA), their magnetic behaviors are totally different (antiferromagnetic for Mn-PEA, T_N=43K, ferromagnetic for Cu-PEA, T_c=10K). In this study, we will present the production process of the inorganic-organic hybrid thin film with 2D perovskite type on Si(001) substrate with native oxide using spin-coating method and the crystallographic results of Mn-PEA, Cu-PEA thin films and Cu-PEA/Mn-PEA heterostructure thin films using x-ray reflectivity (XRR) and cross-sectional transmission electron microscopy (XTEM). Reference [1] Park et al., Dalton Trans. Vol. 41, 1237 (2012) [2] Polyakov et al., Chem. Mater. Vol. 24, 133 (2012)

Keywords:
spin-caoting, inorganic-organic hybrid, thin films

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Impedance Spectroscopy of Surface States in Bi_2Se_3 Nanoparticles

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Abstract:

Increasing the surface-to-volume ratio is one way of detecting the metallic surface states in topological insulators. In this work, we address the issue by employing impedance spectroscopic measurements. Bi_2Se_3 nanoparticles with different surface-to-volume ratios were synthesized and measured. Admittance plots are well fitted with an equivalent circuit consisting of two separate resistance terms. One is independent of surface-to-volume ratio and the other is inversely proportional to the surface-to-volume ratio, indicating that the latter term represents the unusual metallic surface states in the topological insulator. Acknowledgements This work was supported by the National Research Foundation of Korea (Project No. 2016005659)

Keywords:
topological insulator, Bi_2Se_3, impedance spectroscopy, bismuth selenide, surface state

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Facile Transfer of Embedded Ultra-long single crystalline VO_2 Nanowires by Simple Heat Treatment

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Abstract:
Vanadium dioxide (VO_2) is one of the most fascinating strongly-correlated materials due to its metal to insulator phase transition (MIT) that takes place at a temperature slightly above room temperature. We successfully synthesized ultra-long single crystalline VO_2 nanowires with the length over 1mm and diameters ranging from 150~200nm on Y-cut quartz substrates. This platform offers the unique opportunity to unveil the nature of MIT and the distribution of the phases along the length of the nanowires. We found that current-voltage characteristics and MIT temperature varied along the length of nanowire due to the subtle interaction with the substrate. Further, we developed a facile transfer of embedded ultra-long VO_2 nanowires on to other substrates for further processing by releasing the structural constraint imposed by lattice mismatch in-between the VO_2 nanowires and the Y-cut quartz substrates via a simple heat treatment. We fabricated multiple VO_2 nanowire based devices with over 80 electrodes equally positioned along the length of VO_2 nanowire and performed systematic electrical measurements as a function of temperature, attempting to elucidate the origin of inhomogeneous distribution of phases originated from a subtle interaction with the substrate.

Keywords:
ultralong, VO_2, nanowire, metal insulator transition, Y-cut quartz substrate

The Hybridizations of Cobalt 3d Bands with the Electron Band Structure of the Graphene/Cobalt Interface on a Tungsten Substrate

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Abstract:

Since the realization of graphene with exceptional transport properties, a lot of research efforts have been devoted to fabricate graphene-based spintronic devices. One of the efforts has been to enhance spin polarization of graphene through the formation of an interface with a ferromagnetic substrate. Here we present our study on graphene/cobalt interface grown on a tungsten substrate. Using angle-resolved photoemission spectroscopy, we found that cobalt 3d bands strongly influence the physical properties of the interface. The measured electron band structure of the interface showed clear discontinuities at the crossing points with the cobalt 3d bands that are attributed to the hybridization of the cobalt 3d bands with the electronic states in graphene and tungsten, and the interference of the cobalt 3d bands with the quantum-well states in cobalt. We believe that our findings would provide valuable information to understand the electro-magnetic properties of graphene/ferromagnet interface.

Keywords:

Graphene, Cobalt, ARPES, Interface, Spintronic

반쪽 금속 강자성체 CrO_2의 연 X선 방사광 분광 연구

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Abstract:

대부분의 전이금속 산화물은 절연체이면서 반강자성 (antiferromagnetic) 을 띄는 반면, CrO_2는 금속성 강자성을 띄는 매우 흥미로운 물질이다. 특히 CrO_2는 반쪽금속 강자성체 (half-metalic ferromagnet) 로 페르미 준위 근처에서 거의 100% 스핀 분극 (spin polarization) 이 일어나는 특성이 있어서 가장 기대되는 차세대 스핀트로닉스 (Spintronics) 소재 중 하나로 연구되고 있다 [1]. 또한 CrO_2는 거대자기저항 (giant magnetoresistance: GMR) 현상을 보이기도 한다 [2]. 이론 연구에서는 자기 도핑 (Self-doping) 이 Cr 이온의 혼합 원자가 (mixed valent) 상태와 산소를 매개로 한 이중 교환 (double exchange: DE) 상호 작용을 발생시킨다고 제안되었다 [3]. 그리고 NMR 연구에 의하면 CrO_2에서 두 가지 원가자 상태가 섞여있다고 보고되었으나 [4] 이 결론에 대해서는 아직 논란이 있다. 본 연구에서는 연 X선 방사광 분광법을 이용하여 분말 상태의 CrO_2의 Cr 이온의 원자가 상태를 연구하였다. 연구 내용은 방사광을 이용한 연 X-선 흡수 분광법 (soft X-ray absorption spectroscopy: XAS)과 연 X-선 자기원편광 이색성 (soft X-ray magnetic circular dichroism: XMCD) 분광법 실험을 수행하였다. 이 연구를 통해, XMCD의 온도 의존성과 퀴리 온도 (T_C) 가 약 ~ 390 K 임을 확인할 수 있었다. 또한 Cr 이온의 원자가는 표면 근처에서는 3+와 4+가 섞여 있으나, 내부에서는 거의 4+에 가까운 것을 알 수 있었다. 이 연구 발표에서는 CrO_2 의 전자구조와 이 물질의 반쪽금속 강자성 물성과의 상관 관계에 관하여 발표할 예정이다. [1] R. J. Soulen et al., Science 282, 85 (1998). [2] S. Biswas et al., Mater. Chem. Phys., 100, 6 (2006). [3] M. A. Korontin et al., PRL. 80, 4305 (1998). [4] J. H. Shim et al., PRL. 99, 057209 (2007).

Keywords:
반쪽 금속, CrO2, XAS, XMCD

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STM을 이용한 $SnSe_{1-x}S_x$ 표면구조 연구

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Abstract:

SnSe와 SnS는 최근 열전효과를 연구하는 분야에서 큰 흥미를 끌고 있으며, 다양한 방법으로 연구되고 있다. 이번 발표에선 $SnSe_{1-x}S_x$ solid solution을 저온주사터널링현미경(low temperature Scanning Tunneling Microscopy, STM)과 DFT image simulation을 이용해 원자구조와 전자구조를 관측한 결과를 발표하고자 한다. 원자수준의 $SnSe_{1-x}S_x$를 연구한 결과, 실제 원자구조가 어떻게 되는지 관찰할 수 있었고 SnSe와는 다른 밝은 영역과 어두운 영역을 관측할 수 있었다. 또한 STS(Scanning Tunneling spectroscope)측정을 통해 $SnSe_{1-x}S_x$가 p-type 특성을 가진 반도체라는 것을 확인할 수 있었다.

Keywords:

STM, $SnSe_{1-x}S_x$

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에너지 절감을 위한 colorized 단열 멀티 코팅에 대한 효율 연구

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Abstract:
온난화에 따른 에너지 절감에 대한 심각성과 필요성이 대두됨에 따라 냉난방 부하를 위한 적외선 제어 기술에 대한 시장의 수요는 지속 증가하고 있어 한국, 중국, 일본의 많은 업체에서 관련 기술이 적용된 제품을 출시하고 있다. 따라서 본 연구에서는 단열멀티코팅박막을 제조하여 그 단열성능을 확인하고자 하였다. Wet coating 방식이 아닌 DC sputter를 이용한 Dry coating 방법으로 내구성 부분에서 장점을 부각시켰다. 또한 기존 제품들과 차별화를 위하여 colorize 를 통해 Design적인 측면을 더하여 소비자의 다양한 기호에 충족 할 수 있게 설계 되었다. 또한 colorize에 따른 효율성능을 test 하여 제품화에 대한 가능성을 확인하였다. . 사용된 물질들은 저굴절률 물질로 B-Si 타겟을 이용한 SiO_2 를 reactive 방식으로 제작하였고, 고굴절률 물질로 TiOx 타겟을 이용하여 같은 방식으로 박막을 제조하였다. 결과는 UV-visible로 투과도를 측정하였으며 엘립소미터를 이용해 굴절률 및 박막의 광학적인 특성들을 조사하였다.

Keywords:
sputtering, Oxide, Refractive Index, Colorize

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Visible Luminescence Tuning by Element Selective Annealing and Oxide Matrix Etching on Silicon Nanocrystals

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Abstract:

There has been many studies on the size independent luminescence of silicon nanocrystals (Si-NCs). Unlike size dependent luminescence based on quantum confinement effect (QCE), a size independent luminescence could be achieved by selecting appropriate elements in post-annealing process or etching the oxide matrix to make free standing silicon nanocrystals. In these ways, it could make possible to reproduce all over the range of the visible emission from red to blue by using silicon related nanostructures. In this work, we investigate the size independent luminescence properites of Si-NC by selecting hydrogen or nitrogen gase as an annealing ambient, and etching away the oxide matrix by using a very acid chemical. The samples are prepared by the chemical fabrication method based on $HSiCl_3$ and distilled water. After the chemical process, thermal annealing was performed for formation of H- and N-passivated Si-NC in H_2 and N_2 atmosphere. Finally, etching process with HF solution was performed for liberating the H or N passivated Si-NC. We performed PL measurments and found the results; The untreated Si-NC embedded in SiO_2 matrix is red-shifted more than the other passivation treated samples. And also the N-passivated Si-NC is blue-shifted more than the H-passivated Si-NC. To investigate the origin of the luminescent peak position change, we performed additionally TRPL, FTIR and XPS measurements. We discuss the various factors to influence the shift of emision spectral range and what causes such kind of the shift behavior. [Acknowledgements: NRF-2016M2B2A4912288, NRF-2015R1D1A1A01060381]

Keywords:
silicon nanocrystals, PL, size independent luminescence

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Unusual electron self-energy of graphene on a variable dielectric constant material

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Abstract:

Interactions between two different materials sometimes induce novel physical properties that do not exist in each material alone or provide a viable route towards the comprehension of intrinsic physical properties of each material. By using angle-resolved photoemission spectroscopy, we study unusual electron self-energy that is not observed when graphene stands alone. Our findings reveal the role of a variable dielectric constant substrate on the electronic properties of graphene.

Keywords:
graphene, interface, dielectric constant, ARPES

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Ab initio study of strained graphene nanowrinkles on Ni(111) substrate

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Abstract:

Recently, an unique electronic structure of sub-5-nm graphene nanowrinkles (GNWs) on Ni(111) has been reported: one-dimensional van Hove singularity in the GNWs was found using scanning tunnelling spectroscopy, and the possibility of controlling the bandgap by mechanical structuring was suggested. However, the previous experimental study lacks theoretical analysis related to the interaction between GNWs and Ni(111). In this study, we investigate the interaction of GNWs with the underlying Ni(111) substrate using density functional theory calculations. Especially, we focus on the change in electronic structure of GNWs due to the presence of the substrate

Keywords:
Ab initio, Graphene, Ni(111)

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철 산화물 나노입자 제작 및 크기 변화에 따른 자기적 특성 연구

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Abstract:
전자소자의 소형화 추세로 인해 나노사이즈 크기에서의 물리적 현상에 대한 체계적인 이해는 현대물리학의 당면과제이다. 나노사이즈 크기의 자성입자의 경우 임계크기 이하로 작아지게 되면서 준안정적인 상태의 자기요동을 유발하는 초상자성 현상이 나타나는데 이해 대한 정확한 이해가 유한 크기 체계에서의 자성이론 측면은 물론 나노크기 자성입자의 직접적인 응용을 위해 필수적으로 요구된다. 본 연구에서는 철 산화물 나노입자 시료를 sol-gel 방식으로 합성하여 크기 변화에 따른 자기적 특성의 변화를 조사하였다. 반응 온도를 변화시켜 시료의 크기를 조절하였고[1] HR-TEM 분석을 통해 평균 지름이 6.49nm, 6.65nm, 8.81nm 인 시료들이 제작되었음을 확인하였다. 자기적 특성은 초전도 양자 간섭 소자(Superconducting Quantum Interference Device, SQUID)를 이용한 dc magnetization 측정을 통해 조사하였고 세 시료 모두에서 유사한 초상자성 특성이 나타남을 확인하였다. 물론 세부적인 특성에서는 시료들 간의 차이가 있음도 확인되었는데 예상한대로 입자의 평균 크기가 증가함에 따라 blocking temperature, critical temperature가 증가함을 보였다. 한편 saturation magnetization 값도 시료에 따라 차이가 있음을 확인하였는데 이는 크기 변화에 따른 $\gamma-Fe_2O_3$와 Fe_3O_4 의 상대적인 비율의 변화에 기인하는 것으로 이해된다.[1] 또한 나노자성입자에서 blocking temperature distribution에 기인한 전형적인 형태의 magnetic memory effect를 관측하였고[2], blocking temperature distribution에 대한 분석연구도 수행하였으며 그 결과도 발표할 예정이다.[3] [1] C. Martínez-Boubeta et al., PRB 74, 054430 (2006) [2] Malay Bandyopadhyay et al., PRB 74, 214410 (2006) [3] T.H. Lee et al., PRB 90, 184411 (2014)

Keywords:
철산화물, 나노자성입자, 초상자성, 메모리 효과, blocking Temperature

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전해질 내에 Sodium Silicate 농도가 플라즈마 전해 산화에 의해 형성된 마그네슘 산화막 특성에 미치는 영향

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Abstract:
마그네슘 합금의 표면처리기술 중 하나인 플라즈마 전해 산화는 알칼리 전해액을 사용하는 친환경적 기술로서 마그네슘 합금의 단점인 내부식성을 향상시켜 내구성이 요구되는 자동차 경량화 소재로의 응용 가능성을 높이는 기술이다. 이러한 플라즈마 전해 산화는 전해액 내에서 절연파괴로 플라즈마가 발생하여 금속의 용해된 이온들과 전해질의 전기분해에 의한 금속이온이 마그네슘 합금 표면에서 산소와 반응하여 산화막을 형성하는데, 사용하는 전해질의 조성은 산화막 특성에 결정적인 역할을 지닌다. 본 연구에서는 Potassium hydroxide와 Sodium phosphate dodecahydrate으로 이루어진 전해액에 Sodium Silicate 농도를 변화시키면서 추가하여 전해액을 제조하여 실험을 수행하였다. 전해액 내의 Sodium Silicate 농도에 따른 마그네슘 산화막 특성을 SEM, AFM 등을 통하여 표면미세조직, 표면 거칠기, 산화막 두께 등의 표면 특성을 살펴보았다. 전해액 내의 플라즈마 방전을 위하여 직류전원장치를 사용하였다. 전해액내의 Sodium Silicate의 농도가 증가하면 표면의 기공이 작아질 뿐만 아니라 표면 거칠기도 더 매끄러워짐을 알 수 있었다.

Keywords:
마그네슘 합금, 플라즈마 전해 산화, Sodium Silicate, 첨가제 농도

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Annealing dependence of ferroelectric domain patterns in h-REMnO$_3$

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Abstract:

Topological vortices with complex ferroelectric domains and domain walls exist in hexagonal rare-earth manganites(h-REMnO$_3$), which undergo a structural transition accompanying ferroelectric polarization and trimerization. The density of vortex domain network strongly varies depending on heat treatment conditions. When h-REMnO$_3$ crystals are grown below the ferroelectric-trimerization transition temperature (Tc), they exhibit stripe domains(Type-Ⅱ). However, when a h-REMnO$_3$ crystal with stripe domains is heated above and cooled down across Tc, vortex domains form(Type-Ⅰ) in the crystal. We report piezoresponse force microscopy (PFM) studies of the h-REMnO$_3$ single crystal (HoMnO$_3$, YMnO$_3$) utilizing variation annealing environments.

Keywords:
ferroelectric domain, h-REMnO$_3$, piezoresponse force microscopy

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Study on the cytotoxicity of graphene nanosheet for blood-coagulation protein employing molecular dynamics simulation

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Abstract:
Graphene is one of the representative nano-materials, which has been widely used in the fields of electronics, biomedicine and drug delivery system. Despite of high applicability of the graphene to diverse fields of industry, however, the study on the cytotoxcity of graphene is not sufficient. In this study, we investigate the interaction of graphene nanosheets with blood-coagulation proteins on the lipid bilayer membrane employing molecular dynamics simulation. Based on this molecular dynamics simulation result, we discuss the cytotoxicity of graphene at the molecular level.

Keywords:
graphene nano-sheet. molcular dynamic simulation, blood-coagulation

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First-principles study of metal adatom adsorption on blue phosphorene

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Abstract:

We have investigated the structure, adsorption energy, growth mode, diffusion barrier, magnetic property, dipole moment, and work function of Li, Na, Mg, Al, Cr, Fe, Co, Ni, Mo, Pd, Pt, and Au doped blue phosphorene using first-principles density-functional theory. We have found that all the adatoms prefer to stay on the hollow site of hexagonal. It seems that the Li, Na, Mg, Pd, and Au adatoms may have two-dimensional (2D) growth mode on phosphorene substrate, whereas all other adatoms prefer three-dimensional (3D) growth mode. The metallic state is observed in Li, Na, Al and Cr doped systems and the Cr doped phosphorene displays magnetic state. The other eight metals doped systems still preserve semiconducting band gap. Among them, we obtained spin polarized band structures in Fe, Mo, Co, and Au doped systems with a band gap. In particular, the Mo doped phosphorene can be a potential candidate for dilute magnetic semiconductor material because no clustering problem will take place. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and future planning (2016R1A2B4006406)

Keywords:
first-principles calculation, blue phosphorene,

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태양광 발전시스템의 외장 발수를 위한 전이금속이 첨가된 TiO_2 박막의 표면 특성

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Abstract:

독립형 태양광 발전시스템의 고온다습 환경신뢰성을 향상시키기 위해서 외부 환경에 노출된 태양광 컨트롤 박스의 외장에 발수 또는 방오 등의 기능성 코팅이 필요하다. 본 연구에서는 컨트롤 박스 외장 상에 투명 발수 코팅을 목적으로 우수한 광촉매로 널리 알려진 TiO_2 박막을 습식공정인 스핀코팅으로 제조하여 표면특성을 살펴보았다. 또한, TiO_2에 Nd 및 W의 전이금속을 첨가하여 불순물의 첨가효과를 살펴보았다. 일반적으로 코팅 박막이 발수성질을 얻기 위해서는 나노-마이크로 크기의 거칠기를 가지는 표면을 만드는 것인데, 이를 위한 TiO_2 결정입계는 적당한 표면거칠기를 구성하여 물방울이 박막표면과 최소한으로 접촉하게 공기가 존재하는 공간으로서 역할을 한다. 본 실험에서 TiO_2 박막, Nb가 첨가된 TiO_2 박막, W이 첨가된 TiO_2 박막 등 3종류의 박막을 제조하여 첨가 농도별 발수 특성 및 표면 특성을 비교분석하였다. AFM, 자외선-가시광 투과율, 접촉각 측정 등을 이용하여 박막의 표면구조, 접촉각, 광학적 특성을 살펴보였다. 이러한 결과들을 바탕으로 최적의 외장 코팅제 조성 및 코팅 공정 조건을 알아보았다

Keywords:

기능성 코팅, 전이금속 첨가, 발수 기능, 표면 특성, TiO_2 박막

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2016.10.19 - 2016.10.21

Infinite Parallel Plates Algorithm

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Abstract:

Based on the isomorphism between the electrostatic Poisson problem and the corresponding diffusion motion expectation of the first-passage, we develop a new parallel-plates algorithm. The parallel-plates algorithm uses a series solution for the induced-charge density on the parallel plates by a charge at the center between the parallel plates, combined with the acceptance-rejection sampling method. We find that the new parallel-plates algorithm is much more efficient than the old "Walks-on-Spheres" (WOS) one.

Keywords:
Infinite Parallle Plates, WOS, Monte Carlo

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2016.10.19 - 2016.10.21

Strain-dependent magnetic orderings in layered transition metal trichalcogenide CrSiTe3: A first-principles study

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Abstract:

Among many transition metal chalcogenides with layered structure, CrSiTe3 has been suggested as one of the candidates of two dimensional ferromagnetic semiconductors due to its small band gap energy and high Curie temperature. Here we report results of first-principles electronic structure calculations for the magnetic ground states and their strain dependence of CrSiTe3 in different layer configurations. We observe that a ferromagnetic ordering is prefered when either the number of layers or the tensile strain increase, which is consistent with the observed ferromagnetic ground state of bulk CrSiTe3. The three-layer configuration of CrSiTe3, however, exhibits an interesting behavior of magnetic ordering which has magnetic moment only for inner layer. The interlayer interactions appear to play a crucial role in determining the magnetic ordering. Further we expect that this kind of magnetic state can also occur in bulk structure of CrSiTe3.

Keywords:

TMC (transition metal chalcogenides), two dimensional ferromagnetic semiconductors, magnetic ordering, first-principles electronic structure calculations

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Effects of spin-orbit coupling on the electronic structure of band-gap inverted bulk black phosphorus

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Abstract:
We study effects of spin-orbit coupling on the electronic band structure of bulk black phosphorus (BP) by first-principles calculations when the conduction band minimum and the valence band maximum are inverted. Without the spin-orbit coupling, our calculation shows that the crossing points of the valence and conduction bands in the band-gap inverted bulk BP form a closed loop in the momentum space. When we include the spin-orbit coupling in our calculations, the crossing of the valence and conduction bands is lifted at every point in the loop with k-dependent splitting size. We analyze the symmetry of the atomic structure and the orbital character of the wave functions to understand the effects of spin-orbit coupling in bulk BP. This work was supported by NRF of Korea (Grant No. 2011-0018306) and KISTI supercomputing center (Project No. KSC-2016-C3-0002).

Keywords:
black phosphorus spin-orbit coupling

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2016.10.19 - 2016.10.21

Electronic structures and topological properties of YbB6 and YbB12

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Abstract:

Kondo effect has been recently suggested as a new mechanism of driving topological phase in strongly correlated systems. Since the Kondo effect occurs with varying temperature, the topological nature of these systems is expected to be temperature-controllable. Rare-earth borides, such as SmB_6 and YbB_6, are reported to be main candidates of such topological Kondo systems. In this study, we have investigated electronic structures and topological properties of YbB_6 and YbB_{12}, which were reported to have non-trivial topology at high and ambient pressure, respectively. We have identified their topological nature based on DFT and DFT+DMFT band calculations.

Keywords:
Kondo effect, topological matter, electronic structure

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2016.10.19 - 2016.10.21

전하가 주입된 Si(5512)-2x1표면에서 스핀편극 계산 연구

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Abstract:
자기 전자공학(spintronics)에 기반한 대용량 저장장치에 쓰이는 스핀소자를 만들기 위해서는 무엇보다도 스핀편극 특성의 물질이 필요하다. 실리콘은 값싸고 넓은 기반시설을 갖추고 있어 반도체 소자의 원료로 널리 사용되지만, 보통 스핀편극 특성을 가지지 않아 실리콘 원료로 스핀소자 개발은 어렵다. Si(5512)-2x1표면에는 표면원자 재배열에 의해 다양한 표면 원자구조들이 있다. 특히 Si(5512)-2x1은 표면의 계단구조 끝머리에서 그래핀 가장자리와 비슷한 벌집구조를 가진다[1]. 그래핀은 벌집구조 가장자리에서 스핀편극 특성을 가지는데, 실리콘과 탄소는 같은 4족 원소이고 원자구조가 비슷하다면 Si(5512)-2x1의 벌집구조에서도 그래핀 가장자리 같은 스핀편극 특성이 있을 것으로 예측 할 수 있다. 본 연구에서는 스핀편극 제일원리 계산방법으로 전하가 주입 된 Si(5512)-2x1표면의 전자구조와 밴드구조, 스핀상태에 대해 연구했다. 제일원리 계산방법으로는 VASP(Vienna Ab-initio Simulation Package)를 이용했다. 연구결과 Si(5512)-2x1표면에서 홀 이나 전자가 도핑 된 정도에 따라 표면구조의 스핀편극 된 전자 구조가 상이하다. Si(5512)-2x1표면에 6개의 홀을 도핑했을 때 벌집 사슬구조의 매달린 결합(dangling bond)을 가진 실리콘 원자주변의 전자구조에서 스핀편극이 있다. 이는 전하가 도핑된 Si(5512)-2x1표면이 스핀소자의 새로운 소제가 될 가능성이 있음을 시사한다.

Keywords:
surface, silicon,spin polarization, Si(5512), DFT

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2016.10.19 - 2016.10.21

Ab-initio studies on polymorphism and phase transition in MoS_2

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Abstract:

Recently, MoS_2 has been widely studied due to its relatively simple fabrication and much functionality with other materials in many areas. In particular, one of the most interesting properties of MoS_2 is polymorphism that MoS_2 can exist in various phases with distinct properties such as semiconducting 2H-MoS_2, metallic 1T-MoS_2. 1T'-MoS_2, 1T''-MoS_2. Here, using first principles calculations, we investigate the electronic properties and lattice dynamics of each phases, and systematically estimate the required energy for phase transition between 2H and 1T, 1T', 1T''. We expect that our studies can provide the fundamental information to understand polymorphism and phase transition in various transition metal dichalcogenides(TMDs).

Keywords:
Density functional theory,MoS2, Transition metal dichalcogenides, Phase transition

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2016.10.19 - 2016.10.21

First Principle Study of Structure and Electronic Properties with strained GeTe

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Abstract:
Using ab initio density functional theory, we investigate the structural and electronic properties of GeTe, which would be used for phase change random access memory. We focus on a conductance variation in accordance with structural deformation. It is found that its layered structure may be modified by applying uniaxial tensile stress along the (22-1) direction, resulting in significantly different electronic behaviors, such as variation of band gap or electronic conductivity. We ascribe such modification of the electronic properties to the change in its structural symmetry due to tensile strain. We find that the uniaxial stress induces intermediate bonds between layers, which are responsible of the electronic structure modifications. We apply the Boltzmann transport theory to explore the dependence of its conductivity on the structural deformation.

Keywords:
GeTe, Strained structure

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2016.10.19 - 2016.10.21

B20 구조를 가지는MnSi의 응력효과 따른 전자구조 및 자기적 특성에 대한 제일원리계산

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Abstract:

MnSi의 구조는 단위 낱칸당 망간 원자 4개와 실리콘 원자 4개로 이루어져 있으며 비대칭구조를 가지고 있다. 또한 실험에서의 MnSi이 덩치일때 격자상수는 4.558 Å 으로 알려져 있으며 이때의 망간의 자기모멘트는 0.4 μ_B 으로 알려져 있다. 그러나 본 계산에서 얻은 격자상수는 4.52 Å 일때 강자성이 가장 안정적이었으며 자기모멘트는 0.96 μ_B 을 갖는 것으로 계산되었다. 이를 실험치와 비교했을 때 2배 이상 큰 수치였다. 본 연구에서는 응력에 의한 전자구조의 변화 와 그에 따른 자기모멘트의 변화에 대한 경향성을 확인하여 보았고 본 연구에서 고려된 응력의 범위는 a, b 방향으로 계산에서 얻은 총 에너지 최소의 격자상수를 중심으로 -3 % (압축응력)에서 +3 % (인장인력)까지 격자상수를 변화시켜 가면서 자성을 계산하였는데 a, b방향으로의 -3 % 의 압축응력 하에서의 Mn 당 자기모멘트가 0.814 μ_B 으로 줄어 들었고 +3 % 의 인장응력 하에서는 자기모멘트는 1.017 μ_B 로 증가하였다. 이러한 자성의 변화는 응력에 따른 체적의 변화에 따른 것으로 예상된다.

Keywords:
자성, B20구조, MnSi

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2016.10.19 - 2016.10.21

Evolution of crystal structures of GeTe under phase transformation

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Abstract:

We investigated the distorted crystal structure of GeTe observed during the phase change process. Using density functional theory (DFT) calculations, four possible crystal structures were identified: R3m, P1, Cm, and Fm3m. Among these, P1 and Cm are crystal structures newly examined in the present study. By calculating the internal energy of volume changes, we verified that P1, R3m, and Cm can coexist in crystalline GeTe. XRD spectra for annealed and laser-irradiated GeTe films showed evidence of coexisting P1 or R3m and Cm. Moreover, we also confirmed that the Cm structure transforms to P1 or R3m structure after a laser irradiation process. Raman spectra well described the generation of these new structures. Many of the Raman peaks of the crystalized GeTe can be explained by the coexistence of various structures in the GeTe materials of real devices. By calculating the band gap of each structure, we also found that the structural transformation induces changes in resistance arising from differences in the band gaps. The generation of new crystal structures suggests facile phase change and instability during the structural transformation

Keywords:
GeTe, Crystal structure, Raman, Electronic structure

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2016.10.19 - 2016.10.21

Quantum Monte Carlo study on blue phosphorus

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Abstract:

Blue phosphorus is one of stable layered materials among phosphorus allotropes like black phosphorus, but with less puckered honeycomb structure. It is predicted to be a semiconductor with indirect band gap and its monolayer was very recently synthesized on Au(111) surface [1]. Noting that density functional theory (DFT) calculations generally suffer from describing many-body correlations in the layered materials, we have performed quantum Monte Carlo (QMC) simulations, where the many-body Schrödinger equation is directly solved with stochastic processes, to investigate accurate ground-state properties of blue phosphorus. We obtain the optimized lattice parameter for single-layer blue phosphorus under QMC scheme and assess its stability against black phosphorus by making thorough finite-size analysis. We also quantify interlayer binding energies and interlayer distances for bilayer and bulk blue phosphorus and compare them with the DFT results based on several different exchange-correlation functionals. [1] J. L. Zhang et al., Nano Lett. 16, 4903 (2016)

Keywords:
blue phosphorus, black phosphorus, quantum Monte Carlo, many-body, 2D material

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2016.10.19 - 2016.10.21

Structural and Electronic Properties of CdS/ZnS Core/shell Nanowires: A First-principles Study

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Abstract:

Carrying out density functional theory (DFT) calculation, we studied the relative effects of quantum confinement and strain on the electronic structures of II-IV semiconductor compounds with a large lattice-mismatch, CdS and ZnS, in the core/shell nanowire geometry. We considered different core radii and shell thickness of the CdS/ZnS core/shell nanowire, different surface facets, and various defects in the core/shell interface and surface regions. To properly describe the band level alignment at the core/shell boundary, we adopted the self-interaction correction (SIC)-DFT scheme. Implications of our findings in the context of device applications will be also discussed.

Keywords:
core/shell nanowire, DFT, SIC-DFT

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Low-lying energy bands in a periodic potential and energy eigenvalues in a multiple-well potential

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Abstract:

The low-lying energy eigenvalues in finite periodic potentials have long been studied and it is known that the eigenvalues of the finite periodic system in one dimension may be given from those of the corresponding periodic system with some discrete "Bloch phases." Recently, in Ref. [1], we provide a formula for the energy eigenvalues of a finite periodic system, explicitly written in terms of the potential; it turns out that the eigenvalues of the finite periodic system are not degenerate while the formula could reproduce the width of the energy bands of the Mathieu equation in the large amplitude limit of the cosine potential (see, e.g., Ref. [2]). Here, after introducing the methods to evaluate the widths of the tight-binding energy bands, the eigenvalue structures of some systems of multiple-well potential without the finite periodicity will be examined. [1] D.-Y. Song, arXiv:1608.01052v1 [2] G. Catelani, R.J. Schoelkopf, M.H. Devoret, L.I. Glazman, Phys. Rev. B 84 (2011) 064517.

Keywords:
Finite periodic potential, Tight-binding approximation, WKB method, Triple-well potential

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2016.10.19 - 2016.10.21

Controlling CO_2 capture process on Sc-, Ti-, and V-porphyrin-like graphene with mechanical strain

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Abstract:
Nanomaterials such as zeolites and metal-organic frameworks have been studied for the purpose of the CO_2 capture to mitigate global warming. However, this application of those materials has been limited largely because of their poor selectivity for flue gases as well as low CO_2 capture capacities under low pressures. We here perform first-principle density-functional theory calculations on the CO_2 capturing processes of Sc-, Ti-, and V-porphyrin-like graphene structures through the uniform change of their uniform mechanical strains. At room temperatures, we find that a Sc atom can selectively attract CO_2 molecules from gaseous mixtures at 1.5% compression to the substrate under low CO_2 pressures (~10^{-3} bar) and releases them with less constriction. On the other hand, Ti and V are found to have poor CO_2 selectivity from flue gases under the same condition. We find that the CO_2 binding to Sc involves the hybridization of the metal d orbitals with the CO_2 π orbitals, similar to the one observed experimentally in CO_2-transition metal complexes. Our results open a new possible approach of the CO_2 capture process using the mechanical strain to nano substrates.

Keywords:
CO_2 capture, mechanical strain, transition metal, porphyrin-like graphene

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2016.10.19 - 2016.10.21

Implementation of phonon dispersion with LO-TO splitting in OpenMX for studying polar materials

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Abstract:
Phonon dispersion relation combined with LO-TO splitting has been successfully developed in OpenMX to study polar materials in comparison with experimental results. In phonon calculations, specific phonon modes at a selected k-point can be extracted to show its vibrational modes by equation of motion. In addition, the projected phonon density of states (PhDOS) is able to be simulated by summation of contributions of atom(s) over all phonon bands. And, all of the projected PhDOS sum up to the true PhDOS. In this poster, we examined phonon dispersions of polar materials and corresponding properties, such as SiC and MgO crystals.

Keywords:
phonon, OpenMX

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2016.10.19 - 2016.10.21

Magnetic properties of ferromagnetic semiconductors of single-layer $CrXTe_3$ (X = Si, Ge, and Sn): A first-principles study

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Abstract:

Enormous research efforts have been focused on two-dimensional (2D) layered semiconductors due to the potential applications in nanoscale electronics, photonics, valleytronics, photovoltaics, and so on. Particularly, the layered magnetic semiconductors which can display both semiconductor characteristics and magnetic ordering are advantageous for nano-spintronics applications. Recently, theoretical studies reported that single-layer (1L) materials including MnS_2, $CrSiTe_3$, $CrGeTe_3$, and $CrSnTe_3$ have been predicted to have coexistence of ferromagnetic and semiconducting properties. Very recently, it has been revealed through the experimental verification that the exfoliated few-layer samples of $CrSiTe_3$ retained the p-type semiconducting property. In addition, temperature-dependent resistivity measurements for the few-layer $CrSiTe_3$ devices indicate a clear change in resistivity at elevated temperatures of 80 - 120 K. In this work, we have performed the first-principles calculations to investigate extensively the electronic and magnetic properties of 1L-$CrXTe_3$ (X = Si, Ge, and Sn). Detailed discussion of strain, carrier doping, and electric field effects on magnetic properties of 1L-$CrXTe_3$ will be given.

Keywords:
Ferromagnetic semiconductor, $CrSiTe_3$, Spintronics, First-principles calculation

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Interaction of a borazine molecule and the Pt(111) surface: First principles study

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Abstract:
Recently two-dimensional (2D) layered materials are very attractive in various fields because of their interesting properties. For this reason, the study for formation process and growth mechanism of 2D materials has been one of the intensive topics of low-dimensional systems. Using the density functional theory (DFT), we study the absorption structures of borazine/Pt(111) and the hydrogen desorption in the system. Borazine (B3N3H6) similar to the benzene molecule is used as a precursor molecule in chemical vapor deposition of a 2D material, h-BN. First, we perform extensive search for absorption structures of borazine on the Pt(111) surface. Next, we calculate the energy barrier of hydrogen desorption from the most stable structure. Although a hydrogen atom dissociates from the borazine molecule on Pt(111) with an energy gain, the total energy of the system increases as more hydrogen atoms dissociate. We expect that this theoretical study will provide a better understanding in growth of h-BN.

Keywords:
DFT, Pt(111) surface, borazine, hBN, 2D material

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Carbon dioxide adsorption and conversion by metal-porphyrin-like graphene structures

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Abstract:
The consequences of rapid and substantial human-induced global climate change could be far-reaching. Nowadays, carbon dioxide (CO2) is pointed out as the biggest causes of the global warming. So removal of CO2 for environmental remediation has attracted significant interest. In this work, the catalytic reaction transforming CO2 into formic acid (HCOOH) on the selected materials, metal-porphyrin-like graphene structures, was explored using nudged elastic band (NEB) method. In order to searching for a most efficient condition of a composition of air, the reaction rate was calculated with thermodynamics.

Keywords:
Carbon dioxide, first principle calculation, catalytic reaction, thermodynamics

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Local atomic properties on phase change materials $Ge_2Sb_2Te_5$: Ab initio study

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Abstract:

Using ab initio density functional calculations, we investigate the structural properties of the ordered crystalline and disordered amorphous phases of $Ge_2Sb_2Te_5$, which would be expected for phase change random access memory, and their phase transition mechanism. We find various possible structural configurations of $Ge_2Sb_2Te_5$ and identify the equilibrium structure of each of their respective crystalline. Then, we carry out molecular dynamics (MD) simulation to obtain its amorphous phase. First, we perform a pre-melting process with high temperature and low density, to make completely disordered structures. Then, we let each system experience a liquefaction at temperature a little higher than its melting point with a normal density. After this stage, a quenching process is performed from the temperature of the previous stage to room temperature. Finally, we perform a thermal equilibration step at the room temperature. Through all these processes of our MD simulation, we collect all necessary thermodynamic variables and evaluate their ensemble averaged values. To identify the local atomic configurations in the various phases of $Ge_2Sb_2Te_5$, we calculate their radial distribution functions, angle distribution functions and order parameters as a function of coordination numbers. In addition, we check nearest neighbor population of each atoms in crystalline and amorphous phase to find more specific local atomic structures. From these results, we analyze the structural characteristics of both phases and discuss a possible mechanism of their phase transition.

Keywords:
PCRAM, phase change material, $Ge_2Sb_2Te_5$

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First principles study on the electrical and thermoelectric properties of isoelectronic doping in SnSe*

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Abstract:
SnSe has been well-known as an excellent thermoelectric material with the highest ZT up to 2.6 at high temperature [1]. Recently, there has been much attention on the thermoelectric properties of SnSe-based materials [2][3]. In this work, we present first-principles study on the electrical and thermoelectric properties of SnSe by isoelectronic doping such as C, Si, and Ge; S and Te doped to either Sn or Se site, with 3.125~6.250% concentration. Among those dopants, C gives a big modification of band structure with the shift of defect levels into the band gap region, whereas changes in band structure by other dopants are negligible. Associated thermoelectricity such as Seebeck coefficient, electrical conductivity, and power factor is presented in more detail. [1] L. D. Zhao et. al. Nature 508, 373 (2014). [2] D.D. Cuong, S.H. Rhim, Joo-Hyoung Lee, and S.C. Hong , AIP Advances 5(11), 117147 (2015). [3] S.U. Kim, A.T. Duong, S. Cho, S.H. Rhim, and J. Kim, Surf. Sci. 651, 5 (2016). * This work is supported by grants from the Priority Research Centers Program (Grant No. NRF-2009-0093818) and the Basic Science Research Program (Grant No. NRF-2015R1A2A2A01003621) through NRF funded by the MOE and MSIP of Korea.

Keywords:
SnSe, thermoelectric, isoelectronic doping

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Effective tight-binding models of gapped Bernal multilayer graphene

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Abstract:

Single and multilayer graphene show a metallic behavior under usual experimental conditions. Recent experiments in suspended ultraclean multilayer graphene have revealed the presence of band gaps in even layered Bernal multilayer graphene up to eight layers. In this study, we investigate the possible mechanisms leading to an electron-electron interaction induced gap-opening near the Dirac points of even numbered few-layer graphene. For this purpose we construct the Hamiltonian of multilayer graphene using a minimal model as well as an accurate tight-binding model whose hopping parameters are informed from local density approximation density functional theory (DFT) calculations. Our study allows to identify the role of the remote hopping terms in a tight-binding model of multilayer graphene in configuring the features of the bands near the Brillouin zone corners relevant for their electronic properties. Based on this insight and within a mean-field framework we propose plausible models of the Coulomb interaction that can justify the presence of band gaps in multilayer graphene. [Acknowledgements : NRF-2015R1D1A1A01060381, NRF-2016R1A2B4010105]

Keywords:
even layered Bernal multilayer graphene, tight-binding model, band-gap opening

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Effects of Fe-atom on electronic and catalytic properties of two-dimensional C_2N Crystals : A first-principles study

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Abstract:

On the basis of DFT calculations, we here explore the effects of porous embedded iron atoms and substrate on C_2N-h2D [1] layers in terms of oxygen reduction reaction. For the research of complex hybrid interface, C_2N-h2D layers encapsulating an iron substrate are introduced and investigated, in contrast to such single atom catalyst approach. [2-4] We first carry out the atomic structures and corresponding electronic structures of the iron embedded C_2N (Fe@C_2N), and elucidate the effects of iron atoms and the substrate. Next, this study demonstrates superior oxygen reduction reaction (ORR) efficiency of the Fe@C_2N, comparing that of pure C_2N We will also present that effects of iron substrate on C_2N and Fe@C_2N in ORR, respectively.
References J.Mahmood et al, Nat Commun., 6, 6486 (2015). D.W. Ma et al, Carbon, 105, 463-473 (2016). Xiyu Li et al, J. Phys. Chem. Letter, 7, 1750-1755 (2016) B.L.He et al, Phys. Chem. Chem. Phys, 18, 24261-24269 (2016)

Keywords:
DFT, C2N, ORR, 2D-materials

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Understanding Oxidation Mechanism of MoS2 Slab and Ribbon; First Principles Calculations

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Abstract:
In recent years, two dimensional monolayer materials including graphene, hexagonal boron nitride and transition metal dichalcogenide (TMDCs) are gaining considerable attraction of scientific community due to the remarkable electronic and structural properties[1]. Due to the lack of band gap in graphene, TMDC materials are replacing graphene in many fields and becoming more promising candidate for a wide variety of application[2]. Moreover transition metal oxides (MoOx) have various important applications in catalysis, solid state micro batteries, lubricants, recording material and gas sensor. In this work we studied oxygen substitution of MoS_2 2D slab and 1D nano-ribbon to investigate oxidation at surface and edges respectively. Using first principles calculations[3], we calculated the formation energy of oxygen on pristine, defect and edge sites. Our results will give basic understanding of oxidation mechanism of MoS_2 which will help to design experiment efficiently.

Keywords:
TMDCmaterials,MoS2, MoOx, First principles calculations,Formation energy

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Ultrafast Electronic Rearrangement in Fe_3O_4 studied -by x-ray Absorption Spectroscopy Using Laser Plasma x-ray Source

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Abstract:
Ultrafast time- resolved X-ray absorption spectroscopy experiment was performed on a Fe_3O_4 by using a femtosecond laser plasma x-ray source [1] delivering Cu K_α (~ 8.05 keV) and Bremsstrahlung radiation. Temporal evolution of the absorption of Fe_3O_4 after excited by a pump infra-red beam of 10 mJ/cm^2, was observed using a jitter free pump-probe scheme with a time resolution near 100 fs. The x-ray energy resolution achieved by a graphite crystal (HAPG) spectrometer was better than $E/\Delta E < 2000$ which was enough to resolve the x-ray absorption near edge spectrum (XANES) features.The Fe_3O_4 x-rays absorption edge started to shift towards the low energy when IR pump and X-ray probe pulses overlap. The shift in x-rays absorption edge towards the low energy was as large as 10 eV which is attributed to the the reduction of Fe^{3+} to Fe^{2+}. This shift in absorption edge occurred within a 300 fs which is typically the time constant of non-thermal electronic distribution above the Fermi level. Using femto-second pump-probe x-ray absorption spectroscopy, we observed that there occurs ultrafast electronic rearrangement in Fe_3O_4 after excited by IR pumping signal. We believe that ultrafast electronic rearrangement can now be investigated using a laboratory scale table top x-ray source.

Keywords:
X-ray, Iron Oxide, Edge Shift, Time resolved , laser plasma x-ray source

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Finite Element Analysis of Internal Deformation Field Distribution of ZSM-5 Zeolites during Hydrocarbon Adsorption

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Abstract:
ZSM-5 zeolites, nano-porous aluminosilicates, are used widely as applications of sorbents, molecular sieves, and catalysts. In particular, catalytic process including adsorption, desorption and diffusion is depending on their pore sizes and intracrystalline channels' connectivity. During the catalytic process, we observed unique deformation field distribution of ZSM-5 during the absorption of hydrocarbon, in this case, propylene by Coherent X-ray Diffraction (CXD) imaging. In this work, we calculated the lattice displacement of zeolite by Finite Element Analysis for ZSM-5 with the thermal expansion coefficients from high resolution X-ray powder diffraction experiments in propylene and in vacuum environment. The simulation shows a good agreement with the experimental result of CXD. From the results, we were able to set a modified model from the hourglass[1],[2] and core-shell model[3] suggesting the possibility of new internal architecture of a small size ZSM-5. [1] Phys. Chem. Chem. Phys., 2011, 13, 15985–15994 [2] J. Phys. Chem. B 2001, 105, 10217-10222 [3] Nature materials, 2013, 12.8: 729-734.

Keywords:
Zeolite , ZSM-5 , Coherent X-ray Diffraction , Catalysis , Finite Element Analysis

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Kinetics of Internal Strain of Zeolites during the Catalytic Process

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Abstract:
Ion exchanged zeolites are well known heterogeneous catalysts in selective reduction chemistry from the chemically active sites inside of their subnanometer-sized channels. It is highly useful to investigate the local deformation field affecting the pore size and the channel connectivity, as both are related to the catalytic efficiency of the zeolite catalyst. In this study, we report the in-situ local strain development of Cu ion exchanged ZSM-5 zeolite during the NO decomposition catalysis with propylene using coherent X-ray diffraction imaging with an X-ray free electron laser. As a result, the adsorption and desorption processes of the reactants over the specific locations of the ZSM-5 sample are responsible for the unusual strain developed during the catalytic process. The calculation by the finite element analysis shows a good agreement with our results. This research was supported by the National Research Foundation of Korea, ICT & Future Planning of Korea. (Nos. NRF-2015R1A5A1009962, NRF-2014R1A2A1A10052454 and NRF-2016R1A6B2A02005468)

Keywords:
Bragg Coherent X-ray Diffraction Imaging, Zeolite, Catalysis, X-ray Free Electron Laser

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Resolution Improvement of Coherent X-ray Diffraction Imaging by sub-pixel motion

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Abstract:
Coherent X-ray Diffraction Imaging is a lensless non-destructive imaging technique that provides a phase or strain inside an isolated object in addition to its shape by iterating phasing retrieval algorithm from the diffraction patterns. The resolution of both real and reciprocal space is mainly determined by a pixel size of detector and a sample to detector distance (SDD). In this work, we improve the resolution by taking images with sub-pixel motion of the detector in a given experimental condition of the detector and SDD, and by combining the images after. The images are taken by overlapping some portion of the detector smaller than the pixel size. The simulation is performed by accumulating four images generated by staggered binning of the original image. The result with half pixel motion shows increasing resolution by four times. This research was supported by the National Research Foundation of Korea and ICT &Future Planning of Korea (Nos. NRF-2015R1A5A1009962 , NRF-2014R1A2A1A10052454, NRF-2016R1A6B2A02005468)

Keywords:
Improving Resolution,Coherent X-ray Diffraction Imaging, Sub-pixel Shifted Accumulation, Synchrotron, X-ray Free Electron Laser

Characterization of the coherence property of XFEL in shot-to-shot by Young's double slit experiment.

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Abstract:
X-ray Free Electron Lasers(XFELs) are promising facilities that will make a breakthrough because they produce not only brighter, but also far more coherent light than previous light sources. Due to the stochastic nature of XFEL experiment, the degree of coherence of every single pulse may differ, therefore a technique to determine a single-shot coherence measurement is necessary. We recorded diffraction patterns of three double slits with different separation, exposed by unfocused beam from SACLA. This data was analyzed in every single-shots, in order to look on the spatial degree of coherence in one pulse. In spite of fluctuation in the incident intensity, we found that high spatial coherence was achieved. We also examined a focused beam diffracted by two gold particles, which made two-pinhole diffraction patterns on the detector. The same investigation as above shows that focused beam also has high degree of spatial coherence. We expect this approach will make a reliable determination of the spatial coherence of PAL-XFEL, which must be confirmed in advance to coherent diffraction imaging.

Keywords:
x-ray free electron laser, spatial coherence, coherence measurement, coherent diffraction imaging, Young's experiment

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람다구도의 루비듐 기체셀에서 비-고전적 광자 쌍 생성

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Abstract:
우리는 람다구도(Λ-scheme)의 루비듐 원자 기체셀에서 자발 사-광파 조화(spontaneous four-wave mixing) 방법을 이용하여 좁은 선폭(~ MHz)의 상관된 광자 쌍을 생성했다. 그리고 코시-슈바르츠 부등식(Cauchy-Schwarz inequality :)을 이용하여, 이 생성된 광자 쌍이 비-고전적 광자 쌍임을 확인하였다. 이 좁은 선폭의 비-고전적 광자 쌍을 이용하여, 양자광학 실험을 다양하고 효율적으로 수행하려 한다.

Keywords:
자발 사-광파 조화, 코시-슈바르츠 부등식

Young's double-slit interference pattern from a high power THz gyrotron based Laguerre Gaussian beam

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Abstract:
Laguerre Gaussian(LG) beams carrying orbital angular momentum (OAM) are associated with an azimuthal phase structure exp(ilθ), where θ is the angular coordinate and l is the azimuthal index. There are several ways to evaluate the topological charge of LG beams. In Young's double slit experiment, the topological charge is simply measured from the interference pattern. A Gaussian beam encounters exactly the same phase at each slits and thus the interference fringes remain straight lines. Otherwise, the LG beam has spiral phase pattern so the beam has phase differences at each slits. When the phase differences are superposed in between the two interfering paths, the interference pattern is shifted, and the propagated beam pattern gives a twisted interference pattern. Also, the tilting degree will be increased by increasing a number of topological charge. The detail of the experiment will be explained in a talk. Simulation study and experiment results will be compared, and the results show that the interference patterns are clearly identified as characteristic of orbital angular momentum beam.

Keywords:
young's dexperiment, laguerre gaussian beam, phase identification

Average Refractive Index Distribution measurement by Dual-wavelength Digital Holographic

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Abstract:

The refractive index distribution of optical component strongly influences a wavefront propagation. Knowledge of refractive index distribution of optical component is very important, not only in characterizing the phase transformation and aberration correction, but also in controlling the optical quality of the elements. Now a day, aspheric lens are commonly used in digital equipment, digital camera, mobile phone copiers, and other device. Most aspheric lenses are made by injection molding method. Numerous approaches, including the scanning refracted ray imaging, interferometric, and ellipsometric methods, have been presented to investigate the refractive index of a transparent optical element. However, these approaches depend on scanning or a movable mechanism, along with fringe counting and data fitting procedures, for determining position accurately and making full-field measurements from which all of the phase information and spatial refractive index profile of the element can be obtained. Additionally, the procedures of decoupling the refractive index from the optical path length for micro-optical elements of an unknown thickness or with a curved surface are relatively cumbersome and time-consuming. In this work we propose another method for determining the average refractive index distribution of phase object, dual wavelength holography with liquids without knowledge of the three dimensional shape information.

Keywords:

Digital holographic, Phase retrieve, Refractive index

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3-D Measurement of Fine Metal Mask using Fringe Projection Profilometry

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Abstract:

Automated and precise three-dimensional (3D) shape measurement is an important task in quality control. There is a variety of methods to measure the shape of diffusely reflecting surfaces, including fringe projection and stereo sensing, and interferometry. Fringe peojection profilometry (FPP) is whole field, non-contact, non-invasive, inexpensive, and providing high resolution. Fine metal mask(FMM) are used in organic material deposition processes in organic LED display. FMM require high flatness for uniform organic material deposition and fine patterning. The roughness of FMM depends on the roll to roll process direction, and the scatter size depends on the processing direction. The speckle noise should be reduced to obtain phase information of the sample in 3-D shape measurements. In this work, we use FPP to retrive the phase information of the FMM, use second order oriented partial equation filter to reduce the speckle noise.

Keywords:
Fringe projection profilometry, Hilbert transform, Fine metal mask

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메타표면 금 구멍 배열 박막의 Extraordinary Transmission 연구
Extraordinary Transmission of Gold Hole Array Metasurfaces

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Abstract:

폴리스티렌(polystyrene, PS) 나노 입자를 이용하여 제작한 메타 표면(metasurface) 금 구멍 배열(gold hole array)의 광학적 특성에 대하여 연구하였다. 메타 표면을 이용하면 구조의 변화를 통해 광학적 특성을 보다 쉽고 다양하게 조절할 수 있으므로, 메타 표면 구조에 대한 연구가 활발히 진행되고 있다. 본 연구에서는 PS 나노 입자를 스핀 코팅으로 증착한 후, 반응성 이온 식각(Reactive Ion Etching) 방법으로 식각하여 배열의 주기 및 구멍의 크기를 조절하였다(1). 식각한 PS 나노 입자 위에 금 박막을 증착한 후 PS 나노 입자를 클로로포름으로 제거하여 메타 표면 금 구멍 배열 박막을 제작하였다. Extraordinary Transmission(EOT) 현상은 금속 나노 구멍 배열에 의해 주기보다 큰 파장에서 투과 피크가 생기는 현상이다(2). 금 금속 박막의 주기에 따른 EOT 현상은 1차원의 배열일 경우에 표면 플라즈몬 분산 식인 과 수직 입사에서 주기에 따른 G벡터( )에 대한 그래프를 그려서 비교해 보면 그림 1과 같이 주기에 따른 EOT 파장을 예측 할 수 있다(3). 그림 2와 같이 제작한 메타 표면 구조 금 구멍 배열 박막에서 구멍의 주기와 크기에 따라 순수 금 박막의 표면 플라즈몬 투과 피크(~500nm)와 EOT 피크(900~1000nm)가 측정되었는데, 주기 500nm에 대하여 이론적으로는 약 750nm에서 EOT현상이 발견되어야 하나, 구멍의 크기와 그 배열 상태의 차이로 인해 800~1000nm 파장에서 EOT 파장이 나타났다. 측정 결과, 주기 500nm일 경우에 나노 구멍의 크기가 커짐에 따라 EOT 파장의 위치가 장파장 쪽으로 이동하고, 투과율이 증가하는 경향을 보임을 알 수 있다. Finite-Difference Time-Domain 시뮬레이션 또한 이와 같은 경향을 가짐을 볼 수 있었다. 그림 3는 제작한 메타표면 금 구멍 격자 박막의 SEM 이미지이며, 주기 500nm, 금 구멍의 반경은 각각 175nm, 160nm, 140nm이다. 메타 표면 구멍의 반경 및 주기에 따라 금 메타 표면의 광학적 특성을 조절하고 이를 바이오센서에 응용하는 연구를 진행할 예정이다.

Keywords:
metasurface, nanohole, extraordinary transmission

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FTIR 기반 원격 화학탐지장비의 특성 연구

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Abstract:
수동형 적외선 푸리에 변환(FTIR) 분광기술이 적용된 원격 화학탐지장비는 적외선 파장 영역에서 자연 배경과 화학가스와의 온도차에 의해서 생기는 물리량(농도x크기)을 측정하여 화학가스의 존재 유무를 탐지한다. 본 연구에서는 FTIR 기반 원격 화학탐지장비를 이용하여 SF6 가스 등의 화학물질에 대한 농도 및 배경과의 온도차의 변화에 따른 분광 특성 분석 사례를 제시한다.

Keywords:
FTIR, 원격 화학탐지, 적외선 분광

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자외선 유도형광 기술 기반 소형 생물입자 탐지센서 연구

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Abstract:
자외선 유도형광 기술은 생물입자 실시간 측정 기술로 대기중 부유 입자를 흡입하여 자외선 광을 조사하여 발생한 산란신호와 형광신호 세기를 측정하여 생물입자의 존재 유무를 탐지하는 기술이다. 본 연구에서는 대기 중 생물입자 농도를 실시간으로 분석하여 유해 생물입자의 존재를 경보하는 소형 생물입자 탐지센서의 광원부 및 광학셀을 설계 및 제작하고 그 성능을 확인한 결과를 제시한다.

Keywords:
자외선 유도형광, 생물입자 탐지, 산란, 형광

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라만 라이다를 이용한 수소가스의 원격 탐지

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Abstract:
원자력발전소 중대사고가 일어나게 되면, 원전연료 피복관의 산화현상으로 수소가스가 발생하여 격납용기 내부에 축적하게 된다. 이 수소가스는 폭발성이 강해 매우위험하며, 실제로 일본의 후쿠시마 원전사고등에서 폭발을 일으킨 주 원인으로 알려져 있다. 따라서 대부분의 원전 격납건물 내부에는 수소제거장치가 설치되고 있는데, 내벽 전체를 측정할 수 있는 적절한 수소가스측정장치는 아직 개발되어 있지 않다. 본 연구에서는 이러한 목적으로 원거리 수소가스 농도 및 분포탐지가 가능한 라만 라이다 실험을 수행하였다. 본 발표에서는 개발된 라만 라이다의 장치 구성과 신호처리 방볍, 그리고 실제 수소가스를 대상으로한 원거리 측정 실험 결과에 대해 기술하였다.

Keywords:
수소가스, 원격측정, 라이다, 라만분광,

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극초단 전자가속기의 전자빔 변수 최적화

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Abstract:
한국원자력연구원에서는 펨토초 정밀도의 극초단 전자가속기 시설을 개발하고 있다. 극초단 전자가속기 시설은 초고속 전자회절 실험을 수행하는 두 개의 저에너지 빔라인과 초고속 펌프-프로브 실험을 수행하는 두 개의 고에너지 빔라인으로 구성되어 있다. 고에너지 빔라인에서는 광전자총에서 약 10 나노초 간격으로 발생된 3 피코초, 200 pC 인 두 개의 전자빔을 선형가속기를 통해 25 MeV로 가속시킨다. 가속된 두 전자빔은 90도 밴딩 구조를 지나면서 100 펨토초 가까이로 펄스 길이가 줄어든다. 두 개의 전자빔은 테라헤르츠 펄스와 엑스선을 발생시키며, 첫 번째 전자빔에서 발생된 테라헤르츠 펄스와 두 번째 전자빔에서 발생된 엑스선을 이용하여 펌프-프로브 실험을 수행할 계획이다. 극초단 전자가속기의 전자빔 변수와 허용 오차는 전자빔 전자기 계산코드인 ASTRA와 ELEGANT를 사용하여 최적화 하였다.

Keywords:
광전자총, 전자가속기

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테라헤르츠 빔의 공간적 분포를 측정하기 위한 전기광학적 기술

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Abstract:
본 연구에서는 근적외선 레이저를 이용하여 발생시킨 테라헤르츠 빔의 공간적인 분포를 다양한 두께를 갖는 ZnTe와 전기광학적 기술을 사용하여 측정하였다. 본 기술로 측정된 테라헤르츠 빔의 공간적 분포는 기존의 고가의 상용화된 pyroelectric 카메라의 경우와 거의 흡사함을 확인하였다.

Keywords:
테라헤르츠파, 전기광학샘플링, ZnTe결정

10 W Kerr-lens mode-locked Yb:YAG thin disk laser

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Abstract:
Kerr-lens 현상을 이용한 10 W 출력의 얇은 디스크 모드 잠김 Yb:YAG 레이저를 개발하였다. 얇은 디스크 레이저는 열문제가 작아 고출력 레이저 개발에 알맞으며 넓은 선폭을 갖은 매질을 사용하면 피코초/펨토초 영역의 극초단 레이저 개발이 가능하다. 본 연구에서는 넓은 발진 선폭을 갖는 Yb:YAG를 레이저 이득매질로 사용하고 Kerr-lens 현상을 이용하여 모드 잠김을 시도하였다. 이를 통해 레이저 반복률은 30 MHz이고 10 W 출력의 극초단 레이저 펄스를 발생시켰다.

Keywords:
Thin disk laser, Kerr-lens mode-locking

Measurement of sub-100 fs electron bunch duration using RF deflecting cavity

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Abstract:

For the pump & probe experiments, Korea Atomic Energy Research Institute has developed the ultrafast electron diffraction (UED) system. The electron bunch duration for this system would be less than 50 fs. To measure the femto-second bunch duration, we developed an S-band RF deflecting cavity working on TM_{120} mode. Due to a strong transverse magnetic field at the cavity, the beam would be deflected to transverse direction. The electron bunch duration is related with the transverse beam size at the screen located downstream at the cavity. In this conference, we will present about the performance of the deflecting cavity and experiment results of bunch length measurement.

Keywords:

RF deflecting cavity, bunch length measurement, UED system

New Circuit QED system based on Triple-leg Stripline Resonator

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Abstract:

Conventional circuit QED system consists of a qubit located inside a linear stripline resonator, which has successfully demonstrated a strong coupling between a single photon and a qubit. Here we present a new circuit QED system, where the qubit is coupled to triple-leg stripline resonator (TSR). We have shown that TSR supports two-fold degenerate photon modes among others. By coupling them to a single qubit, we have obtained the dressed states of a coupled system of a single qubit and two-fold degenerate photon modes. By locating two qubits at two legs of TSR, we have studied a potential two-bit gate operation (e.g., CNOT gate) of the system. We will discuss the main advantage of utilizing two-fold degenerate photon modes. *This work is partially supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2016R1D1A1B01013756).

Keywords:
Circuit QED, Stripline Resonator

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SESAM을 이용한 모드 잠금 레이저의 발진 특성

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Abstract:

피코초 (10^{-12} s)나 펨토초 (10^{-15} s)에 해당하는 펄스폭을 가지는 초단펄스 레이저는 모드 잠금 기술에 의해 가능해진다. 모드 잠금 기술은 크게 수동형과 능동형으로 나누어진다. 전기광학 변조기나 음향광학 변조기를 포함한 능동형 모드 잠금 레이저의 구성에 비해 포화흡수체를 사용한 수동 모드 잠금 레이저는 공진기의 구성, 비용 등 많은 부분에서 이점이 있다. 본 연구에서는 반도체 포화흡수체 (Semiconductor Saturable Absorber Mirror;SESAM)를 사용하여 모드 잠금 레이저를 제작하고, 발진되는 빔의 출력, 반복률, 빔 질, 편광도 등 다양한 특성에 대해 연구하였다. 그림 1은 LD 펌프 파워에 따른 편광도, 빔 질, 발진된 레이저의 출력 특성이다. LD 펌프 파워 600 mW에서의 레이저 출력은 30 mW 이었고, LD와 Laser의 편광도는 각각 20%, 98%였다. 이 때 평균 M^2는 LD 펌프 파워가 증가함에 따라 2에서 3까지 증가하였다. 포화흡수체에 가해진 파워 밀도에 따른 반복률의 변화를 확인하기 위해 포화흡수체에 포커싱 시키는 렌즈의 초점 거리를 조절하여 파워 밀도를 변화 시켰다. 초점 거리는 17.3 mm를 기준으로 50 의 간격으로 2번의 변화를 주었다. Spot size는 각각 107.6 , 113.6 , 120.5 이고, LD 펌프 파워 340 mW에서 반복률은 각각 1.75 MHz, 1.46 MHz, 1.11 MHz 이다. Spot size가 가장 클 때와 작을 때의 반복률은 평균적으로 600 kHz의 차이를 보였다. 발진된 레이저의 안정성을 확인하기 위해 위치 지향 안정성 (Pointing stability)을 시간 변화에 따라 측정하였다. 레이저 발진 2시간까지의 축과 축의 위치 지향 안정성은 각각 60 , 40 으로 큰 변화는 없었고, 2시간 이후 위치 지향 안정성은 각각 120 , 80 으로 2배 정도 높았다.

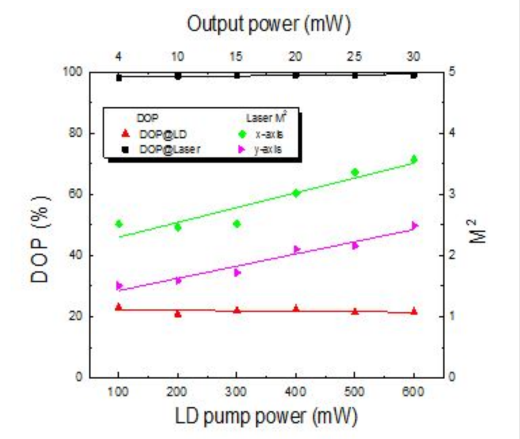

그림 1. LD Pump power에 따른 Laser의 발진 특성

Keywords:
SESAM, mode-locked laser

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Design of a stereo time-of-flight spectrometer for the measurement of the carrier-envelope-phase of ultrashort laser pulses

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Abstract:
We have designed and assembled a stereo time-of-flight spectrometer that can measure the carrier-envelope-phase of ultrashort laser pulses. The carrier-envelope-phase of the ultrashort laser pulses can be determined by analyzing the photoelectron spectra emitted along two opposite directions in the polarization direction of the laser pulses, which can be measured by the stereo time-of-flight spectrometer [1]. We present the results of numerical analysis obtained by solving time-dependent Schrodinger equation with a soft-core potential and a few cycle laser pulse. In addition, a genetic algorithm that extracts more accurate CEPs from the photoelectron spectra is presented. [1] Wittmann, T. et al. Single-shot carrier-envelope phase measurement of few-cycle laser pulses. Nature Phys. 5, 357 – 362 (2009).

Keywords:
Time-of-Flight, Spectrometer, Carrier-Envelope-Phase, Ultrashort Laser

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2016.10.19 - 2016.10.21

Nonlinear Optical Loop Mirror 기반의 모드잠금된 편광유지 이터븀 광섬유 레이저 공진기

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Abstract:

본 연구에서는 Nonlinear Optical Loop Mirror(NOLM)을 사용하여 그림 1과 같이 all-normal-dispersion 이터븀 광섬유 레이저 공진기를 구성하였다. 공진기에 사용된 광섬유는 모두 단일모드 편광유지 광섬유(Polarization-Maintaining fiber)로 구성하였으며, NOLM에도 PM980 편광유지 광섬유를 사용하였다. 모드잠금 조건을 최적하기 위해 NOLM용 coupler 비율을 60:40, 70:30 등으로 변화시켰으며, PM980의 길이도 8 m, 15 m 등으로 모드잠금 실험하였다. 980 nm의 레이저 다이오드와 WDM을 사용하여 이터븀 광섬유를 코어 펌핑 하였으며, isolator를 사용하여 단일 방향으로 공진하도록 하였다. 모드잠금을 위해 PM980 광섬유를 흔들어 요동을 주면 모드잠금된 펄스가 발진 되는 것을 확인하였다. 초기에 모드잠금된 펄스는 다중펄스로 나오다가 펌프출력을 줄이면 안정된 단일펄스열이 형성된다. 모드잠금된 레이저의 선폭은 5 nm이며, 펄스 반복률은 11.9 MHz이었다. 평균 출력은 2.3 mW이며, 편광도는 100:1이었다.

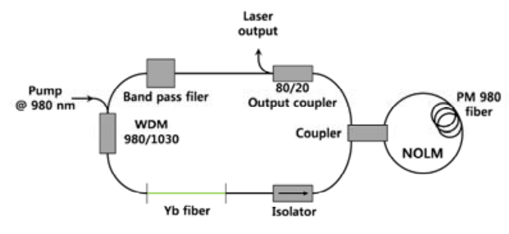

그림 1. 모드잠금 이터븀 광섬유 레이저 공진기 구성도

Keywords:
NOLM, Mode-locked laser, All-normal-dispersion, PM fiber

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2016.10.19 - 2016.10.21

Yb 첨가된 광섬유 공진기와 광섬유 전단 증폭기로 구성된 레이저 시스템의 모드 잠금된 출력 특성 연구

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Abstract:
Yb 첨가된 광섬유 공진기와 광섬유 전단 증폭기로 구성된 레이저 시스템의 모드 잠금된 출력 특성 연구를 수행하였다. 광섬유 공진기는 ANDi(all normal dispersion)구조 이다.

Keywords:
mode-lock, pre-amplifier, Yb doped fiber

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Classical understanding of an electron vortex in a uniform magnetic field

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Abstract:
We have constructed a classical wave by the composition of individual cyclotron motions with a constant canonical angular momentum in the symmetric gauge, which models electron vortex beams, in a uniform magnetic field. This classical wave is a wave similar to the water wave created by the circular motion of constituent water molecules. The basic features of circulating currents in the electron vortex beams are explained by the classical vortex waves through the canonical angular momentum in the symmetric gauge.

Keywords:
Electron vortex beam, Electron microscope, Landau states, kinetic angular momentum

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다이오드 여기 Yb 첨가 광섬유의 방출광 분석

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Abstract:
Yb가 첨가된 광섬유를 다이오드로 여기하고 광섬유에서 방출되는 빛의 파장과 세기를 위치에 따라 수집하여 광섬유 특성을 조사하였다. 코어의 직경이 100 ㎛인 광섬유에 결합된 다이오드로 여기하였다. Yb가 첨가된 광섬유의 코어 직경은 5.5, 10 ㎛이다. 여기 다이오드의 파장이 각각 915 nm, 974 nm인 경우에 대하여 각 광섬유에 입사된 여기 다이오드 빔의 전파 거리에 따른 형광의 세기를 측정하여 광섬유의 흡수계수를 결정하였다. 이 결과를 절단(cutback) 방법을 이용하여 구한 흡수계수 측정 결과와 비교하였다.

Keywords:
광섬유 레이저, 형광, 흡수계수

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유체역학 모델을 이용한 2차원 금속 구조에서의 2차 조화파 발생 수치 해석 연구

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Abstract:
1960년대 초 금속에서 2차 조화파 발생 (Second Harmonic Generation)이 처음으로 관측된 이래, 수많은 연구자들은 이러한 현상의 기전과 원리를 찾고자 노력해 왔다. 더욱이 최근 공정, 실험 기술 및 컴퓨터 기술의 발달에 힘입어 2차 조화파 발생과 관련하여 종전에는 불가능 했던 여러 시도들이 이루어 지고 있으며, 이를 통해 새로운 결과들이 많이 보고되고 있다. 본 연구에서는 이러한 금속에서의 2차 조화파 발생의 해석 방법중 하나인 유체역학 모델 (Hydrodynamic model)을 이용한 수치해석 툴을 제작하고 이를 통해 금속 구조에서의 2차 조화파 발생에 대한 연구를 진행하였다. 제작한 수치해석 툴을 검증하기 위해 선형영역에서 2차원 원통 구조의 해석적 해와 수치해석적 해를 비교 검증하였으며, 2차원 U 자 구조에서의 2차 조화파 발생과 선형 영역에서의 공명간의 관계를 확인하였다. 마지막으로 최근 발표된 실험 결과를 근사적으로 전산모사하여 유사한 경향성을 확인 하였다.

Keywords:
2차 조화파, 비선형성, 유체역학 모델

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5차조화파 생성을 위한 공랭식 4면여기 Nd:YAG 레이저 개발

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Abstract:
라만 분광학은 미지의 화학물을 식별할 수 있는 유용한 기술이다. 야외에서 지표면에 살포되어 있는 화학물을 라만 분광법으로 식별할 경우 태양에 의한 배경잡음이나 지표면에 존재하는 미생물 등의 단백질에서 발생하는 형광을 피하여야 하며 250 nm 이하의 자외선 레이저가 필요하다. 본 연구에서는 야외에서 사용할 수 있는 Nd:YAG 5차 조화파 레이저를 연구하였다. 펌핑 광원으로 LD를 사용하였으며 LD 및 레이저 이득 물질로부터 발생되는 열을 효과적으로 배출하기 위해 플레이트 핀 형상의 펌핑 챔버를 설계하고 챔버 하단에 열전소자를 부착한 후 열전소자의 반대편에는 다시 플레이트 핀 형상의 구조물을 부착한 뒤 냉각팬을 통해 강제적으로 공기가 순환되어 발생하는 열을 방출시킬 수 있도록 설계하였다. 5차 조화파 생성을 위해 3개의 BBO 결정을 사용하여 2ω, 4ω의 조화파 생성 후 최종적으로 $1\omega+4\omega=5\omega$가 되도록 제작하였다. 특히 조화파 생성의 효율을 높이기 위해 균일한 빔모드를 가지는 1064 nm 의 Nd:YAG 레이저를 위하여 4면에 LD를 교차하여 위치시켰다. 최종적으로 7 mJ 의 213 nm 자외선 레이저를 발진하였으며 특히 1064 nm의 Nd:YAG 레이저는 공랭식으로 7시간 이상 발진하였다.

Keywords:
Nd:YAG 레이저, 공랭식, 단자외선 고체레이저

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Optically controlled terahertz modulator based on $CH_3NH_3PbI_3$ perovskite materials

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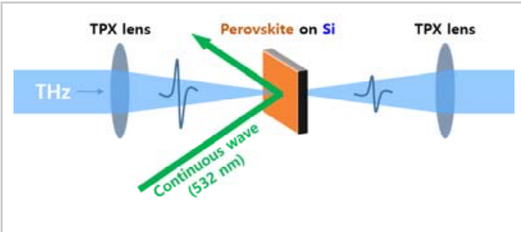

Abstract:
The modulation of terahertz transmission at $CH_3NH_3PbI_3$ perovskite / Si structures was demonstrated at a frequency range from 0.2 to 2 THz. External continuous laser source at a wavelength of 532 nm was used to generate photo carriers on the device and to controll the modulation. We achieved the modulation depth of about 70% at the laser irradiance of 1.5 W/cm^2. In addition, the modulation properties according to 3-type perovskite fabrications were compared.

Keywords:
Terahertz modulator, Perovskite,Terahertz time-domain spectroscopy

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레이저 빔 프로파일에 따른 광 포획 효율의 변화

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Abstract:
광 집게는 레이저 빔의 광압을 이용하여 작은 물질의 위치를 조작할 수 있어 혈액 성분별로 분류하는데 유용하게 사용되고 있다. 광을 이용하여 물질의 위치를 조작하는데 있어서 사용하는 광원의 최적화는 광포획의 효율을 결정하는 중요한 요인이다. 다양한 광원 파라메터들 중에서 레이저의 광세기, 레이저 빔의 단면 프로파일 그리고 사용하는 대물렌즈에 입사하는 빔의 직경과 렌즈의 개구수에 대한 의존성을 가진다. 특히 실험적으로 대물렌즈에 입사하는 빔 사이즈는 초점이 다른 두 렌즈를 이용하여 원활하게 확대하여 조절할 수 있다. 또는 개구수가 다른 대물렌즈를 이용하여 빔의 프로파일을 조절할 수도 있다. 이러한 방법을 이용하여 레이저 빔의 프로파일의 변화에 따른 광 집게 포획 효율의 변화를 실험적으로 관찰함하고 유체의 항력을 이용하여 광포획 효율을 분석하고자 한다. This work was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(grand no. 2014R1A1A2059532) and the Ministry of Trade, Industry & Energy(MOTIE), Korea Institute for Advancement of Technology(KIAT) through the Encouragement Program for The Industries of Economic Cooperation Region(grand no. R40004732).

Keywords:
광집게, 광포획, 레이저 빔 프로파일

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Speos를 기반으로 차량 운전자가 느끼는 태양광 눈부심 연구

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Abstract:

목적 본 연구는 차량의 운전자가 전방을 주시할 때 태양광에 의해 발생하는 눈부심의 정도를 알아보고자 하였다. Speos를 기반으로 태양광을 시간대별로 나누어 눈부심의 차이를 모의연구 하였다. 방법 실험 도구로는 광학해석 프로그램인 Speos(Optis 社, France)를 이용하였다. Speos는 조명 광학해석 하는 프로그램으로, 차량의 내부 환경 및 연령과 광원을 설정 및 적용 가능한 모의 프로그램이다. 실험의 모의상황을 구현하기 위한 조건으로 차량의 대시보드 색상은 Light Grey color, 계절은 겨울, 그리고 차량의 방향은 남향으로 설정하였고, 태양광원(6500k)과 정상안을 가진 운전자의 상황으로 가정하였다. VGC는 정상적인 입사 개구를 통하여 입사한 복사선의 일부에 의하여 발생되는 광학계인 VG(Veiling Glare)를 수치화 한 것으로, 태양광의 입사각에 따른 휘도 값을 분석하고 이를 VGC로 변환하여 눈부심을 비교하였다. 결과 시간에 따른 태양광원의 위치를 오전 9시, 10시 30분, 오후 12시, 2시 30분, 6시로 설정하였으며 눈부심에 대한 정도를 VGC로 비교하였다. 그 결과 가장 낮은 VGC는 오전 9시, 오후 6시일 때 VGC 〈 30%인 반면, 가장 높은 VGC는 오후 12시와 2시 30분일 때 VGC 〉 60%으로 측정되었다. VGC의 값(%)은 낮을수록 선명하게 보이고, 높을수록 눈부심이 심해진다. 분석한 VGC값(%)의 경향성을 통해 태양의 고도에 따른 운전자의 눈부심에 대한 연관성을 볼 수 있었다. 그리고 시간대별 눈부심 양의 차이를 비교 할 수 있었다. 결론 지금까지 운전자가 느끼는 눈부심의 정도를 연구하는 결과가 많았지만, 본 연구에서는 우리는 Speos라는 프로그램을 활용해 운전자가 느끼는 눈부심의 정도를 모의연구하고 이를 정량화 하였다. 시간과 나이에 따른 운전자의 눈부심의 연관성을 볼 수 있었고 특정 시간대에 눈부심으로 인한 사고의 발생빈도가 높아질 수 있음을 확인하였다. 이번 연구는 차량의 주행 속도나 날씨 등에 대한 세부적인 조건이 아닌 전반적인 상황에서 실험을 했다. 이를 바탕으로 더 세부적인 상황을 결합하여 추가적인 연구를 진행 할 것이다. 또한 Speos를 이용한 연구 방법은 차량 및 운전자 이외에도 설정하는 조건에 따라 다양한 분야로 확대될 것으로 기대된다.

Keywords:
휘도, 태양광, 입사각, 도로 주행

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청색광 반사코팅에 의한 미광분석

성훈금[1], 최은정[*1], 양석준[2], 이태현[1], 이우진[1], 심햇살[1], 김윤정[1]
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Abstract:

목적 최근 청색광의 위험으로부터 눈을 보호할 목적으로 개발된 청색광 차단렌즈에서 발생되는 미광을 분석하고, 이 미광이 상의 질에 어떠한 방식으로 영향을 미치는지 알아보고자 연구를 진행하였다. 방법 미광분석을 위해서는 우선 미광분석을 위한 모델이 요구되는데 본 연구에서는 내부반사에 의한 산란을 중심으로 이상적인 안경렌즈, 내부반사 없는 무반사 안경렌즈, 내부반사 있는 무반사 안경렌즈, 내부반사가 있는 청색광 차단 안경렌즈(5%, 10%, 15%, 20%) 4가지 광학계를 사용하였다. 청색광 차단을 위한 반사코팅은 박막설계용 소프트웨어인 Essential Macleod로 설계하였다. 설계에 사용한 코팅물질은 SiO2와 TiO2 이고 반사코팅의 피크는 청색광 위험도가 가장 높은 435~440 nm 사이에 있도록 하였다. 청색광 반사코팅의 반사율은 최대 피크를 나타내는 파장에서 약 5%, 10%, 15%, 20%가 되도록 하였다. 결과 이상적인 렌즈와 내부반사가 없는 무반사 렌즈의 측정 데이터를 분석한 결과, 미광이 포함되어 있지 않았지만 내부반사가 있는 무반사 렌즈와 내부반사가 있는 청색광 차단 렌즈의 경우 미광이 존재하는 것으로 나타났다. 광도에는 정상광과 미광이 모두 포함되어 있으므로 광도에서 정상광을 빼주면 미광을 구할 수 있다. 이렇게 구한 결과에 따르면 청색광 반사코팅의 반사율이 증가할수록 중심부(0°) 근처에서는 미광이 감소하는 것으로 나타난 반면, 중심-주변부 (15°) 및 주변부(30°)에서는 미광이 증가하였다. 특히, 미광의 세기는 중심-주변부(15°)에서 최대를 이루고 있는 것으로 나타났다. 결론 미광분석 결과에 따르면 중심부에서의 미광은 다소 감소하고 중심-주변부와 주변부에서의 미광은 크게 증가하는 방식으로 상의 질 저하를 유발하고 있음을 알 수 있다. 그리고 이러한 현상은 청색광 반사코팅의 반사율이 증가할수록 더 심해진다. 결국, 청색광 차단렌즈에서 상의 질은 청색광 반사코팅으로 인한 중심부에서의 광도 감소와 주변부에서의 미광 증가에서 비롯되며 이러한 현상은 청색광 반사코팅의 반사율이 증가할수록 심화된다. 따라서 청색광 차단렌즈의 성능을 좌우하는 성능지표인 청색광 차단율, 시감투과율, 청색광 위험 등을 종합적으로 고려하여 시각적으로 불편이 없는 수준에서 적절히 조절할 필요가 있다.

Keywords:
청색광 차단 렌즈, 내부 반사, 상의 질, 미광

Light tools을 이용한 수정체 혼탁에 따른 망막 상의 질 평가

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Abstract:
목적 최근 노령화 사회로 인해 고령 인구증가로 백내장 환자가 많아지면서 백내장에 대한 관심이 증가하고 있고, 이러한 영향에 대한 특성을 전산모사를 통해 예측한 결과는 거의 없다. 따라서 사람의 눈에 백내장과 같이 혼탁이 발생했을 때 수정체의 광학적 투과율에 따라 망막에 맺히는 상의 질 변화를 LightTools를 사용하여 광학 특성 변화를 예측하고자 한다. 방법 광학 설계 프로그램인 LightTools를 사용하여 가상의 눈을 구현한 뒤, 수정체에 혼탁의 정도를 광학적 투과율로 변환하여 총 5단계(100%, 80%, 60%, 40%, 20%)로 나누어 설정하였다. 눈앞 60cm에 광원 “R”을 생성한 다음, 수정체의 광학적 투과율을 변화시키면서 상의 질을 평가할 수 있는 조도 및 오차를 비교 분석하였다. 결과 LightTools 프로그램을 사용하여 망막에 맺힌 광원 "R" 상을 측정한 결과, 수정체의 광학적 투과율 100%시 오차 1.42%, 조도 3.81X10-3W/mm2로 측정되어 상의 질이 가장 좋게 나타났으며, 투과율 80%시 오차 1.75%, 조도 2.56X10-3W/mm2로 측정되어 투과율 100% 측정 시에 비하여 오차가 크고 조도값이 낮아 저하된 상의 질을 관찰할 수 있었다. 이어서 투과율 60%는 오차 2.24%, 조도 1.76X10-3W/mm2로 측정, 투과율 40%는 오차 3.12%, 조도 0.69X10-3W/mm2로 측정, 투과율 20%는 오차 5.11%, 조도 0.19X10-3W/mm2로 측정되어 투과율이 낮을수록 오차가 크고 조도값이 낮아지는 현상을 볼 수 있었다. 결론 임상실험으로 얻을 수 없는 정량적 수치를 인위적으로 모사한 수정체의 혼탁 정도를 변경시키며 확인할 수 있었다. 백내장 환자에게 발생하는 것과 같이 수정체의 광학적 투과율이 낮아지는 경우 상의 질이 낮아지는 것이 확인되었는데 이러한 정량적 수치를 분석한 결과, 투과율이 60% 미만으로 떨어질 경우 측정된 오차가 급격히 커지는 것을 알 수 있었다. 본 실험의 결과들은 모든 사람들의 눈의 특성을 반영하였다고 할 수는 없지만 이러한 정량적 결과가 실제 백내장 질환 연구 시 기초자료로 유용하게 쓰일 수 있기를 기대한다.

Keywords:
백내장, 수정체, 투과율, 상의 질

컬러 미러 렌즈의 색상에 따른 투과율 및 반사율과 색상 분석

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Abstract:
목적 현재 시장에 출시되는 컬러 미러 렌즈는 색상을 변화시킬 때 발생하는 광학적 변수에 대한 연구가 미흡하다. 따라서 색상이 다른 컬러 미러 렌즈의 투과율과 반사율에 의한 광학적 차이에 대한 구체화된 연구가 없으므로 많은 소비자들이 색상 선택에 혼란을 가져온다. 이에 본 연구에서는 시중에서 유통되고 있는 컬러 미러 렌즈를 대상으로 색상 별 특성과 광학적 성질에 대하여 조사하였다. 방법 사용 렌즈로는 골드, 반골드, 실버, 반실버, 레드, 핑크, 그린, 블루, 스카이블루, 다이아블루 총 10종의 색상을 사용하였고 Shimadzu UV-Vis의 Spectrophotometer(UV-2450)를 사용하여 가시광선 영역인 380 ~ 780nm 에서의 투과율 및 반사율과 색상을 측정하여 분석하였다. 결과 레드, 핑크, 골드, 반골드, 그린, 블루, 스카이블루, 다이아블루, 실버, 반실버의 투과율은 22.6%, 28.1%, 28.1%, 30.0%, 27.6%, 33.2%, 32.7%, 28.8%, 23.1%, 28.3% 로 블루의 투과율이 가장 높았으며, 투과율의 경우 큰 차이를 보이지 않았지만 레드와 실버의 투과율이 조금 낮게 측정되었다. 반사율 같은 경우는 29.5%, 17.1%, 28.8%, 10.8%, 17.3%, 16.7%, 30.0%, 24.0%, 24.5%, 22.0%로 레드의 반사율이 가장 높았고, 반골드 반사율이 가장 낮게 나타났다. 미러 렌즈의 투과율을 평균 투과율은 28.3%±5.1%이고, 평균 반사율은 22.1%±9.6% 정도로 투과율 차이보단 반사율의 차이가 더 크게 나타나는 양상을 보였다. 색상 분석 결과로 a*/b*로 나타낼 때 투과색은 Red -13.66/-13.46, Pink -5.86/3.67, Gold 8.2/-24.29, H.Gold는 -4.23/-8.61, Green 11.79/-9.18, Blue 3.4/11.79, Sky Blue 11.5/12.77, Dia Blue 2.67/-1.6, Silver 0.19/-4, H.Silver -2.02/-1.09 로 나타났다. 반사색으로는 Red 93.64/48.22, Pink 24.59/-83.81, Gold -54.43/148.95, H.Gold는 32.45/12.82, Green -126.25/59.1, Blue -66.96/-85.03, Sky Blue -81.75/-47.41, Dia Blue -36.78/-22.38, Silver -6.62/5.66, H.Silver -11.2/-35.36으로 나타났다. 결론 컬러 미러 렌즈의 투과율과 반사율을 측정한 결과 투과율에 비해 반사율의 차이가 더 크게 나타나는 것을 확인하였다. 컬러의 종류에 따라서 투과율은 큰 차이를 나타내지 않기 때문에 색상에 의한 시각의 차이가 나타나지 않는다는 것을 확인하였다. 그리고 측정에 사용한 미러 렌즈들이 국가기술표준원에서 제시한 시감투과율의 범위인 18%초과 43%이하라는 조건에 적합함으로, 어느 색상의 렌즈를 사용하여도 모두 선글라스의 기능을 온전히 수행 할 수 있다. 그러므로 컬러 미러 렌즈 선택 시 광학적 요소를 굳이 따지지 않고 소비자의 기호에 따른 선택을 하여도 큰 영향을 미치지 않을 것 이라 사료된다.

Keywords:
컬러 미러 렌즈, 색상, 투과율, 반사율

Gas Electron Multiplier 검출기 기반의 핀홀 카메라를 활용한 KSTAR 플라즈마의 2차원 연X-선 이미징 진단

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Abstract:
Gas electron multiplier 검출기 기반의 x-선 핀홀 카메라 영상진단 시스템은 토로이달 플라즈마의 접선 방향에서 플라즈마에서 방출되는 연X-선 영역의 방사광 영역의 방출광을 측정하여 2차원 영상을 제공하는 진단장비로, 2014년에 KSTAR에 설치되었다[1]. GEM 핀홀 카메라가 측정 가능한 광자 에너지 영역대는 4-15 keV이며, 최대 1 ms의 시간 분해능을 가진다. KSTAR에 설치된 GEM 핀홀 카메라의 특징은 데이터 수집장치를 포함하여 크기가 매우 콤팩트하고(20x24x10 cm^3), 검출기를 상하좌우로 모터를 이용해움직일 수 있어 플라즈마의 관측 구역을 선택할 수 있으며, 공간분해능은 최대 줌-아웃 시 10 cm에서 최대 줌-인 시 3.3 cm까지 바꿀 수 있다. 2015년 KSTAR 캠페인 동안 수집된 실험데이터로부터 톱니파 진동, 전자공명가열(ECH), vertical displacement event, 아르곤 불순물 주입 시의 방사율 변화 등의 현상을 2차원으로 관측하였다[2]. 검출기로 수집되는 방출광은 토로이달 플라즈마의 접선방향으로 선적분된 신호이므로 Philips-Tikhonov 토모그래피 알고리즘을 통해 플라즈마의 2차원 영상을 재구성하였으며, 재구성된 2차원 영상과 rtEFIT, ECE, 가시광 카메라 데이터와 비교하여 서로 잘 일치하는 것을 확인하였다. 2016년 캠페인에서는 핀홀과 GEM 검출기 사이의 공간에 헬륨을 채워 넣어, 공기에 의한 x-선 광자의 감쇠를 감소시켜 관측되는 방출광량이 증가하는 것을 확인하였으며 상세한 분석이 진행 중이다. 인용문헌 [1] D. Pacella et al., 40th EPS Conference on Plasma Physics (2013) P5.118 [2] I. Song et al., Curr. Appl. Phys. 16 (2016) 1284

Keywords:
영상진단, 연X-선, 재구성

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Amorphous Hydrogenated Carbon Layer Deposition for Erosion Study in KSTAR

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Abstract:

So called "reactive plasma", are in a mixing state of erosion and deposition depending on the plasma parameters such as electron density, temperature, pressure, and bias voltage: if the plasma i in erosion dominate state, materials from the surface of electrode/samples are sputterd and released from the surface, while there is layer formation on the surface, if deposition is dominant. By controlling plasma parameters, one can actively change the dominant process. In a tokamak, however, control of plasma parameters, especially at the edge SOL (scrape-off layer) region is very difficult and it is hard to quantify the amount of erosion or deposition. A technique to study erosion/redeposition is to utilize coupons with cavity structure inside with wel characterized thin film layers. In this paper, we report the deposition of reference amorphous hydrogenated carbon (a-C:H) layers by using a standard GEC (Gaseous Electronic Conference) cell an physical and chemical characterisitics of the layers, obtained by spectroscopic ellipsometry and Raman spectroscopy.

Keywords:

Erosion/Deposition,Carbonlayer,tokamak

Empirical scaling for global energy confinement time in KSTAR using Neural Network

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Abstract:
Deriving an empirical scaling for global energy confinement time is important in the design of a next-step tokamak and a fusion reactor because the theoretical energy transport in tokamak is not fully understood yet. Multiple Linear Regression (MLR) with power law has been commonly applied for the energy confinement time in tokamaks including KSTAR [1,2,3]. Such linear regression can easily interpret results because it shows how much influence each input parameter affects to the target quantitatively. But, because it covers only a monotonic dependence, its accuracy of prediction is a little bit behind. Recently, with development of various algorithm, neural network is applied in many tokamak problems, including the real time control system [4], prediction of the onset of plasma disruptions [5], and modeling of transport phenomena [6]. In this work, NN is applied for global energy confinement time scaling using KSTAR database and compared the previous MLR results. [1] H.-S. Kim et al., Nucl. Fusion 54, 083012 (2014) [2] Z.X. Liu et al., Plasma Phys. Control. Fusion 54, 085005 (2012) [3] G. Verdoolaege et al., Plasma Phys. Control. Fusion 54, 124006 (2012) [4] Seung Hun Lee et al., Review of Scientific Instruments 87, 11E533 (2016) [5] Ding Yonghua et al., Plasma Science and Technology 15, 1154 (2016) [6] O. Meneghini et al., Physics of Plasmas 21, 060702 (2014)

Keywords:
Global energy confinement time, Neural Network, KSTAR

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ECE measurement of electron temperature using a W-band heterodyne radiometer in KSTAR

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Abstract:
A W-band heterodyne radiometer (78 – 110 GHz) has been developed for 28 Ch electron cyclotron emission (ECE) measurement of electron temperature in the low field side during the 2 Tesla operation of KSTAR tokamak. By means of the 5-point calibration with a hot calibration source, the full electron temperature profile without harnomic overlap was obtained from the 1.8 Tesla experiment. However, the calibration factor was corrected by the second order polynomial curve fitting due to nonlinearity of the detector characteristic curve. In this poster, the detailed system as well as the absolute calibration result will be presented and ECE measurement results in combination with the D-band heterodyne radiometer (110 – 162 GHz) during the 2016 KSTAR experimental campaign will be discussed. Furthermore, electron temperature profiles measured under various toroidal magnectic field values will be cross-checked with Thomson scattering diagnostics.

Keywords:
W-band,heterodyneradiometer,electron cyclotron emission,electron temperature,KSTAR

Measurement of bremsstrahlung by using improved hybrid-type polychromator in KSTAR Thomson system

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Abstract:

In tokamak machine, to research high temperature plasma physics, we need more information by many diagnostic systems throughout a viewing window. However viewing windows are limited because of tokamak machine's lay out. For this like reason, many people make an effort to merge or get rid of similar diagnostic system. KSTAR also viewing windows for diagnostics are already saturated. Thus we are testing a merge of diagnostic systems between VB (visible bremsstrahlung) and Thomson scattering diagnostic system. VB system measure Z_{eff} that is important parameter for impurity information in tokamak, and Thomson scattering system is measure electron temperature and density profiles that also most important parameter to research most tokamak plasma physics. Last year, to combine these two diagnostic systems, we modified a design of only one Thomson polychromator system [1]. By using this proto-type hybrid-polychromator, we measured visible bremsstrahlung successfully. However this signal included many noises than stand-alone VB system. For a reason, we improve VB measuring parts in polychromator and increase a number of hybrid-polychromator systems to 4. By using these polychromators, we measured clear visible bremsstrahlung and can calculate relative Z_{eff} profile with Te, ne profile. In this research, we will show new type hybrid-polychromator system and calculated data. In the next year, we will get absolute Z_{eff} profile through absolute spectral calibration in KSTAR tokamak. References: [1] J.H. Lee et al., Conceptual design of new polychromator on Thomson scattering system to measure Z_{eff}, Rev. Sci. Instrum. 83 (2012) 10E334.

Keywords:
bremsstrahlung, Zeff, polychromator, Thomson scattering, KSTAR

5-GHz 0.5-MW prototype PAM development for KSTAR LHCD system

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Abstract:
KSTAR LHCD system is to be upgraded to 4-MW system in 2021. The basic configuration of the system is composed of eight 5-GHz 500-kW CW klystrons, low-loss transmission line with oversized circular waveguide, and PAM launcher for the mid-plane injection. As a preliminary study, prototype PAM is under development with the aim of 2018 campaign application. The peak value of parallel refractive index, N// of the prototype PAM is designed to be 2.5 with a pitch of 18 mm. The number of active waveguide is 32 by 4 rows x 8 columns. Dimension of the active and passive waveguide is 58 mm x 7 mm with 2-mm septum. In this paper, detailed design of PAM launcher will be described including the power splitting scheme, RF design of each component, spectrum and reflection properties of the launcher, mechanical construction model, and so on. For the development of a low loss circular waveguide transmission line system, two types of mode converters were developed. The test result of the mode converter and new scheme of waveguide switch-circulator will be presented as well.

Keywords:
KSTAR LHCD PAM RF C-band

The Study of Quasi-Optical Pulse Compression System in Millimeter wave for Fast Control of ECH/CD Beam

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Abstract:

In Neoclassical Tearing Modes (NTMs) feedback control system, a fast control of Electron Cyclotron Heating and Current Drive (ECH/CD) gyrotron beam is required with real-time plasma diagnostics. However, an internal control of gyrotron pulse is physically and technically difficult and it also has a financial problem. Therefore, an external pulse control system is necessary in transmission line. We suggest a quasi-optical pulse compression system using quasi-optical resonator and plasma plane mirror. A pulse compression system is usally used in accelerator application [1]. In millimeter and THz wave region, we choose quasi-optical resonator concept because HE11 mode in transmission (corrugated waveguide) cannot apply to pulse compression system in waveguide cavity (TE/TM mode exciation). We will show pulse compression process using Finite-Difference Time-Domain (FDTD) method (CST MWS simulation). [1] A.L. Vikaharev., Radiophysics and Quantum Electronics, VOL 51, NO.7, 2008

Keywords:
NTM feedback control, ECH/CD gyrotron, pulse compression, quasi-optics, quasi-optical resonator

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KSTAR에서 IRTV 진단을 이용하여 in/out target으로 빠져나가는 열속 측정

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Abstract:
Survey IRTV 진단장치는 2010년도에 KSTAR장치에 설치되어 지금까지 운영되고 있다. 이 진단장치는 KSTAR장치에서 플라즈마와 접해있는 타일의 온도와 가열장치의 안테나등의 온도변화를 감시하는 것이 주된 목적이다. 2014년에 divertor IRTV 진단장치를 새롭게 설치하였으며, 이후에는 장치의 온도를 감시하는 것 이외에 플라즈마로부터 빠져나가는 열속에 관련된 연구를 시작하였다. ELM이 발생시 target으로 빠져나가는 열속으로 인하여 target이 녹을 수가 있기 때문에 ELM시에 target으로 빠져나가는 열속을 제어하여 장치의 안전을 확보할 수 있다. 일반적으로 in/out방향으로 열속이 방출되어지고 있으나 대칭적으로 방출되지는 않는 것으로 알려져 있다. KSTAR에서는 survey IRTV와 divertor IRTV를 이용하여 동시에 in/out으로 방출되는 열속을 측정하여 어떤 비율로 방출되는지 연구할 계획이다. 이번 학회에서는 측정된 IR data를 이용하여 계산된 열속과 ELM시에 방출되는 열속을 측정하여 in/out target으로 방출되는 비율을 보여줄 것이다.

Keywords:
KSTAR, plasma, Fusion, Infrared, heat flux

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The Korean Physical Society

Upgrade of the in-vessel visible inspection system operation software and hardware for a long-pulse plasma in KSTAR

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Abstract:
Since first plasmas in 2008, the in-vessel visible inspection system(IVIS) used the Korea Superconducting Tokamak Advanced Research (KSTAR) device to monitor the global formation of shaped plasmas, motion, and damage to the internal structures of the vacuum vessel. The system contributed much to research progress on KSTAR such as the plasma start-up, plasma wall interactions, edge-localized modes, and disruptions but this system was designed 16bit operation software and the photo date can be saved just until 30 second. Latest plasma research, the old system is not enough that observe for long time plasma and to protect from electric arc from the Neurtal Beam Injector(NBI). we describe the upgrade of the system of the new 32bit communication operation software, automatic function and CCD hardware shield from electric are. we discuss the technical problem for a long pulse steady-state operation.

Keywords:
fusion CCD camera

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Gyro-kinetic Simulation Study of Tokamak Micro-turbulence

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Abstract:

It is well known that plasma turbulence driven by micro-instabilities causes anomalous transport of particle, momentum, and heat observed in tokamaks. Ion temperature gradient (ITG) and electron temperature gradient (ETG) are considered as main sources of micro-turbulence with the spatial scale of ion and electron thermal radius respectively. The ITG-driven turbulence get saturated due to zonal flow which is self-generated from the turbulence. Since this regulation is a key in effectively reducing the turbulent transport, understanding the nonlinear mechanism of saturation is important. Hence, we examine the entropy balance derived from nonlinear gyro-kinetic equation, which shows the transient of micro-fluctuation entropy and electrostatic energy [1]. Using a local gyro-kinetic simulation code GKV, we observe the nonlinear saturation of both ITG- and ETG-driven turbulence with weak collisionality, which is due to the balance of turbulent transport flux and collisional dissipation. Velocity space structures of each turbulence are investigated to obtain the wavenumber dependency of entropy. The electrostatic energy is regulated by zonal flow successfully for both cases. For ETG case, it takes much longer time to saturate than the ITG case because of weak generation of zonal flow. Due to this, enhanced level for ETG-driven turbulence in saturated phase makes a large heat conductivity, compared to that of ITG case normalized to the gyro-Bohm unit. References: T. -H. Watanabe and H. Sugama, Nuclear Fusion. Vol. 46, No. 1, 2006

Keywords:

ITG, ETG, plasma turbulence, nonlinear saturation, entropy balance,velocity space structure

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2016.10.19 - 2016.10.21

Runaway Electron Suppression by Supersonic Molecular Beam Injection in KSTAR Plasmas

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Abstract:
Runaway electrons (RE) are high energy electrons which rarely collide due to their high speed close to the light speed. REs generation and its collapse to plasma facing component (PFC) during plasma disruption is one of critical barrier for harnessing nuclear fusion energy from tokamak machine. To suppress runaway electrons generation or derive mild landing to PFC various techniques are studied. In KSTAR supersonic molecular beam injection (SMBI) which injecting low temperature deuterium molecules with supersonic speed is tried to suppress REs. KSTAR has runaway electrons in the low density Ohmic plasma. We found that SMBI excites the low-n mode magnetic perturbations. The magnetic perturbation suppressed the REs from the plasma region. We also found that suppression timing depends on the RE energy. This RE suppression and energy dependency is studied in terms of RE orbit stochastization depending on its energy by using relativistic guiding center motion solver. This poster will present about experimental results and theoretical exploration.

Keywords:
Tokamak, Runaway Electron, Supersonic Molecular Beam Injection, Orbit stochastization

FPGA를 이용한 KSTAR MMWI의 플라즈마 밀도 측정 알고리즘

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Abstract:
KSTAR에서는 Milimeter Wave Interferometer (MMWI)를 이용하여 플라즈마 밀도를 측정하는 시스템을 활용하고 있다. Field Programmable Gate Array (FPGA)는 FPGA칩 상에서 사용자가 원하는 프로그램을 실행시킬 수 있는 장치로 고속의 연산이 가능하다. MMWI에서 밀도를 측정하는 원리는 입사된 파형이 플라즈마를 투과하면서 파형의 주파수가 달라지고, 원래 파형(Reference)과 플라즈마를 투과한 파형(Probe)의 위상 차이를 측정하여 장치에 맞는 변환상수를 적용하면 밀도로 바뀌어 계산 된다. 고주파수의 파형을 입사할수록 파형의 왜곡을 최소화 할 수 있으며, KSTAR MMWI에서는 10MHz의 사인파형을 입사하고 있다. 고주파수의 파형에서의 위상 차이를 측정하기 위해서는 고속 데이터 측정 이 필요하며, 또한 실시간으로 밀도를 계산하기 위해서는 고속 연산이 필요하다. 고속 측정과 연산이 가능한 NI사의 Flex-RIO FPGA를 이용하여 KSTAR MMWI 밀도 측정 시스템을 구현 하였다. 본 논문은 FPGA를 이용하여 플라즈마 밀도를 계산하기 위한 프로그램의 알고리즘에 대하여 기술하고자 한다.

Keywords:
KSTAR, MMWI, FPGA, 플라즈마 밀도

이미징 볼로미터 진단계를 이용한 KSTAR 플라즈마의 2차원 방출광 영상 진단

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Abstract:

플라즈마 방출광의 파워분포는 핵융합 플라즈마의 파워 균형 및 불순물 수송을 이해하는데 필수적인 물리량으로 진단이 매우 중요하다. 본 연구에서는 적외선 이미징 볼로미터(InfraRed imaging Video Bolometer, IRVB) 진단계를 활용하여 KSTAR 플라즈마에서 방출되는 플라즈마 방출광의 폴로이달 단면 분포 측정을 수행하였다. 플라즈마 방출광에 의해 가열된 백금 박막의 온도를 적외선 카메라로 측정하고, 2차원 열확산 방정식을 풀어 플라즈마 방출광 세기를 계산하게 된다. 측정된 방출광 세기는 진단계 시선을 따라 선적분된 값이므로, 폴로이달 단면 영상을 얻기 위해서 토모그래피 재구성 을 수행하였다. 일반적인 D자 모양의 플라즈마, 그리고 디버터 영역의 방출광 분포 등을 포함한 다양한 가상 광방출 팬텀을 이용한 토모그래피 재구성 시험을 통해 코드의 유효성이 입증되었다. 초기 결과로 2014년 KSTAR 캠페인의 ELM 완화 실험 중 플라즈마의 방출광 분포를 재구성하였다. 플라즈마 전체의 방출광 파워는 L-H 모드 전이 시 최대 1.5 MW, ELMy H-모드 시 120 - 800 kW 정도로 측정되었으며, 공명자기섭동(RMP)를 통한 ELM 완화 전후 방출광 분포의 변화를 관찰하였다. 2016년 KSTAR 실험결과도 일부 발표된 예정이다.

Keywords:
토카막, 볼로미터, 토모그래피, ELM

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2016.10.19 - 2016.10.21

Thermo-mechanical assessment of K-DEMO divertor target with heat sink materials applying RAFM steel and CuCuZr

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Abstract:

Divertor is one of the most challenging and important components in DEMO plants that will be constructed in the future. One of the main functions of the divertor system is power exhaust. In order to faithfully perform the function, the primary requirement is to handle the heat loads on the divertor targets for the steady-state plasma operation, which is done through selecting materials and considering cooling capability. Especially, the choice and design of heat sink material in the divertor target are quite important. The role of heat sink is to efficiently dissipate the high heat flux from edge plasma and to cool down divertor target. RAFM(Reduced Activation Ferritic Martensitic) steel and CuCrZr have been considered the most promising candidates for the heat sink material. In this study, thermo-hydraulic analyses were carried out to find out the design parameters satisfying the thermal requirement operating within materials' own allowable temperature. Based on these parameters for RAFM steel and CuCrZr, thermomechanical analyses were performed for divertor target including support structures to assess structural stability.

Keywords:
Divertor, Plasma Facing Component, Thermo-mechanical Analysis

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2016.10.19 - 2016.10.21

Classification of Operation regimes by sawtooth activity in KSTAR high heating phase

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Abstract:

We try to determine operation windows to find access conditions for various advanced regimes in KSTAR . Hybrid scenarios and high scenarios are dealt with and their access conditions are investigated in two different operation windows. Presence of sawtooth activities is the most important factor to distinguish these windows. The high scenario window does not exhibit sawtooth overally, on the other hand the hybrid scenario window does show it since the central q-value is close or lower than unity. Transport modelling is performed to see the characteristic of q-profile in connection with sawtooth to evaluate the identified operation window. Based on this finding, the operation windows can be presented in terms of edge safety factor, , and plasma current, . The high scenario and the hybrid scenario window locate in the region of high & low and low & high , respectively. We analyse the experimental results of KSTAR in high heating phase with 3 neutral beam sources so to identify critical parameters determining plasma performance in each operation window. The access conditions for hybrid and high scenarios are discussed with these identified parameters..

Keywords:
operationwindows in KSTAR, sawtooth activity, hybrid scenario, high beta_P scenario

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-pl.016
2016.10.19 - 2016.10.21

Mode Converter and Bend for Lower Loss KSTAR LHCD Transmission-line

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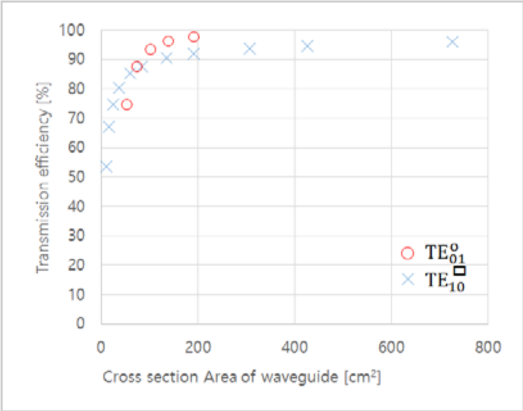
Abstract:

The KSTAR LHCD system uses a 5 GHz, 0.5 MW c. w. klystron and oversized rectangular waveguides. In order to transfer RF power effectively from a klystron to the launcher, we have to use lower loss RF mode on transmission lines. At present, transmission line is used to connect fundamental RF mode on oversized rectangular waveguides. To improve transmission efficiency more, we are going to use TE01 mode on circular waveguides which provides almost 90% transmission efficiency. In this case, mode converters are required in connecting fundamental mode on rectangular waveguide and TE01 mode on circular waveguide. In this paper, we present RF measurement result for the mode converter and simulation result for bend.



Keywords:
LHCD, Transmission line, Mode converter, Bend

KPS 한국물리학회 The Korean Physical Society

Effect of the pressure gradient of top pedestal region on the Stability of Edge Pedestal

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Abstract:
The width of the plasma edge pedestal, formed by the transport barrier, and the pressure at the top of pedestal strongly affect the performance of fusion plasmas. To achieve the plasma of targeted performance in future devices such as ITER, an optimization of edge pedestal is required. However, the improvement of the pedestal pressure and width still has many difficulties and understanding of its physics remains as a challenge. For this purpose, we have investigated the impact of pressure gradient ( ) at top of pedestal region on pedestal properties. We have used EPED1 model [1], the edge pedestal predictive model which is based on the peeling-ballooning mode [2,3] and the kinetic ballooning mode (KBM) [2,4,5], to predict and understand the behaviour of the edge pedestal in terms of . HELENA [6] was used for plasma equilibrium calculation and MISHKA-1 [7] was used to determine their instabilities properties. From this study, we found that and Shafranov shift () strongly affect the edge pedestal. Especially, it turned out that small pressure gradient at top of pedestal can significantly improve the performance of edge pedestal. The results showed good consistency with previous studies and experimental findings [8, 9]. Finally, we suggest optimum ways to improve the height of the edge pedestal by modifying and poloidal beta ( ) based on our conclusions. References: [1] P. B. Snyder et al 2009 Phys. Plasmas 16 056118 [2] J. W. Connor et al 1998 Phys. Plasmas 5 2687 [3] P. B. Snyder et al 2004 Plasma Phys. Controlled Fusion 46, A131 [4] F. Jenko et al 2001 Plasma Phys. Controlled Fusion 43 A141 [5] P. B. Snyder et al 2002 Phys. Plasmas 9 2037 [6] G. T. A Huysmans et al 1996 HELENA Installation and User Guide [7] A. B. Mikihailovskii et al 1997 Plasma. Phys. Reports 23(10) 844 [8] N.Oyama et al 2010 Nucl. Fusion 50 064014 [9] Y. Kamada et al 2002 Plasma. Phys. Control Fusion 44 A279

Keywords:
edge pedestal, EPED, shafranov shift, edge stability, pedestal gradient, poloidal beta, peeling-ballooning

Influence of gap geometry and leading edge height on re-deposition pattern and fuel retention

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Abstract:
In the next fusion reactors like ITER or DEMO, the plasma facing components (PFCs) of the first wall and divertor will be castellated to improve their thermo-mechanical strength and to decrease the heat loads. Fuel retention inside re-deposited layers inside the gap of castellation causes severely influence on the in-vessel fuel inventory which is limited by nuclear safety authority, e.g., 700 g in ITER. Efforts are given to achieve both minimization of the fuel inventory and reduction of the thermal loads onto castellated structure [1, 2]. We have fabricated four different shapes of tungsten castellated tile to study corresponding issues in KSTAR: conventional "basic" rectangular shape, chamfered leading edge (1 mm for leading edge experiment), double-chamfered and rounded edge for 2014 campaign. Three blocks of each shape are assembled with 0.5 mm and 1 mm poloidal gap distance, and with constant toroidal distance of 0.5 mm. And three different shapes of tungsten castellated tiles were exposed for 2015 campaign: ITER shape, EAST shape and round shape. These blocks are assembled with 0.5 mm poloidal gap distance and second line blocks have ±0.3 mm height difference to analysis of misalign effect. These tungsten block tile are exposed plasma L- and H-mode discharges during a whole campaign in 2014 and 2015. The blocks are then removed from the vacuum vessel after the campaign and analyzed by energy dispersive spectroscopy (EDS) to obtain surface concentration (atoms/cm^2), and by Raman spectroscopy to identify chemical bonding structure. The surface density of both gap is in a range from 1.0×10^{15} atom/cm^2 up to 7.5×10^{15} atom/cm^2. In general, the surface density of toroidal gap is higher than that of poloidal gap due to the contribution of both ions and charge exchange neutrals [3]. Compare the surface density of toroidal and poloidal gaps, contribution of each species can be separated, since the contribution of neutrals is common for both gaps. At the gap entrance, neutral contribution is about 5.0×10^{15} atom/cm^2, decreases down to 2.0×10^{15} atom/cm^2 at a depth of 0.5 mm, and remain constant at 1.0×10^{15} atom/cm^2 afterwards down to the depth of 5 mm. The contribution of ions is concentrated on very narrow position within 0.6 mm from the entrance. In the poloidal gap, the difference depending on the geometry is much more clearly visible. The surface density profiles of double chamfered and conventional blocks were almost identical down to 0.7 mm, meaning the contribution of ions was identical in both shape. Deposition in 1.0 mm gaps show much larger deposition patterns and particles have reached much deeper inside the gap. In 2015 campaign, the surface density of ITER and EAST shape were less than that of round shape. And the surface density of +0.3 mm the leading edge to exposed particle flux direction was higher than other zero and -0.3mm height misalign block.

Keywords:
tungsten castellation, leading edge, retention

In-situ TDS measurements of ARAA irradiated with deuterium ions

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Abstract:
Deuterium retention behaviors in reduced activation ferritic/martensitic (RAFM) steels have been studied for fusion applications by many investigators. However, most of thermal desorpsion spectroscopy (TDS) system measurement have not performed in situ following deuterium irradiation. In this experiment, advanced reduced activation alloy (ARAA) samples were irradiated with 1.7-keV deuterium ions by using a home-built TDS system at Dankook University, clustered with an inductively coupled plasma ion source. TDS measurements were performed in-situ immediately or one-week exposure to air after the irradiation, and both results are compared and presented.

Keywords:
retention, deuterium, TDA, ARAA

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Hydrogen-permeation Experiments of the Ti-RAFM Steel

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Abstract:

Participating countries in the ITER project have been developing reduced activation ferritic/martensitic (RAFM) steels, which are candidates for fusion structural materials. Thus, hydrogen-isotope transport in RAFM steel is a critical issue required for the fusion safety assessment. In this study, we have performed hydrogen-permeation experiments in elevated temperatures by using a Ti-RAFM membrane supplied by KIMS. The hydrogen transport parameters (permeability, diffusivity, solubility, trap site density, and trapping energy) were determined. The results of this work are presented, and comparisons with previously reported ones for other RAFMs by others are also provided. --- * "This work was supported by the National Research Foundation of Korea (Project No. 2015M1A7A1A01002234)."

Keywords:
hydrogen, permeation, RAFM

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KSTAR의 플라즈마 제어를 위한 자기적 신호의 개선

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Abstract:
Korea Superconducting Tokamak Advanced Research (KSTAR) 장치는 자기적 진단 센서들을 이용하여 플라즈마 제어를 수행하고 있다. H-모드 달성 (kappa > 1.7) 을 위해서는 플라즈마의 수직제어에 In-vessel control coil (IVCC)이 필요하였으며 이로 인하여 플라즈마 제어에 필요한 Flux loop (FL) 과 Magnetic Peobe (MP) 의 자기적 진단센서에 신호상의 노이즈가 발생하였다. 자기적 진단신호에 측정된 신호를 확인한 결과 IVCC에서 나오는 스위칭 주파수 4 kHz 로 확인 되었다. 신호상의 노이즈를 개선하기 위해 수 많은 개선 테스트를 수행하였으며 저 주파수 필터를 적용하여 플라즈마 제어에 필요한 신호들의 노이즈를 개선하였다. 또한 저 주파수 필터의 주파수는 플라즈마의 평형 상태 (860 Hz) 와 빠른 수직제어 (2.2 kHz) 에 필요한 두 가지 종류의 특성으로 설계되었다. 이중에서 860 Hz의 저 주파수 필터는 KSTAR 장치에서 연료주입 시스템과 진공 모니터링 시스템에 적용하여 사용되었다. 또한 2.2 kHz의 저 주파수 필터는 2016년도 캠페인에 개선하여 최적화된 필터로 설계를 수행하였다. 이에 본 발표에서는 KSTAR 장치에 적용된 저 주파수 필터의 기술적인 사항에 대해 기술하고, 2016년도 캠페인에 개선된 효과로 측정된 자기적 진단 신호의 데이터에 대해 발표한다.

Keywords:
자기적 진단

반사계를 이용한 플라즈마 밀도 분포 측정

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Abstract:
플라즈마 밀도 분포를 빠른 시간 분해능으로 보기 위해 KSTAR 토카막에 33-102 GHz 영역의 반사계가 설치되어 있다. 반사계 진단은 10 μs 정도의 짧은 시간 동안 전 주파수 대역을 선형적으로 증가 시키면서 믹서의 IF 출력단을 200 MSamples/s 의 빠른 디지타이저로 측정한다음, 물방울 변환을 거쳐 시간에 따른 IF의 주파수를 얻고, 이를 바탕으로 밀도 분포를 계산하는 복잡한 데이터 해석 과정을 거친다. 주파수 증가가 선형적일수록 데이터 해석이 간단하고 정확해지나, Voltage Controlled Oscillator (VCO)의 동작 특성이 비선형적이고 회로의 동적 특성을 고려해서 되므로 완벽히 선형화 하는데 어려움이 있다. 본 연구에서는 VCO의 입력단을 RC 저주파 필터와 상수의 시간 지연을 갖는 전압 변환기로 모델링해서 기존의 방법보다 더 선형에 근사하게 주파수를 변조 시킬 수 있었다. 주파수를 선형화하는 방법을 자세히 설명하고, 이를 바탕으로 KSTAR 토카막의 여러 플라즈마 현상에 대해서 밀도 분포를 측정한 결과를 제시한다.

Keywords:
반사계, 밀도 분포 측정, VCO 주파수 변조

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1차원 Hybrid model을 이용한 Pulse mode Capacitively Coupled Plasma 장치 해석

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Abstract:
최근 나노 크기의 소자를 식각하면서 공정 중 식각 선택비와 플라즈마에 의한 손상을 줄이기 위해 펄스 플라즈마를 많이 사용하고 있고 플라즈마 공정 산업에서 펄스 플라즈마의 해석이 요구되고 있다. 이것은 플라즈마에 인가하는 파워의 on-off를 반복하는 것으로, 펄스 개시는 turn-on 구간으로서 이후 플라즈마는 정상 상태에 도달하고, 펄스 off 시에는 애프터 글로우 영역이 되며 이러한 과정이 계속해서 반복된다. 이로 인해 전자 온도를 낮추고 전하 축적을 저감할 수 있고 플라즈마 내부에 생성되는 라디칼의 비율도 바꿀 수 있다. Hybrid model은 Fluid model과 Particle-in-cell (PIC) 모델의 장점을 결합한 시뮬레이션 방법으로서, Electron Monte Carlo collision (EMCC) 방법을 이용하여 Fluid model이 다루기 어려운 낮은 압력에서 해석의 정확성을 보이며 PIC model 보다 계산속도가 빠르다는 장점이 있다. 본 연구에서는 1차원 Hybrid model 시뮬레이션을 이용하여 CF4 혼합기체를 사용한 Plused Capacitively Coupled Plasma (CCP)를 해석하였다. 그 결과로 시간에 따라 플라즈마 밀도, 전자 온도, 플라즈마 변위, 라디칼 밀도 등 특성들이 바뀌는 것을 보고, 이와 더불어 Fluorine 계열의 음이온들의 시공간에서의 변화를 관찰하였다.

Keywords:
Pulse mode Capacitively Coupled Plasma

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2차원 Particle-in-Cell Model을 이용한 증착용 Capacitively Coupled Plasma의 Step Ionization 효과 연구

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Abstract:

용량성 결합 플라즈마(Capacitively coupled plasma)는 반도체 및 디스플레이 공정에서 널리 이용되고 있는 방식 중 하나이다. 반도체 공정이 미세화 되고 기술이 고도화 됨에 따라서 비용 절감과 실험적으로는 파악하기 어려운 문제 해결을 위해 시뮬레이션에 대한 수요가 급증하고 있다. 수십년 동안 Particle-in-cell Simulation (PIC) Model을 이용한 많은 연구가 이루어 졌으나 [1-2], 컴퓨터 계산 능력 제한과 높은 압력대에서의 복잡한 화학 반응으로 인하여 모든 연구가 주로 저압 (수십~수백 mTorr) 조건 위주로 이루어 졌다. 이러한 한계점을 극복하기 위해서, 본 논문에서는 Particle-in-cell Simulation (PIC) Model 을 병렬화 하여 시뮬레이션에 소요되는 시간을 비약적으로 단축시켰고, 유체 모델에서의 중성자의 들뜬 상태에서의 화학 반응식을 적용하여 시뮬레이션 결과의 신뢰도를 높였다. 예로서, 전자와 준 평형 상태의 Ar 과의 충돌로 인한 이온화를 반영하는 step-ionization 을 시뮬레이션에 적용했다. 저압 조건에서는 step-ionization 에 의한 영향이 미미하지만, 압력을 높임에 따라서 효과가 우세하게 된다. 이를 확인하기 위하여 시스템 내의 압력을 0.5 Torr부터 4 Torr까지 변화시키면서 2차원 PIC simulation을 수행하여 플라즈마 특성을 관찰하였다. Step-ionization 을 적용하지 않는 경우에는 압력이 증가함에 따라서 전자 밀도가 낮아지고 전자 온도가 증가하여 실험 결과와는 상반되는 결과를 도출 함을 확인 할 수 있다 [3]. 반면 Step-ionization 을 적용하는 경우에는 수 Torr의 용량성 결합 플라즈마에서의 전자 밀도와 전자 온도의 경향이 실험 결과와 잘 일치함을 보여주었고, 전자 에너지 분포 함수(Electron energy distribution function)을 이용하여 두 경우의 차이점을 분석하였다. 또한, 여기종이 관여하는 이온화(step-ionization and penning ionization)가 플라즈마의 공간 분포에 미치는 영향을 관찰하였다. [1] J. K. Lee et al., IEEE Trans. Plasma Sci. 32(1), 47 (2004). [2] Z. Donko, Plasma Sources Sci. Technol. 20, 024001 (2011). [3] V. A. Godyak, R. B. Piejak, and B. M. Alexandrovich, Plasma Sources Sci. Technol. 1, 36 (1992).

Keywords:
Capacitively coupled plasma, Particle-in-cell simulation, Step-ionization, Deposition

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CF_4/O_2 가스를 사용한 식각용 유도결합 플라즈마의 전산모사

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Abstract:
유도결합 플라즈마 (Inductivity Coupled Plasma, ICP)는 안테나에 의해 발생된 자기장의 시간 변화가 전기장을 유도하여, 그 유도 전기장으로 전자를 가열하여 플라즈마를 발생 시키는 장치로서 고밀도 플라즈마를 만들기에 용이하여 오래전부터 이에 대한 연구가 진행되어 왔으며 특히 식각 공정에 많이 사용되고 있다. 식각용 유도결합 플라즈마 장치에서는 식각율을 높이기 위해서 웨이퍼가 놓이는 기판에 RF (Radio Frequency) 전력이 별도로 인가된다. 이는 유도결합 플라즈마에서 발생되는 이온의 에너지가 낮아 높은 에너지가 필요한 비등방성 식각 공정을 위해 쉬스의 전압을 별도의 RF 전원을 통해 높일 필요가 있기 때문이다. 이 연구에서는 미시간 대학교의 Mark Kushnner 교수 연구실에서 개발한 HPEM (Hybrid Plasma Equipment Model) 코드를 활용하여 식각용 유도결합 플라즈마를 전산모사 하였다. HPEM은 저온 플라즈마를 해석하는 하이브리드 타입의 유체 시뮬레이션이며 플라즈마내에서의 다양한 화학반응식을 고려할 수 있다. 또한 웨이퍼와 플라즈마 간의 표면반응식을 첨가하여 식각율을 계산할 수 있다. 본 연구에서는 CF_4/O_2 가스를 사용하는 SiO2 식각용 유도결합 플라즈마 장치를 HPEM 코드로 시뮬레이션 하고 RF 전력의 크기 변화에 따른 이온 및 중성종들의 flux, 에너지, 그리고 식각율을 계산하였다.

Keywords:
HPEM (Hybrid Plasma Equipment Model) 식각용 유도결합 플라즈마 장치

Wide Bandwidth of Anti-Reflective Window for Terahertz Vacuum Electronic Devices

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Abstract:
Analytical design of broadband terahertz vacuum window is presented. Using transmission line theory and equivalent circuit analysis, we found that <-20dB return loss is achieved over 7-12% bandwidth of the band center frequency if the dielectric disk is 3 or 4 times the half-wavelength in the dielectric cylindrical guide keeping the length of the air guide of each side in the pillbox to be about half wave length. Experimental results will be presented in the conference.

Keywords:
Broad band, Equivalent circuits, Terahertz (THz), Vacuum window, Vacuum electronic devices (VEDs)

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대기압 플라즈마 화학종의 바이오필름 제거 역할 연구

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Abstract:
미생물이 스스로 생성한 고분자 물질에 둘러싸여 군집체를 형성한 바이오필름은 고체 표면에 부착되어 오염, 감염 등의 심각한 위생 문제를 야기할 수 있다. 이 때문에 위생과 바이오필름의 상관관계를 인지하고 이를 제어하기 위해 천연 향균제 개발, 쿼럼 센싱(Quoroum sensing) 등이 연구되고 있으며, 최근 들어 플라즈마를 이용한 처리 또한 연구가 진행되고 있다. 플라즈마의 역할으로는 전자기장, 화학종, 온도 등이 있지만, 그 중에 가장 큰 역할을 하는 것은 활성화학종(radical)으로 알려져 있다. 본 연구에서는 활성산소종(ROS) 및 활성질소종(RNS)과 같이 산화력이 높아 살균작용에 유리한 활성종들이 바이오필름에 미치는 영향을 파악하였다. 본 연구에서는 격자형식의 유전장벽 방전(DBD) 형식의 공기 플라즈마 소스를 개발하여 바이오필름의 효과적인 제어 가능성을 확인하고, 플라즈마 활성종과 바이오필름 제어 방식의 관계를 파악하였다. 대기중 방전으로 생성된 과산화수소(H_2O_2) 및 수산화라디칼(OH*)은 각각 0.1 mM과 0.1 uM으로 바이오필름을 25%와 22%씩 감소시킨 것을 확인하였다. 반면, 아질산염(NO_2^-)과 질산염(NO_3^-)는 각각 5 mM와 1 mM을 생성하지만 아질산염은 9%, 질산염은 바이오필름 감소에 아무런 영향을 주지 못한 것으로 확인되었다. 또한 플라즈마 소스의 격자형식 및 유전체 재질과 플라즈마 처리 습도에 따라서 플라즈마 화학종의 변화를 확인하여 바이오필름 제어와의 연관관계를 확인하였다. 본 발표에서 플라즈마 활성종과 바이오필름 제어 상관관계 대해 더 자세한 결과가 발표될 예정이다.

Keywords:
DBD plasma, Reactive species, biofilm

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Design of High Efficiency Flat-Field Grating Soft X-ray Spectrometer

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Abstract:

A flat-field soft X-ray spectrometer which has high efficiency and high resolving power is required to investigate the property of laser-induced X-ray source and research warm dense matter X-ray absorption spectroscopy. The flat-field soft X-ray spectrometer to resolve the energy range from 248 eV to 1240eV can be constructed with toroidal mirror and aberration-corrected concave grating. The important component of this spectrometer is grazing incidence type aberration-corrected concave grating which has 2400 grooves per mm and 57680 mm radius of curvature. The concave grating will resolve incident x-ray photons, collected by toroidal mirror, by its energy and focus it to the X-ray diagnostic equipment such as X-ray CCD or X-ray streak camera. The flat-field soft X-ray spectrometer can be calibrated and its resolving power can be calculated with non-linear fitting function which is derived from grating equation. This spectrometer will have about 1640 resolving power at 930 eV by assuming soft X-ray comes from perfect point source. This work was supported by the Institute for Basic Science (Project code : IBS-R012-D1) and the National Research Foundation (NRF-2016R1A2B4009631) of Korea.

Keywords:
aberration-corrected concave grating, flat-field gratingsoft X-ray specrometer, spectromter resolving power

Linear mode conversion of fs laser pulse into THz pulse at the surface of high pressure plasma jet

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Abstract:

Linear mode conversion in inhomogeneous plasma can provide a way to convert electromagnetic (EM) laser pulse into electron plasma wave and another EM wave. If the characteristic length of the electron density gradient is comparable with the wavelength of the incident EM wave, a hybrid resonance layer can exist where the dispersion relations of several different waves become indistinguishable. Some portion of the incident EM wave can be absorbed at the resonant layer, driving plasma oscillations. This in turn can generate another EM wave with the frequency around the electron plasma frequency of the resonant layer. An experimental setup has been constructed using a high-pressure plasma jet with diameter ~ 100 μm to demonstrate the linear mode conversion of fs laser pulse (~25 mJ, 10 Hz) and generation of THz EM pulse. We present the details of the experimental setup and the numerical simulation on the spectrum of the converted EM waves as a function of frequency and incident angle. *Work supported by the National Research Foundation of Korea under BK21+ program and grant No. 2015R1D1A1A01061556 (Ministry of Education).

Keywords:

Linear mode conversion, THz light source, high pressure plasma

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Measurement of the plasma density by using terahertz time-domain spectroscopy (THz-TDS)

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Abstract:
Electron density is a primary parameter in various plasma researches. In our study, the plasma densities in an argon inductively coupled plasma (Ar-ICP) are measured by Terahertz time-domain spectroscopy (THz-TDS) in the electron density of 10^{13} cm^{-3} range. The figure shows a schematic layout of the THz-TDS system for plamsa density measurements. The plasma was produced by RF discharge at a frequency of 13.56 MHz by varying both RF power and gas pressure in a cylinderical quartz tube. We used the THz wave which was generated by focusing femtosecond laser in air with a DC electric field in our plasma measurements. In addition, the analytical model based on the ambipolar diffusion equation is used to compare the experimental results and to explain the behavior of the electron density in the ICP source. The analytical results from the model found to be in good agreement with the THz-TDS results. In this presentation, the new plasma diagnostic method by using THz-TDS is introduced ans some experimental results are reported.

Keywords:
terahertz (THz), plasma, femtosecond laser, inductively copuled plasma (ICP)

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2016.10.19 - 2016.10.21

고효율 홀 추력기 개발을 위한 전자전류 최소화용 자기장 구조 제어 연구

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Abstract:
플라즈마 추력기는 소형위성의 궤도유지 및 자세제어를 위한 필수부품이다. 최근 소형위성에 홀 추력기를 적용하기 위해 추력기의 소모 전력을 최소화하는 방안이 연구되고 있다. 특히 플라즈마-대면재 간 충돌이 생성하는 이차전자에 의한 전자전류 증가를 억제하고자 자기장 구조가 제어된 홀 추력기가 활발히 연구되고 있다. 자기장 구조 설계를 통한 전자전류 억제효과를 분석하기 위해서는 홀 추력기가 발생하는 이온빔에 대한 다양한 진단이 요구된다. 본 연구에서는 고리형 홀 추력기가 발생하는 이온빔의 이온 전류 밀도 각도 분포, 이온 에너지 분포, 다중 이온 분포를 측정하여 자기장 구조 제어를 통한 전자전류 억제 효과 및 추력기의 성능 향상의 주요 원인을 분석하였다. 대면재와 평행하게 설계된 자기장 구조를 통해 플라즈마와 대면재 간 상호작용을 감소시킨 결과, 300-500 V 수준의 양극전압에서도 전자전류의 급격한 증가없이 0.3 A 수준의 일정한 전자전류, 0.5-0.7 A의 이온전류 발생이 가능하였다. 하지만 기존의 자기장 구조 제어 개념이 적용되지 않은 일반 홀 추력기에서는 400 V 수준의 양극전압에서도 전자전류가 0.5 A까지 증가하였으며, 500 V의 양극전압에서는 과도한 전자전류 향상으로 운전 안정성이 급격히 감소하였다. 자기장 구조가 제어된 홀 추력기의 전자전류 억제 특성은 높은 비추력 발생을 위해 요구되는 500 V 수준의 양극전압에서도 소모전력의 과도한 증가를 막을 수 있었다. 또한, 양극전압이 증가함에 따라 증가하는 이온전류, 이온빔 인출 각도 감소가 고추력 확보에 기여함을 진단결과를 통해 확인하였다. 홀 추력기의 자기장 구조 최적화 조건에서 제논가스 방전을 통해 얻은 최대 추력은 22±1 mN, 비추력 2200±70 s, 양극효율 51±2 %로, 이는 지금까지 보고된 300-500 W급 추력기 성능대비 우수한 값이다.

Keywords:
플라즈마 추력기, 자기장, 전자전류, 추력, 이온빔 진단

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Two dimensional simulation of underwater wire explosion driven by pulsed capacitive discharge

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Abstract:

The dynamic behavior of non-ideal copper plasmas generated during the underwater wire explosion has been analyzed using two-dimensional (2D) simulation code. As an extension of our previous work on the development of a 2D magneto-hydrodynamics (MHD) code [1], the current continuity equation and circuit equation solvers are newly integrated. This upgraded model enables us to obtain the internal current density distribution of plasma channel as well as the global circuit parameters such as current and voltages for each time step. With the aid of the wide-range equation of state (EOS) and the electrical conductivity for copper covering the liquid-vapor phase transition region, our model is capable of describing the transient behavior of the metal copper wire up to non-ideal plasma state. For the validation of numerical results, fast-framed shadowgraph images of expanding plasma channel and radial shock-wave were taken and the current and voltage waveforms were also measured. When the axial heat loss through the electrodes is ignored in 2D model, the simulation reproduced the identical numerical results with 1D model. It is noted that the numerical results showed excellent agreements with the measured data over the entire discharge process. The significance of the axial heat loss is also investigated with Dirichlet boundary condition applied on the temperature of the electrodes. [1] K. Lee, K. J. Chung, D. K. Kim, S. G. Lee, and Y. S. Hwang, Development of two-dimensional magneto-hydrodynamic simulation code in cylindrical geometry using discontinuous Galerkin finite element method, 6th International Conference on Computational Methods and Experiments in Materials Characterisation, 4-6 Jun. 2013, Siena, Italy, (2013) 159. Acknowledgement: This work was supported by the Defense Research Laboratory Program of the Defense Acquisition Program Administration and the Agency for Defense Development of Republic of Korea.

Keywords:
non-ideal copperplasma,undewater wire explosion, magneto-hydrodynamics, liquid-vapor phase transition

Dual effects of solutions treated with plasma generated nitric oxide (PGNO)

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Abstract:

Dual effects of plasma treatment have been attracted in the field of agriculture. We have developed solutions treated with plasma generated gas containing nitric oxide (PGNO) using 10 lpm nitrogen and 400sccm oxygen. In these solutions, NO and other nitrogen species were detected in large portion. In this study, we analyzed effects of the PGNO solutions on plant germination and growth as well as on viability of microbes. NO concentration in treated water and phosphate buffer reached up to about 100 μM after 50 min. Then, NO level was continuously decreased for over 16 h after PGNO injection was stopped. In 0.5mM phosphate buffer treated with PGNO, pH was dramatically decreased. After pH was adjusted to 6.0, PGNO solutions were applied to spinach (Spinacia oleracea). There was no significant change in seed germination but seedling dry weight was slightly enhanced. Seedling leaves were wide and big, compared to control. We also investigated bacteria (Staphylococcus aureus and Escherichia coli) inactivation by using PGNO solution. Our result show that bacteria were significantly inactivated in PGNO solution. These results indicate that PGNO solution may have dual effects on plant development enhancement and bacteria inactivation. This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP), (No. 2010-0027963) and National Fusion Research Institute (NFRI).

Keywords:

microwave plasma, plasma generated nitric oxide(PGNO), plant development, bacteria inactivation,

Study on the disinfection of rice seeds using ozone and arc discharged plasma

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Abstract:
We found that arc discharge plasma and the combined treatment of ozone and ultrasonic wave were effective in sterilizing rice seeds infected with Fusarium fujikuroi, causing rice bakanae disease. We have recently focused on elucidating mechanism(s) for seed sterilization and optimizing method(s) in order to improve the sterilization efficiency. The treatment with arc plasma and/or ozone can disinfect fungal infection inside rice seeds. FTIR analysis exhibits that seed surface becomes more oxidized after exposed to ozone. The combined treatment with arc plasma and heat has disinfected rice seeds more effectively than separate treatment. Disease symptoms were developed in much less number of seedlings germinated from seeds treated with heat and arc plasma consecutively than separately treated seeds. In order to know mechanism of inactivation, the shockwave were measured by pressure sensor during plasma discharge. Germination rate of the treated seeds was not much changed compared to that of control. This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP), (No. 2010-0027963), Rural Development Administration (RDA) grant, No. PJ009891, and National Fusion Research Institute (NFRI).

Keywords:
arc plasmaozone rice seeds fusarium fujikuroi bakanae disease shock wave

Study on defect states in InP/InGaAs/InP heterostructures by deep level transient spectroscopy

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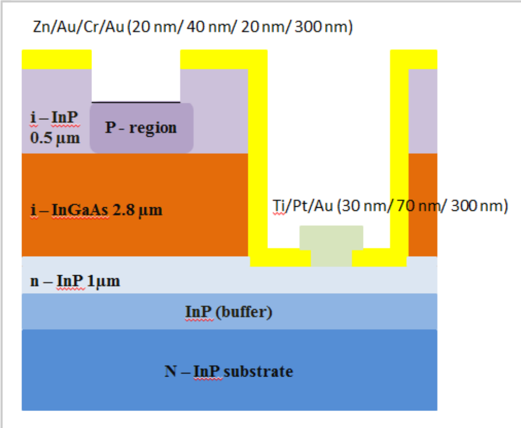
Abstract:



In recent years, p-InP/i-InGaAs/n-InP photodetectors have attained much interest due to their applications in short-wavelength region. To improve the device properties of the p-InP/i-InGaAs/n-InP photodetectors, it is very important to get the high quality InGaAs ep-layer. Deep-level transient spectroscopy (DLTS) has been widely used to measure defects states in semiconductor materials. In this work, we studied the electrical property and defect states of InP/InGaAs/InP heterostructures by I-V, C-V and DLTS measurements. The samples were grown by molecular beam epitaxy. The sample structure for the electrical measurements was shown in Fig. 1, which included n-InP substrate, InP buffer, n-InP layer (1 µm), i-InGaAs layer (2.8 µm), and i-InP layer (0.5 µm). After the structure was grown, Zn/Au/Cr/Au (20 nm/ 40 nm/ 20 nm/ 300 nm) and Ti/Pt/Au (30nm/70 nm/ 300nm) films for ohmic contacts were deposited by thermal evaporator with a shadow mask. HP 4280A capacitance meter was used to measure the capacitance voltage and the time-dependent capacitance transient. The capacitance transients by the HP 4280A C-meter were measured 64 points with sampling time of 50 ms. The measurement temperature was varied in the ranges from 20K to 400K continuously by using a closed-cycle refrigerator.

Keywords:
InGaAs, defects states, deep level transient spectroscopy

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Effect of interfacial reaction on electrical properties in HfO_2/InAs structure

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Abstract:
We report on changes in the electrical properties of 5, 8, and 10nm HfO_2 grown on InAs by atomic layer deposition (ALD). The deposited HfO_2 on InAs at a temperature of 200 ° C was in an amorphous phase with low interfacial defect states. During post deposition annealing (PDA) at 600 ° C, the In-As bonding was dissociated and diffused through HfO_2. X-ray photoelectron spectroscopy (XPS) data indicated the diffusion of In atoms from the InAs substrate into the HfO_2 during the PDA at 600 ° C. This process generated In-O and As-O bonding on HfO_2 surface, which degraded capacitance equivalent thickness (CET). The change in the defect states resulted from the diffused In and As was also investigated by C-V measurement. 1nm-thick Al_2O_3 as a passivation layer on InAs substrate reduced the diffusion of In atoms. Moreover, after additional annealing process using NH_3 at 200 ° C, t the diffusion of As atoms could be reduced. The stress induced leakage current (SILC) data showed that gate leakage current was reduced by the passivation layer. Using the C-V measurement, the change in border traps and interface trap density (D_{it}) was investigated. As a result, we could successfully control the elemental diffusion in III-V semiconductor by using 1nm-thick Al_2O_3 and NH_3 gas annealing process.

Keywords:
InAs, HfO_2, interface trap density, diffusion process

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Introduction of GaN capping layer in the InGaN/GaN multiple quantum wells for long wavelength emission

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Abstract:

In the growth of InGaN/GaN multiple-quantum-wells (MQWs) structure by molecular beam epitaxy, the decomposition of In-N bonding in InGaN layer is significantly decreased by introducing the GaN capping layer between well and barrier layer. During the growth of cap layer growth, substrate temperature is synchronized to that of InGaN wells (590 °C) and the migration enhanced epitaxy (MEE) is utilized to compensate low kinetic energy of atoms. This method results in smooth surface morphology corresponding to 0.5 nm of route mean square (RMS) roughness and suppresses the generation of deep pits. As varying the thickness ratio between cap and barrier, quantum efficiency of MQWs and In-incorporation into InGaN layer is investigated by photoluminescence (PL) measurement. As increasing the thickness of cap from 0 to 7.5 nm, photon energy of samples decreased from 2.95 to 2.25 eV, respectively. Elevating temperature from 590 to 790 °C for growing the GaN barrier layer, In-composition of InGaN was degraded due to InN-decomposition and In-desorption. We achieve InGaN/GaN MQWs structure emitting 550 nm-wavelength at room temperature without phase separation.

Keywords:

InGaN/GaN multiple quantum wells, molecular beam epitaxy (MBE)

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Optical quenching in InAs quantum dots

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Abstract:
InAs quantum dots (QDs) were grown on a $Al_{0.95}Ga_{0.05}As$ wetting layer by using the molecular beam epitaxy technique. Photoluminescence (PL) measurements were made as functions of magnetic fields and temperature. Two prominent PL transitions were observed from QDs and impurities in the wetting layer at 5 K. In magnetic fields, the transition from QDs does not change its spectral shape up to 15 T, whereas the impurity related transition show blue-shift above 8 T. By varying temperature from 5 K to room temperature, the transition from QDs persists up to ~ 200 K and the impurity related transition quenches quickly near 70 K. The activation energies obtained by the Arrhenius fitting of the PL intensities suggest that the dissociated excitons by thermal energy transfer into higher energy levels.

Keywords:
Photoluminescence, quantum dots

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플라즈몬 공명을 통한 나노와이어 투명 전극 연구

조유현[1], 박현선[1], 김민우[1], 김자연[2], 권민기[*1]
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Abstract:
GaN 기반의 LED 에서 p-GaN 층의 높은 면저항에 의한 Current crowing 현상을 억제하기 위하여 일반적으로 투과도가 높으며 면저항이 낮은 Indium tin oxide (ITO) 를 투명 전극으로 이용하고 있다. 하지만 ITO 의 경우 희소하기 때문에 최근 인듐 가격 상승으로 어려움을 겪고 있으며 또한 UV 영역에서 투과도가 낮아지는 단점 및 산과 염기의 노출시 특성이 변하는 화학적 불안정성을 가지고 있다. 본 연구에서는 청색 및 UV 영역에서 투과도가 ITO 보다 우수하고 면저항이 낮으며, p-GaN 와 Ohmic 특성을 이룰 수 있는 Ag 나노와이어를 투명 전극으로 이용한 LED 를 제작하고자 한다. 우선 Ag 나노와이어층은 Spin coating 방법을 이용하여 제작하였고 희석 농도, rpm, 시간 등을 조절함으로 370~450 nm 에서 투과도가 85% 이상, 면저항이 30~40 Ω/sq 로 ITO 에 상응할 만한 투과도와 면저항 특성을 확보하였다. 본 연구에서 사용하는 Ag 는 금속 내의 자유 전자가 집단적으로 진동함으로 외부 광원과 공명을 통해 광효율을 향상 시킬수 있는 표면 플라즈몬을 일으키는 금속으로 알려져있다. 따라서 본 발표에서는 청색 및 자외선 LED 를 위한 Ag 나노와이어 투명 전극의 전기적, 광학적 특성 및 Ag 나노와어이가 갖는 표면플라즈몬 공명 현상이 LED에 미치는 영향에 대해 자세히 소개할 것이다.

Keywords:
표면플라즈몬, 투명전극, LED, 발광다이오드, Ag nanoparticle

고연색 백색 LED를 위한 표면플라즈몬을 이용한 형광체 효율 향상

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Abstract:
LED가 차세대 조명으로 많은 관심을 받고 있지만 LED가 궁극적으로 모든 조명 광원을 대체하기 위해서는 광효율이 130 lm/W 정도는 되어야 할 뿐 아니라 연색지수가 최소 90 이상 되어야 한다. 백색 LED를 제작하는 가장 일반적으로 이용되는 Blue LED에 $Y_3Al_5O_{12}:Ce^{3+}$ 형광체를 조합하는 구조는 광효율은 높지만 연색지수가 80 이하로 낮다. 연색지수를 높이는 가장 효율적인 방법은 Red, Green, Blue LED를 조합하는 것이다. 하지만, 각각의 chip의 발광 스펙트럼이 그다지 넓지 않고, 구동전압이 각각 다르기 때문에 chip마다 특성을 조절해 주어야 하며, 제작단가가 비싸기 때문에 양산에 어려움이 있다. 이러한 문제점을 해결하는 방법으로 UV LED를 광원으로 blue, green, red 형광체를 조합하여 white LED를 제작하는 방법이 활발히 연구되고 있다. 그러나 이러한 구조는 형광체 내에서의 흡수와 산란에 따른 손실이 발생하게 되거나 형광체의 양이 늘어남에 따라 에너지 변환에 의한 손실인 Stokes-shift 현상에 의해 LED의 광효율이 저하되게 된다. 본 연구에서는 금속 내의 자유 전자가 집단적으로 진동함으로 외부 광원과 공명을 통해 광효율을 향상 시킬수 있는 기술인 표면 플라즈몬 현상을 이용하여 형광체의 광효율을 향상시키고자 한다. 특히 가시광 영역에 광효율 향상이 있는 gold와 silver nanoparticles 및 core-shell 구조를 적용하여 green, blue, red 형광체의 광효율을 향상하고자 하였다. nanoparticles의 종류, 형태, 크기와 밀도, ITO(spacer)의 두께, 에폭시 두께에 따른 LSPR와 형광체간의 상호 공명 현상을 분석하여 최적의 효율 향상 조건을 확보하였다.
과제는 중소기업청의 시장창출형 창조기술개발사업 (S2232024) 및 연구마을 지원사업 (C0364332) 에 의해 지원되었습니다.

Keywords:
표면플라즈몬, 형광체, LED, 발광다이오드, 발광소자

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Cu 불순물 도핑을 통한 p형 NiO 전도성 산화물의 합성

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Abstract:

산화물 반도체를 이용한 투명 전도성 소재는 디스플레이뿐만 아니라 태양전지 같은 에너지 소자에 있어서 필수적인 부품소재이다. 대표적인 투명 전도성 산화물인 인듐-주석 산화물 (ITO)를 필두로 근래에도 저온/대면적 공정이 가능한 다양한 전도성 산화물에 대한 연구가 계속되어 오고 있다. 하지만, 현재까지의 산화물 전도성 소재는 주로 n형 소재 위주로 개발되고 있으며, 산화물 내에서 hole carrier의 강한 localization 특성 및 hole donor의 비활성화 특성 등으로 인하여 상대적으로 p형 소재에 대한 보고는 드문 상황이다. 본 연구에서는 Cu 도핑을 통한 p형 전도성 산화물인 NiO 소재의 합성 및 그 전도 물성 향상 원리를 고찰하였다. NiO와 CuO 산화물 소재간의 고상합성을 통해 Ni-site에 Cu가 성공적으로 치환된 $Ni_{1-x}Cu_xO$ (0 〈 x 〈 0.25) 소재를 합성하였으며, XRD 결정 구조 분석 및 전도도의 온도 의존성 분석을 통하여 NiO 물질내에서의 Cu의 화학적/물리적 거동 mechanism을 분석하였다.

Keywords:
투명 전도성 소재(transparent conduction materials), p형 전도성 산화물(p-type conductive oxide), 치환 도핑 (interstitial doping)

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Hydrothermal Synthesis of $CuCo_2O_4$ electrodes for supercapacitor applications

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Abstract:

Ternary metal oxides have attracted a lot of attention for pseudocapacitor applications because of better performance than their binary counter parts. $CuCo_2O_4$ as an active electrode for supercapacitors are grown using a hydrothermal process with variation in concentration of reactants. Concentration plays an important role in determining the morphology of $CuCo_2O_4$. As the concentrations of precursors are increased, $CuCo_2O_4$ nanowire change into sheet-like morphology through intervening needle-like nanorods. The galvanostatic charge discharge (GCD) measurement reveals that the needle-like $CuCo_2O_4$ electrode possesses high electrochemical performance than other types of $CuCo_2O_4$. As it is well known that the performance of electrode materials are determined by their morphologies and chemical composition. The needle-like $CuCo_2O_4$ exhibits a maximum specific capacitance of 242.96 F/g at a current density of 2 A/g in a 1 M aqueous KOH solution. Besides, the capacity retention for the active electrode is 76.71 % at a higher current density of 8 A/g. EDS study confirms the presence of copper, cobalt, and oxygen.

Keywords:
CuCo2S4, morphology, Supercapacitoretc.

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Sequential annealing effects of HfSiON gate dielectric films on n-type Ge substrate

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Abstract:

The sequential annealing effects of HfSiON films deposited on Ge substrate were investigated through the capacitance-voltage (C-V) and current density-voltage (J-V) measurements. Furthermore, the band edge defect states below the conduction band were studied by using spectroscopic ellipsometry (SE). The HfSiON films were deposited by remote plasma-enhanced metalorganic chemical vapor deposition (RPE-MOCVD) method. After the HfSiON film deposition, the post deposition annealing treatment was conducted with two different method. One-step annealing process was treated only at 700° C for 1 min, while two-step annealing process consisted of 550° C for 30 sec and then 700° C for 30 sec in Ar/N_2 ambient. The C-V hysteresis characteristics of two-step annealed HfSiON films clearly indicated the lower value than one-step annealed HfSiON films, and the effectively trapped charge density was also decreased from 1.25×10^{12} to 4.5×10^{11} cm^{-2}. Moreover, the leakage current density of HfSiON film was reduced by adopting the two-step annealing process, it could be related with the decrease of band edge defect states below the conduction band.

Keywords:
Post-deposition anneal, HfSiON, defect states

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치환형 Cu 도핑을 통한 p형 $NiWO_4$ 산화물의 전도도 향상

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Abstract:

ITO를 위시한 투명 전도성 산화물은 현재의 디스플레이 산업뿐만 아니라 차세대 디스플레이 및 태양전지 소자 개발에 필수 불가결한 부품소재이다. 하지만, 기존 전도성 산화물 소재는 n형 전도성 소재 위주로 연구, 개발되어 왔으며, 상대적으로 p형 산화물 연구는 더딘 상황이다. 이는 Cu_2O와 같은 p형 산화물의 경우 상대적으로 작은 band-gap (~2 eV)과 더불어 고농도의 홀전하 도핑이 어렵다는 점에서 기인하는 것으로, 이러한 물리적인 한계를 극복할 수 있는 소재 개발 전략이 절실하다. $NiWO_4$의 경우, 기존의 p형 산화물 소재들에 비하여 큰 band-gap (~3.4 eV) 특성을 가진 p형 반도체 소재로서, 고농도의 홀전하 도핑이 가능할 경우, 고투과도, 고전도도의 p형 전도성 산화물의 구현이 가능할 것으로 기대되는 소재이다. 본 연구에서는 $NiWO_4$ 산화물 반도체에 Cu 불순물의 치환형 도핑을 통한 전도도 향상 현상을 보고한다. NiO와 WO_3 및 CuO 산화물 원재료 간의 고상합성을 통해 Ni-site에 Cu가 성공적으로 치환된 $Ni_{1-x}Cu_xWO3$ 소재를 합성하였으며, XRD 결정 구조 분석 및 4-point-probe 법을 통한 전도도 분석을 통하여 그 전도도 향상 mechanism을 고찰하였다.

Keywords:
전도성 산화물(conductive oxide), p형 산화물(p-type oxide) , 치환형 도핑(interstitial doping)

Optical and electrical properties of Sn-doped ZnO thin films studied with spectroscopic ellipsometery

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Abstract:

Transparent conducting oxides (TCOs) have a wide range of application areas in flat panel displays, photovoltaics, transparent thin film transistors, and transparent memory devices. TCO films require a low resistivity ($\rho \leq 10^{-3}$ Ω·cm), a high optical transmittance (≥ 80%), and a large optical band gap energy (≥ 3.5 eV). We investigated the optical and electrical properties of as-grown and annealed tin (Sn)-doped zinc oxide (ZnO) thin films grown using co-sputtering deposition method at room temperature. Cosputtered targets were ZnO and Sn (10 wt%) doped ZnO a targets. Varying the relative power ratio of the two targets, we controlled the Sn-composition of ZnO:Sn. Through annealing, we improved the carrier concentrations and mobilities.. We measured the ellipsometry angles, Ψ and Δ, of ZnO:Sn thin films using spectroscopic ellipsometry. The dielectric functions were obtained from the measured ellipsometric angles using the Drude and parametric optical constant models. With increasing Sn doping concentration, the Drude model amplitude increased substantially because the carrier concentration was larger than 10^{19} cm^{-3}. We determined the Urbach energies and optical gap energies of ZnO:Sn films from the dielectric functions. We measured the carrier concentrations and mobilities of ZnO:Sn thin films using Hall effect measurements. We analyzed the shift of the optical gap energy of Sn doped ZnO as a combination of Burstein-Moss effect, electron-electron interaction, and electron-impurity scattering. Effective mass of ZnO:Sn was estimated to be 0.274 m_0 assuming that the carrier concentrations measured by ellipsometry and Hall effect measurements were the same.

Keywords:
ZnO, SnO_2, transparent, semiconductor, oxide, TCO, effective mass

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Effect of growth pressure for zinc tin oxide channel layer on characteristics of thin film transistor

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Abstract:

Recently, oxide semiconductors represented by indium gallium zinc oxide (IGZO) have been a lot of research, as candidate materials for the flexible and transparent thin film transistors (TFTs). Among the many different oxide semiconductors such as aluminum zinc oxide (AZO), gallium zinc oxide (GZO), indium zinc oxide (IZO), we studied zinc tin oxide (ZTO). ZTO channel layer of TFTs was deposited by ultra-high vacuum (UHV) radio frequency (RF) magnetron co-sputtering system. In previous study, we optimized the sputtering conditions such as sputtering power applied to tin oxide target, and plasma gas partial pressure. ZTO films showed a transmittance more than 85 % in the visible light region, and we obtained the TFT characteristics with field effect mobility as about 19 cm^2/V s. In this study, we conducted an experiment with change of the working pressure from 2 mTorr to 6 mTorr. ZTO film and device characteristics were examined by atomic force microscope (AFM), Hall measurement system, and current-voltage measurement system.

Keywords:
thin film transistor (TFT), oxide semiconductor, zinc tin oxide (ZTO), sputter

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수소 처리된 ZnCoO의 자기저항과 DOS

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Abstract:
수소 처리된 $Zn_{0.8}Co_{0.2}O$ 시료의 자기저항을 일정한 자기장 하에서 gate 전압을 바꿔 가며 5 K의 저온에서 조사하였다. $Zn_{0.8}Co_{0.2}O$ 시료는 표면에 매우 약하게 수소 처리가 되어 있어 Co-H-Co complex 들이 매우 독립적으로 형성되어 자화의 유닛을 형성할 것으로 예상되며 gate 전압은 시료의 전하밀도를 조절하게 된다. 각 자기장 하에서의 저항은 gate voltage에 따라 조금씩 다른 경향을 보였다. 작은 자기장 하에서는 gate 전압이 20 V에서 감소함에 따라 저항이 증가하다 음의 gate 전압에서 최대값을 가진 후 다시 감소하였다. 반면 큰 자기장 하에서는 작은 자기장에서 보였던 최대값 외에 gate 전압에의 의존성이 달라지는 변곡점이 존재하였다. 이와 같은 저항의 자기장과 gate 전압에 따른 의존성으로부터 수소 처리된 $Zn_{0.8}Co_{0.2}O$의 DOS를 유추하였으며 유추된 DOS는 실험 결과를 잘 설명하고 제일원리로 구한 결과와도 일치하였다. 이 결과는 전기장을 통해 자기적 성질을 제어하는 연구에 기여할 것이다.

Keywords:
ZnO, Co, H, 자기저항, gate 전압, DOS

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Enhanced Performance of Solution-processed Indium-free Metal Oxide Thin Film Transistors Using New Sn Precursor

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Abstract:
Solution-processed metal oxide thin film transistors (TFTs) have attracted considerable attention for their applications in the backplanes of flexible and transparent displays because of their high mobility, simple fabrication process, and good optical transparency. Among the solution-based metal oxide semiconductors, indium-based materials have been extensively studied as channel layers for use in high performance metal oxide TFTs. However, it is necessary to develop indium-free metal oxide alternatives because indium is limited and expensive. Zn-Sn-O (ZTO) is one of the promising indium-free metal oxide candidates, which is usually prepared from Zn acetate and Sn chloride precursors. However, chlorine groups in Sn chloride are not completely removed even after high-temperature annealing over 500 ° C, which may preclude the fabrication of high performance metal oxide TFTs due to the insufficient metal-oxide-metal (M-O-M) condensation of ZTO channel layer. In this study, we successfully demonstrate high-performance solution-processed indium-free ZTO TFTs by introducing new Sn precursor. The ZTO TFTs with new Sn precursor exhibit enhanced mobilities exceeding $15\,cm^2\,V^{-1}\,s^{-1}$, as compared to those obtained from the conventional ZTO TFTs. Effects of the new Sn precursor on ZTO TFTs are elucidated based on X-ray photoelectron spectroscopy, transmission electron microscopy, and thermogravimetric analysis (TGA)/differential scanning calorimetry (DSC) analyses. From the TGA and DSC results, we confirm that new Sn precursor has lower thermal decomposition temperatures than Sn chloride, so dense M-O-M condensation can be formed at the same annealing temperature compared with Sn chloride. In addition, we assume that the improvement of device performance of ZTO TFTs with new Sn precursor originates from reduced oxygen defects and interface trap densities in ZTO films.

Keywords:
In-free metal oxide, new Sn precursor, TFTs, high performance

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Structural analysis of nonpolar a-plane GaN Films by using high-resolution X-ray diffraction

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Abstract:
Nonpolar a-plane GaN films typically exhibit an in-plane anisotropy along the X-ray in-beam directions due to the anisotropic differences in the lattice mismatch and the thermal expansion coefficient. a-plane GaN films with different structural anisotropies were prepared. The lattice parameter determination was required to analyze the lattice distortion of the basal plane of the a-plane GaN. High-resolution X-ray diffraction was used to determine the d-spacings for (hkl) planes in the three principal directions and the lattice parameters were calculated. The symmetric (110) and (22) reflections at four azimuth angles separated by 90° were directly measured to determine the normal lattice parameter. For the lattice constants in the in-plane surface, (002), (004), (100), and (200) reflections were taken in grazing incident angle mode. Raman spectroscopy was used to study the strain state in the a-plane GaN films.

Keywords:
X-ray diffraction,Gallium Nitride, Nonpolar, Anisotropy, Ramanspectroscopy

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Photoluminescence study of Si-doped a-plane GaN film grown on r-plane sapphire substrate

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Abstract:
Nonpolar a-plane GaN films with structural anisotropy were grown by metal-organic chemical vapor deposition. The anisotropy of GaN film was characterized by high resolution X-ray diffraction and X-ray rocking curve widths with M- or W-shaped dependence on the azimuth angles were measured. The minimum peak width of M- and W-shaped a-plane GaN films can be found along the c-axis and the m-axis directions, respectively. The room temperature PL spectra showed strong band-edge emissions for both the M-and W-shaped a-plane GaN films and the relative peak intensity of the W-shaped a-plane GaN was stronger than that of the M-shaped a-plane GaN. Three distinct peaks were observed for both samples in low temperature photoluminescence. The emission peaks were investigated by temperature-dependent and excitation power-dependent photoluminescence measurements.

Keywords:
a-plane, GaN,Photoluminescence,X-ray diffraction, Structural anisotropy

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Sputtering growth of VO_2 films at low temperature (150 °C) for applications to flexible smart window

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Abstract:

Vanadium dioxide (VO_2) with high transmittance of visible-ultra violet radiation but the complete blockage of infrared solar radiation can be used for `solar control` windows. A thermocromic smart window was designed such that the VO_2 films or particles regulate solar infrared radiation and scatter partial light to a solar cell for electricity generation. VO_2 thin films with ~50 nm in thickness were grown on TiO_2-buffered polyimide films and on TiO_2-buffered PET flims under identical conditions by RF magnetron sputtering deposition using a VO_2 target. The sputtering pressure was set at 6 mTorr with 10 sccm flow of Ar gas. VO_2 thin films on TiO_2-buffered polyimide films and on TiO_2-buffered PET flims were grown at 150℃. After sputtering deposition, all samples were annealed with 1 sccm of O_2 flow for 1hr. The structural and morphological properties of all samples were studied by X-ray diffraction (XRD), scanning electron microscopy (SEM), and Raman spectroscopy. We measured the hysteresis curve of sheet resistance as a function of temperature. The ratio of switching resistivities was 10^{-2}. These results provide important progress for the fabrication of flexible thermochromic films for energy-saving windows

Keywords:

Vanadium dioxide (VO_2) , flexible, sputtering, low temperature, smart window

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Synthesis of large grain MoS_2 films by chemical vapor deposition method without seed promoter

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Abstract:
Molybdenum disulfide (MoS_2) as one of transition-metal dichalcogenides family presents exhibits promising physical, chemical, optical and mechanical properties. To obtain large grain MoS_2 films, several chemical vapor deposition (CVD) methods have been reported, which used seed promoter such as PTAS and r-GO. However, a challenge to obtain a pure MoS_2 films remain because MoS_2 films synthesized by these methods can be easily contaminated by seed promoters. Here, we report a technique of the synthesis of large grain MoS_2 by chemical vapor deposition method without seed promoters. It was analyzed also the MoS_2 layer dependence on MoO_3 powder quantity during CVD growth, which was done on 1.5x1.5 cm^2 SiO_2/Si-substrate. The samples were analyzed by Raman spectroscopy, atomic force microscopy, X-ray photoelectron spectroscopy and photoluminescence spectroscopy. Transistor was fabricated with the MoS_2 for examining electrical performance. The CVD-MoS_2 was analyzed as single layers, 2H-MoS_2 structure and grain size was about 70 um.

Keywords:
MoS_2, CVD, Synthesis, Transistor

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2016.10.19 - 2016.10.21

Influences of ambient gas on electrical properties of CVD-grown MoS_2 thin films (w/ and w/o Au nanoparticles)

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Abstract:

We investigated the influence of the gas (H_2 and O_2) adsorption on the resistance (R) and surface work function (WF) of trilayer MoS_2 thin films, with and without Au nanoparticles (NPs), grown by chemical vapor deposition (CVD). The NP coating could reduce the resistance of the MoS_2 thin films by 2 orders of magnitude. While the WF largely varied for each gas, R was almost invariant for both the bare and NP-coated samples regardless of which gas was used. Temperature-dependent transport suggested that variable range hopping, rather than an Arrhenius-type activated behavior, dominated electrical conduction for the bare and NP-coated MoS_2 thin films. Based on such results, we could propose two possible scenarios: (1) The charges transferred from the gas adsorbates might be insufficient to induce measurable R change and (2) the charges transferred from the gas adsorbates could be trapped in the localized states instead of added to the extended states in the conduction band. The enhanced electrical conduction in the NP-coated MoS_2 could be attributed to the increased carrier concentration and the reduction of the defect sites. Our comparative investigations of R and WF enabled us to clearly understand the ambient dependent transport characteristics of the CVD-grown MoS_2 thin films.

Keywords:
MoS_2, adsorption, variable range hopping

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2016.10.19 - 2016.10.21

$AuCl_3$ 및 은나노선이 복합으로 도핑된 그래핀을 투명 전극으로 사용하여 제작한 Si 기반 태양전지의 특성 연구

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Abstract:
Si 기판 상단에 투명 전도성 전극인 그래핀을 이용하여 상부전극을 간단한 방법으로 제작하고, 염화금($AuCl_3$) 및 은나노선의 복합 도핑 농도에 따른 그래핀의 구조적, 광학적, 및 전기적 특성과 태양전지로서의 응용성을 분석하였다. 단층 그래핀을 화학 기상 증착법에 의해 제작하였으며, 석영기판과 Si 기판에 전사하였다. 그래핀의 전도성을 높이기 위하여, 먼저 $AuCl_3$를 도핑한 후 은나노선을 도핑하였다. $AuCl_3$의 몰농도(M)는 1에서 10 mM까지 변화시켰으며, 은나노선은 0.1 wt%로 고정하였다. 에너지 분산형 X선 분석(EDX)에 의하여, Au, Cl, 및 Ag 원소가 그래핀에 존재함을 확인하였다. 도핑농도가 증가함에 따라 그래핀의 면저항은 950에서 30Ω/sq로 감소하였다. 투과도 역시 도핑농도가 증가함에 따라 97에서 82%로 감소하였다. 면저항과 투과도의 결과를 통해 전기전도도/광학전도도 (σ_{DC}/σ_{op})의 비율을 계산한 결과, 5 mM $AuCl_3$와 0.1wt% 은나노선을 복합도핑한 시료에서 ~66의 값을 보였으며, 이것은 상업적으로 허용되는 최소수치(~35) 보다 높은 값이다. 불순물에 따른 투명전도성 전극의 특성을 확인하기 위해 그래핀/Si 이종접합 구조에 불순물을 첨가하지 않은 시료, 0.5mM $AuCl_3$ 또는 0.1wt% 은나노선만을 도핑한 시료, 0.5mM $AuCl_3$ 및 0.1wt% 은나노선을 복합도핑한 시료 등 4 가지 태양전지를 제작하여 태양전지 변환효율을 측정한 결과, 각각 1, 1.7, 3.7, 및 4.5%로 복합도핑한 태양전지가 가장 높은 효율을 보였다. 본 연구에서는 도핑농도에 따른 그래핀의 투과도, 면저항, 일함수의 결과를 바탕으로 태양전지 효율과의 연관성 및 관련 메커니즘을 규명하고자 한다.

Keywords:
그래핀, 태양전지, $AuCl_3$, 은나노선, Si, 도핑

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그래핀/다공성 실리콘 태양전지 특성 연구

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Abstract:

최근 그래핀/실리콘 Schottky 접합을 이용한 태양전지에 관한 연구가 활발히 진행되고 있지만, 여전히 실리콘의 높은 반사도가 문제되고 있다. 실리콘의 반사도를 낮추기 위해 반사 방지막을 이용한 연구도 진행되고 있지만, 반사 방지막의 경우 대부분이 유기물이기 때문에 특성이 변질되는 단점을 가지고 있다. 따라서 본 연구에서는 흡수계수가 높은 다공성 실리콘을 제작하고 그 상단에 그래핀을 전사하여 기존 그래핀/실리콘 태양전지에 비해 효율이 높은 태양전지를 구현하고자 한다. 다공성 실리콘을 제작하기 위해 실리콘 기판 위에 Au의 두께 (t)를 각각 2, 4, 6 nm로 증착하였다. 그 후 HF : H_2O_2 용액에 담구어 10초간 에칭함으로써 다공성 실리콘을 제작하였다. 주사현미경을 이용하여 다공성 실리콘의 표면을 확인하였으며, Au의 두께가 증가함에 따라 다공성도가 증가함을 확인할 수 있었다. 또한 다공성도에 따른 반사도를 측정한 결과, 실리콘에 비해 반사도가 낮아졌으며, 특히 6 nm Au로 제작된 다공성 실리콘의 경우 적외선 영역에서 실리콘 웨이퍼보다 1/3 정도 감소하였다. 태양전지에 응용하기 위해 다공성도에 따라 제작된 실리콘 기판 위에 그래핀을 전사한 후 Al 전극을 증착하였다. 태양전지 효율 측정결과 t = 4 nm에서 그래핀/다공성 실리콘 태양전지의 효율이 그래핀/실리콘 웨이퍼 태양전지에 비해 약 2배 이상 증가하였다. 그래핀의 전도성을 높이기 위해, 0.1 wt% 은나노선을 스핀코팅을 이용하여 분산시킨 후 태양전지 효율을 측정한 결과, 최고 3.5 %까지 효율이 증가하는 것을 확인하였다. 이상의 결과로부터 다공성도에 따른 반사도 및 외부양자효율과 태양전지 효율과의 연관성 및 관련 메커니즘을 규명하고자 한다.

Keywords:
그래핀, 다공성 실리콘, 태양전지, Schottky, 은나노선

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그래핀/p형 그래핀/Si 양자점 구조 태양전지 특성 연구

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Abstract:

본 연구에서는 $AuCl_3$가 도핑된 p형 그래핀에 그래핀을 보호막으로 추가 전사함으로써 외부환경에 의한 도핑효과의 감소를 방지한 태양 전지의 효율 향상에 대해서 보고한다. 단층 그래핀은 화학 기상 증착법에 의해서 제작하였으며, 준비된 실리콘 양자점 위에 전사하였다. 그래핀의 전기전도도를 높이기 위해서 $AuCl_3$를 농도별 (5 ~ 30 mM)로 도핑한 후 그 위에 그래핀을 다시 전사하여 그래핀/p형 그래핀/Si 양자점 구조의 태양 전지를 제작하였다. 최종적으로, Al 박막을 상부전극과 하부전극으로 증착한 후, 경계면에서 접촉 저항을 줄이기 위해서 오븐에서 열처리하였다. 주사 전자 현미경 (SEM)으로 도핑 농도에 따른 표면 구조의 변화를 확인하였다. 라만 분광법에 의해 그래핀의 라만 G 밴드와 2D 밴드가 p 형의 도핑농도가 증가함에 따라 청색 천이하는 것을 확인하였다. 도핑농도가 증가함에 따라 그래핀의 면저항은 1440에서 550 Ω/sq로 감소하였다. 투과도 역시 도핑농도가 증가함에 따라서 94에서 77%로 감소하였다. 태양전지의 에너지 변환효율을 AM 1.5의 빛에서 분석한 결과, 도핑된 그래핀만 있는 경우는 도핑 농도가 증가함에 따라 효율이 감소하였으나 그래핀 보호층을 입인 경우는 10 mM의 농도까지는 효율이 증가하다가 그 이상에서 감소하였다. 본 연구에서는 그래핀 복층 구조의 태양전지에 대해서 도핑 농도에 따른 면저항 및 투과도의 결과를 바탕으로 그래핀 기반 태양전지 효율 향상에 대한 관련 메커니즘을 규명하고자 한다.

Keywords:
그래핀, 도핑, p형, Si 양자점, 태양전지, 복층 구조

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Heterojunction p-n diodes with atomically sharp interface of n-MoS_2 on p^+-Si substrate

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Abstract:
Two-dimensional (2D) materials such as transition metal dichalcogenides (TMDs) family have interesting physical and chemical properties. Among them, the Molybdenum disulfide (MoS_2) is one of the most popular materials in TMDs family. It could be easily exfoliated just like graphite because molybdenum atomic layer is sandwiched between two sulfur atomic layers via strong covalent bonding interaction, whereas MoS_2 layer-by-layer interaction is holed by weak van der Waals forces. The characteristics of layer dependent indirect-to-direct band transition are particularly suitable for the application of visible range optical nano-devices. Indeed, there are various interesting devices, such as light emitting diode, photo-detector, and solar cell have been demonstrated by employing basic building block of p-n junction. In this study, we report fabrication of the heterojunction p-n diodes which composed of highly doped p-type Si and n-type MoS_2 with atomically sharp interface. Few-layered MoS_2 was obtained from bulk crystal by a mechanical exfoliation of "Scotch tape method", and subsequently the MoS_2 flakes were transferred onto SiO_2/Si substrates for formation electrical contact with silicon. Topography image and material quality were acquired from atomic force microscopy and Raman spectroscopy, respectively. We also conducted I-V characterization by means of HP 4156A semiconductor parameter analyzer.

Keywords:
MoS_2, heterojunction p-n diode, mechanical exfoliation

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High yield liquid exfoliated MoS_2 dispersion for thin film transistor

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Abstract:

Recently, the semiconducting two-dimensional (2D) materials including transition-metal (TMDs) and hexagonal boron nitride have received much attentions in the research fields from conventional silicon technology to flexible nanotechnology due to their outstanding mechanical characteristics with wide range strain limits (up to 30%) and high Young's modulus (around 300 GPa comparable with single-layer). To prepare these materials, however, widely known methods like mechanical exfoliation and chemical vapor deposition (CVD) are not suitable because of limitation in large-area, random distribution of 2D flake and high temperature process. Unlike previous two methods, a liquid exfoliation method can be applied to obtain large-area manufacturing and allowing low temperature process. In this study, molybdenum disulfide (MoS_2) thin films were prepared by liquid exfoliation method and applied to fabricate field-effect-transistor (FET). MoS_2 nanosheets were formulated by ultra-sonication of MoS_2 powder for more than 6 hours in ethanol/deionized water solution with 1:1 vol.%. A centrifuge with 2000~3000 rpm was employed for ideal size selection of MoS_2 nanosheets. The obtained MoS_2 nanosheets were transferred on SiO_2/Si substrate by using spin coater or oven evaporation technique. Finally, MoS_2 FET array was fabricated and characterized.

Keywords:
Liquid exfoliation method, molybdenum disulfide, field-effect-transistor

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Electrical transport behavior of bilayer graphene during thermal annealing

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Abstract:
Graphene has attracted much interest due to its superb material properties, such as excellent electrical transport in the 2D monolayer with linear dispersion relation near the Dirac point. The remarkably high carrier mobility of 10,000 cm^2/Vs at room temperature shows promise for potential applications in nanoelectronics. However, graphene does not have the energy band gap which is necessary to be used as a useful transistor. Recent studies have shown that band gap opening is possible in patterned nanoribbons, bias-applied bilayer, strained or molecule-doped graphene, and even in substrate-modulated graphene. Though the band gaps were opened in various structures, precise control of the properties is still a challenge. On the other hand, defects and impurities in graphene are important in transport phenomena, because scattering hampers carrier transport in graphene, making the modulation of graphene transport properties significantly important for scientific and practical implications. In particular, defects in graphene have been a subject of intense study because vacancy is predicted to induce quasi-localized states in the vicinity of Fermi energy. However, fundamental properties allowing the transition from metal to semiconductor or insulator have not specifically been studied so far. Here, we report the transport behavior of bilayer graphene grown by thermal chemical vapor deposition. The bilayer graphene films annealed at 700 ° C in a furnace under Ar atmosphere exhibited transitions from a metal to a semiconductor or insulator, with temperature-dependent resistances. This modulation of electrical properties could be explained by two possible mechanisms: variable range hopping (VRH) and thermally activated (TA) conduction. In particular, Anderson localization was suggested for the metal-insulator (MI) transition in the transport of bilayer graphene, shifting the transition point to room temperature by an increase in the disorder up to $7.5 \times 10^{13}\ cm^{-2}$.

Keywords:
Graphene, Raman, Metal-Insulator Transition, Annealing

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Low-dimensional yarn-based hybrid self-powered System by Energy Harvesters/ Supercapacitors for Wearable Devices

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Abstract:

Stretchable and wearable electronics are strongly becoming an emerging class of electronics that enable a wide range of applications such as electronic skins, implantable devices, wireless healthcare sensors, portable electronics. Consequently, the development of wearable power sources for such devices is highly demanded with the possibility that they can harvest energy from the human motions in which the device is deployed. However, the electrical outputs generated by energy harvesting devices are alternating current (AC) mode and somtimes with irregular magnitudes owing to the uneven strength of the mechanical motion. To enable it to serve as a direct power source, it is necessary to integrate the energy harvester with an energy storage device. For this purpose, a supercapacitor is a choice because of its high power and energy density, and charging/discharging rates compared with batteries and other conventional dielectric capacitors. In this work, we demonstrate a piezoelectric and triboelectric hybrid nanogenerators for enhanced output performance and a packaged self-powered system based on one-dimensional threads. We also designed ZnO and TiO_2 nanostructure-based supercapacitor using one-dimensional threads for the energy storage. This work provides a feasible approach in applying energy harvesting nanogenerators to wearable devices.

Keywords:

ZnO Nanostructure, TiO2 Nanostructure, Hierarchical,Energ Harvester, Supercapacitor

F 원소 치환형 도핑을 통한 $SnSe_2$ 이차원 소재 전도 물성 제어

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Abstract:
Graphene과 더불어 다양한 이차원 층상 구조 물질에 대한 연구가 보고되어 오고 있다. 특히 MoS_2 등의 전이금속 기반의 이차원 transition metal dichalcogenide (TMD) 소재의 경우, 유한한 밴드갭(> 1.0eV) 및 높은 전하 이동도 특성(>500 cm^2/Vs)을 통한 차세대 반도체 소재로의 응용 가능성이 높을 것으로 기대되고 있다. 그러나, 실질적인 전자 소재로의 응용을 위해서는, 기존의 Si 소재에서 그러했듯이, 화학적인 도핑을 통한 전도도 제어 기술의 확보가 절실하나, 현재까지의 TMD 소재군의 경우 화학적인 치환형 도핑을 통해 전도성을 제어한 연구가 부재한 실정이다. 본연구에서는 전이후 금속 기반의 $SnSe_2$ 이차원 소재 내에서 F 불순물 치환형 도핑을 통한 전도 물성 제어 원리에 대하여 고찰해 보았다. F 원소의 Se-site로의 안정적인 치환형 도핑을 통하여 $SnSe_2$ 반도체 소재의 전자 농도를 성공적으로 증대시킬 수 있음을 확인하였으며, 이로 인한 전도도 향상을 관찰하였다.

Keywords:
이차원 층상 구조 물질, 치환형 도핑, 전도성 제어

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Effect of gas flow rate for spinnable CNT forest growth

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Abstract:

We have studied a spinnable CNT forest growth used for large-area application of CNT. The advantage of CNT is that they have superior physical and mechanical properties compared to other material. The CNT forest was grown by using Thermal CVD system. We split the process conditions into thickness of Fe thin film used for catalyst and Mixing rate of reaction gas and carrier gas for growing the spinnable CNT forest. Finally, we got the spinnable CNT forest through the process that is flowing mixed gas with Ar and hydrogen. In this study, we will discuss what is the role of Ar used for carrier gas in the CNT growth.

Keywords:
CNT, Spinnable CNT forest

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Br 도핑을 통한 $SnSe_2$ 2차원 층상구조 물질의 금속 전도 전이 현상

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Abstract:
Graphene의 발견 이후, 이차원 전도 물성을 발현할 수 있는 다양한 이차원 층상구조 물질계에 대한 연구가 활발히 이뤄지고 있다. 근래에 들어, band gap이 존재하지 않는 Graphene과 달리, 유한한 band gap을 갖는 MoS_2 등의 전이금속 기반의 2차원 transition metal dichalcogenide (TMD) 물질계에 대한 연구 역시 각광 받고 있으나, 전이금속 기반 궤도의 강한 localization 특성 등으로 인해 반도체/금속 전이와 같은 물성 제어가 어려운 것으로 보고되어 오고 있다. 본 연구에서는 전이후 금속 기반의 2차원 층상구조 반도체인 $SnSe_2$ 소재의 Br 도핑을 통한 반도체/금속 전도 전이 현상을 보고한다. 고상합성법을 통해 Se-site에 Br이 성공적으로 치환형 도핑된 $SnSe_{2-x}Br_x$ ($0 < x < 0.02$) 소재를 합성하였으며, XRD 및 전도도/홀전압의 온도 의존성 분석을 통하여, 기존의 TMD 반도체 소재와 달리 금속 전도가 쉽게 일어나는 원리를 고찰하여 보았다.

Keywords:
이차원 물질 (2D materials), 금속 전도 (metallic conduction), 치환형 도핑 (interstitial doping)

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Magnetization of a modified magnetic dot

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Abstract:

Magnetization of a modified magnetic dot is investigated. The modified magnetic dot is a quantum structure that is formed by spatially inhomogeneous distributions of magnetic fields. Electrons are magnetically confined in the plane where the magnetic fields inside and outside the dot are different from each other. The wave functions and the eigenenergies of a single electron in the modified quantum dot are calculated by solving the Schrödinger equation without any electron-electron interaction. The carrier magnetization of the modified magnetic dot is calculated numerically for various physical parameters. Figure 1 Magnetization of a modified dot without electrostatic potentials Figure 2 Magnetization as a function of a magnetic field and a chemical potential

Keywords:
Magnetization of a modified magnetic dot

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Thermodynamics of the two-dimensional Blume-Capel model ; a transfer-matrix approach

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Abstract:

We investigate signatures of the first-order phase transition in thermodynamical quantities of the two-dimensional Blume-Capel model at high crystal splitting field by using transfer matrix method. On the phase boundary, heat capacity exhibits the double-peak structure. We observe discontinuity in entropy and particle number, signaling the first-order phase transition, which directly provides the slope of phase boundary from the Clausius-Clapayron relation. In addition, from the free energy we estimate the value of central charge about 0.70 at the tricritical point which well agrees with the expectation from the conformal invariance theory.

Keywords:
Phase transitions, Multicritical Phenomena, Transfer Matrix, Blume-Capel Model

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Sample-to-sample noise of the Wang-Landau sampling in the Fisher zero calculations of the 2D Ising model

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Abstract:

We investigate the effectiveness of the Wang-Landau (WL) sampling for the density of states (DOS) in the partition-function-zero analysis of phase transitions, by employing the two-dimensional Ising model as an example. We compare the lowest zero computed from the Wang-Landau density of states with the one from the exact density of states. We find that the errors in the WL DOS are systematically kept below the accuracy level needed for the determination of the lowest zero for system sizes up to 256 x 256 lattice sites. The location of the lowest zero from the WL DOS numerically agrees very well with that from the exact density of states, and we argue that the finite size scaling characteristics of the Fisher zero are closely related to the performance of the WL approach.

Keywords:
Wang-Landau sampling, Ising model, Fisher zero

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The percolation property of electrochromic cell in sol-gel process

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Abstract:
Sol-gel process are applied in various fields of science and engineering. Researchers have interested in the study of the mechanisms of formation of fractal structures in sol-gel process since 1980s. Sol-gel phase transition can be described as percolation. The percolation theory most clearly manifests in a transformation of a liqud polymer solution into gel. We investigated the electrochromic property within the percolation approach in sol-gel process. Tungsten oxide and ITO were selected as electrochromic materials and transparent electrode in electrochromic(EC) cell. The EC cell was characterized by IR spectroscopy, Transmittance, images and etc.

Keywords:
percolation, sol-gel process, electrochromic, tungsten oxide, ITO

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Ground States of Polymers with Attractive Interactions

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Abstract:

We exhaustively enumerate the ground-state conformations of polymers with attractive nearest-neighbor interactions on a square lattice. We find that when the ground state number is considered as a function of chain length, the local minima appear at magic lengths. However, the ground-state entropy per monomer does not vanish in the thermodynamic limit when extrapolation is performed with the magic-length data, implying that the number of ground-state conformations grows exponentially. We also study the entropy difference between the ground and the first-excited states. The entropy difference per monomer diverges in the thermodynamic limit, indicating that the zero-tail density of states is modified in the thermodynamic limit.

Keywords:
Lattice polymer, Ground-state entropy

Zero-temperature directed polymer in random potential on 4+1 dimension

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Abstract:

Zero-temperature directed polymer in random potentials on 4+1 dimension is described. The energy fluctuation ΔE (t) of the polymer grows as t^{β} with β = 0.159 ∓ 0.007 as function of polymer length t and ΔE follows $\Delta E \sim L^{\alpha}$ at saturation with α = 0.275∓ 0.009, where L is the system size. The dynamic exponent z = $\alpha/\beta \approx$ 1.73 is obtained. The estimated values of exponents satisfy the scaling relation α+z = 2 very well. We also monitor the end to end distance of the polymer and obtain z independently. Our results show that the upper critical dimension of the Kardar-Parisi-Zhang Equation is higher than d=4+1 dimension.

Keywords:
zero-temperature directed polymers, random potential, Kardar-Parisi-Zhang equation, dynamic exponent

Realization of a Brownian motor through real time feedback control

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Abstract:
Recent studies on the relation between information and thermodynamics showed that in the presence of a feedback control, an information quantity known as mutual information, should be included in describing non-equilibrium dynamics of fluctuating systems. Here, we designed an information motor that consists of a colloidal particle in a single heat bath. The motor is capable of transporting the particle along one direction by utilizing the information about the microscopic state of the system. In addition, the motor can be considered as a Brownian motor that makes an effective temperature gradient at the particle. We measured the average extracted work for various cycle time τ and found that the average extracted work per engine cycle increases with increasing τ, and for large τ, our system is capable of achieving an upper bound to the extractable work thereby verifying the generalized second law of thermodynamics. We have also investigated the relation between the average transport speed of the motor and information quantity. The average transport speed is limited by the amount of information obtained per one cycle.

Keywords:
Brownian motor, information ratchet

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2016.10.19 - 2016.10.21

Evolution of limit order book and the price discovery in London stock exchange

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Abstract:

Investigation of the nonlinear dynamics of the ultra-high frequency data with the order-driven market provides valuable insights about the evolution in firm's price formation over time. We empirically identify the feasible factors, including the limit, market, cancel orders, and order flow data as the significant factor were sowed in financial variables of limit order book. The nonlinear properties of price formation are the results of trader's investment strategies. The empirical analysis of the correlation between variables supports usefulness of considered variables created from limit order book.

Keywords:
Econophysics, Order-driven market

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Duality between cooperation and defection in the presence of tit-for-tat in replicator dynamics

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Abstract:
The prisoner's dilemma describes a conflict between a pair of players, in which defection is a dominant strategy whereas cooperation is collectively optimal. The iterated version of the dilemma has been extensively studied to understand the emergence of cooperation. In the evolutionary context, the iterated prisoner's dilemma is often combined with population dynamics, in which a more successful strategy replicates itself with a higher growth rate. Here, we investigate the replicator dynamics of three representative strategies, i.e., unconditional cooperation, unconditional defection, and tit-for-tat, which prescribes reciprocal cooperation by mimicking the opponents previous move. Our finding is that the dynamics is self-dual in the sense that it remains invariant when we apply time reversal and exchange the fractions of unconditional cooperators and defectors in the population. The duality implies that the fractions can be equalized by tit-for-tat players, although unconditional cooperation is still dominated by defection. Furthermore, we find that mutation among the strategies breaks the exact duality in such a way that cooperation is more favored than defection, as long as the cost-to-benefit ratio of cooperation is small.

Keywords:
prisoner's dilemma, replicator dynamics, duality, tit-for-tat

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Dynamical analyses of microscopic and mesoscopic community communicability structures in complex networks

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Abstract:

We study microscopic and mesoscopic community structures in Korean scientific societies. We simulate and analyze the communicability functions as the temperature is increased in community networks. The community structure for network of quantum oscillators changes non-trivially with temperature, while the change of temperature affects linearly the structure of classical network. Particularly, we may provide some important results giving evolutionary information, as the community structures are investigated. The difference between intra-cluster and inter-cluster communicability is calculated in mesoscopic community structure.

Keywords:
Communicability function, Community structure, Modularity

Fluctuations in strongly heterogeneous networks with different minimum degrees

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Abstract:
Synchronization problem in complex networks has been a great issue due to its widespread application in various fields. In Family model, it is discovered that the spectral dimension is the representative characteristic of networks which defines the scaling behavior of the saturated roughness of the surface: the value of link density around which the scaling exponent goes to zero almost coincides with the point that the spectral dimension exceeds the value two. However, in strongly heterogeneous networks, the role of spectral dimension is overwhelmed by the local fluctuations around hubs and their neighbors. We discover that the scaling behavior of the saturated roughness is also influenced by the networks' minimum degrees. Here we investigate the origin of this effect by examining the spectral dimension and the local fluctuations in complex networks.

Keywords:
complex network, surface roughness

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Complex network에서 Heterogeneous Core Contact Processs의 다양한 상전이현상

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Abstract:
본 연구에서는 일반적인 감염 과정을 이해하기 위해 heterogeneous core contact process(HCCP)모형을 제안하고 연구하였다. HCCP 모형에서 각 노드 i는 서로 다른 infection threshold k_i 를 갖는다. 감염되지 않은 노드 i를 HCCP를 통하여 감염시키기 위해서는 k_i개 이상의 감염된 이웃과 연결되어 있어야 한다. mean-field theory(MFT)를 이용한 해석적 방법을 통해 우리는 infection threshold의 분포에 따라 불연속 상전이, hybrid transition, 연속 상전이와 같은 여러 종류의 상전이 특성이 존재함을 확인하였다. 또한 우리는 전산 simulation을 통하여 MFT의 결과를 수치적으로 확인하였다.

Keywords:
contact process, phase transtion, core structure

Neural avalanche in complex networks

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Abstract:
We study critical phenomena in neural model in complex network. We simulate a LHG model (Levina, Herrmann, and Geisel, Nat. Phys. 3 (2007) 858) in the fully-connected network and complex networks. The LHG model shows critical phenomena of avalanche size distribution in fully-connected network. In the regular network, this model does not show critical phenomena, but we observe critical behaviors in random network and scale-free network with the same size. We observed that the short-cut of the network is crucial role in the power-law. The critical exponent of the distribution function of the avalanche size in the random network and the scale-free network is different to that of the fully-connected network.

Keywords:
neural network, complex network, LHG, critical phenomena, power law

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얼마나 많은 작가가 필명을 쓸까?

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Abstract:
한국에서는 새로운 성씨를 만들어내거나 다른 성씨로 변경하는 것은 문화적인 금기하고 있다. 한편, 성씨는 변경하지 않고 이름만을 바꾸는 것은 법적으로나 문화적으로나 받아들여지고 있다. 성씨와 이름에 대한 이러한 차이는 사람들이 그들의 원래 성씨와 이름을 바꾸고자 할 때 영향을 미칠 것으로 예측한다. 즉, 본인의 원래 성씨와 이름 중 성씨를 바꾸는 비율은 무시할 수 있을 정도로 작지만, 원래의 이름을 다르게 바꾸는 것은 이보다는 훨씬 높은 비율로 일어날 것이다. 이를 살펴보기 위해 작가들의 성씨와 이름의 자료를 이용했다. 작가들이 처음 작품활동을 시작할 때 기존의 작가와의 구별을 쉽게 하거나 본인의 예술적 정체성을 더욱 잘 나타내기 위해 원래의 성명(성씨와 이름)을 바꾸려는 경향이 있을 것으로 예상한다. 분석 결과, 작가들의 성씨의 분포는 일반인들과 거의 비슷하지만 이름은 일반인들보다 유의미한 정도로 더 다양하다는 결과를 얻었다. 2053명의 작가 중 본명이 아닌 필명을 쓰는 사람은 53명 이상일 것으로 예상하고 있다.

Keywords:
이름, 성씨, 필명, Heaps의 그림

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Heavy-tailed distribution on SSH brute-force attack duration

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Abstract:
There are quite a number of cyber-attacks against supercomputer that provides high performance computing (HPC) services to public researcher. Particularly, the SSH brute-force attack is one of traditional attack methods but it still occur endlessly even in recent days. Because there is a possibility of the occurrence of stealth attacks that feign regular access, they are even harder to detect. This paper introduce methods to detect SSH brute-force attacks by analyzing the server's unsuccessful access logs and the firewall's drop events in a multi-user environment. Then we analyze the duration of SSH brute-force attacks that are detected by applying these methods. The analyzing results about 10 thousands attack source IP addresses show that the behavior of abnormal users using SSH brute-force attacks are based on human dynamic characteristics of a typical heavy-tailed distribution.

Keywords:
Human dynamic analysis, Heavy-tailed distribution, Brute-force attack, Supercomputing

Crossings and alignments of irreversibly adsorbed Worm-like-chains.

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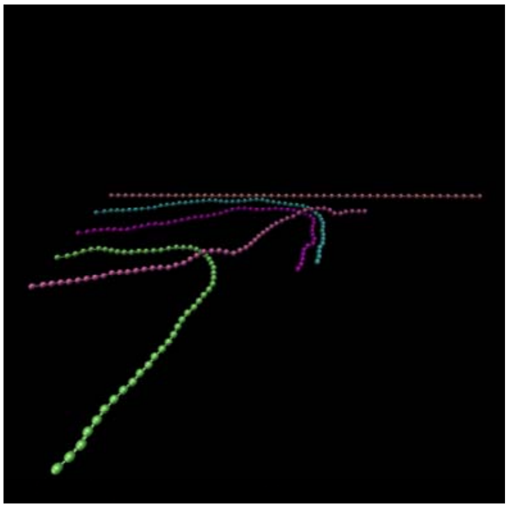
Abstract:

We study irreversible adsorption of Worm-like-chains (WLC). When kinetics is controlled by the reaction limited adsorption (chemisoprtion), the late coming chains can adsorb either by crossing over the pre-adsorbed chains or by bending along the contour. The latter results in local nematic ordering of WLCs. Using molecular dynamics simulations, we investigate the probability of crossing and alignment in the presence of a linear obstacle chain. We also theoretically compute the reduction of partition function due to the obstacle and compare with the theory for the annealed adsorbed chain.



Keywords:

Worm Like Chain, Chemisorption, Irreversible Adsorption, Molecular Dynamics Simulation, Crossing and Alignments, Nematic Order

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-st.016*
2016.10.19 - 2016.10.21

Squeezed Helical Molecules under Tension

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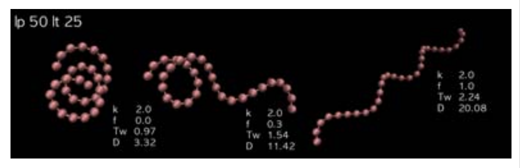

Abstract:
Helical molecules are numerous in nature and its functionality is often associated with its chirality. When helices are squeezed close to an interface, they manifest a variety of 2-d conformations characterized by a number of inflection points (twist-links). Under given tension, a specific configuration is favored thus provide an efficient tool to access geometric and elastic parameters of original 3-d helical form, which is often elusive. Using theory and molecular dynamics simulations, we study the conformation of helical molecules under confinement and tension. With increasing tension, more twist-kinks are into 2-d squeezed helices. The kinetics of twist-kink injection is also investigated.

Keywords:
Helical Molecules, Molecular Dynamics Simulation, Tension, Elastic Properties

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-st.017*
2016.10.19 - 2016.10.21

Study of electric signal induced by water droplet spreading

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Abstract:
A solid surface in contact with water or aqueous solution carries specific electric charges. We observed voltage generation during the initial contact and spreading of a water droplet on solid surface. Simultaneously, high speed camera was used to study the water droplet spreading phenomena. After the initial contact, a water droplet spreads for 2 ms. The spreading radius on the solid surface follows a well-defined power-law dynamics [1,2]. During this short time region (〈2ms), monotonic increase of voltage generation was observed as well. In this study, correlation between water droplet spreading and voltage generation is studied by using the electric double layer capacitor (EDLC) model [3,4]. For the further analysis of correlation between water droplet spreading and electric signal, we used the interferometric technique which gives the information about the shape change of the droplet during the spreading. This method can measure both the water droplet spreading and electrical properties on the solid-liquid interfaces at the same time and will be useful in the study of electrical phenomena on solid–liquid interfaces.

Keywords:
Spreading dynamics, Electro chemistry, Solid-liquid interface,

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2016.10.19 - 2016.10.21

An analog controller inspired by glucose homeostasis

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Abstract:

Pancreatic islets maintain glucose homeostasis, and provide stable energy resource for the brain. The micro-organs contain two counter-regulatory components: β cells secreting insulin under hyperglycemia and α cells secreting glucagon under hypoglycemia. Interestingly, these hormones are secreted in a pulsatile manner to control the glucose homeostasis. Recently, we have developed a mathematical model that describes the pulsatile hormone secretions by adopting coupled oscillators with phase modulation. Then we have found that the dynamic equilibrium can be controlled by adjusting the degree of synchronization between endocrine cells. Here we demonstrate the control mechanism by building an analog circuit mimicking the endocrine system.

Keywords:
Bio-inspired system, Pancreatic islets, Analog contoller

Network analysis on the conformational change of c-Src tyrosine kinase by employing molecular dynamics simulation

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Abstract:
A non-receptor Src-family protein tyrosine kinases (SFKs) play a critical role in cell growth, differentiation, and various metabolism by controlling cell signal. The regulation of cell signaling by SFKs is mediated by the conformational activation/inactivation of the tyrosine kinases. We investigated the conformational change of c-Src, one of the member of SFKs, from the inactive form (PDB id: 2SRC) to the active form (PDB id: 1Y57) employing targeted molecular dynamics (TMD) simulation. In this study, we proposed the potential allosteric pathway for the conformational change of the c-Src tyrosine kinase based on network analysis.

Keywords:
network analysis, molecular dynamics simulation

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2016.10.19 - 2016.10.21

Dependence of the Error Threshold and the Crossing Time on the Number of the Allowed States in the Sequence Element in the Mutation-Selection Model

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Abstract:

The sequence element is allowed to take on four different states for the real DNA sequence. However, the sequence element is allowed to take on only two different states in most studies. This study examined the error threshold in an infinite population for a range of fitness parameters and sequence lengths by changing the number of the allowed states in the sequence element in the haploid, coupled discrete-time mutation-selection model. The error threshold was found to decrease as the number of the allowed states in the sequence element increased. Therefore, the genetic information was lost by the decreased mutation rate as the number of the allowed states in the sequence element increased. The time-dependence of the relative density and the crossing time in an infinite population for a range of fitness parameters, asymmetric parameters and sequence lengths was examined and compared for various number of the allowed states in the sequence element by switching on an asymmetric, sharply-peaked landscape, from an initial steady state in a sharply-peaked landscape in the haploid, coupled discrete-time mutation-selection model.

Keywords:
Mutation-Selection Model, Error Threshold, Crossing Time

광학 관련 과학 개념의 향상을 위한 광원의 제작과 적용

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Abstract:
광학 관련 개념들에 대해서 1970년 중반 이래 지금까지 국내외적으로 많은 연구가 진행되어 왔다. 이들 연구 결과에 의하면 광학 현상에 대한 학습자들의 개념들이 과학 개념들과 다르며, 학습자들의 개념들을 과학 개념들로 변환시키기 매우 어렵다는 것이다. 특히 상에 대한 개념들이 그러하다. 이를 해결하기 위한 방안으로 물체에서 눈에 이르는 빛의 경로를 추적하는 광선추적법을 활용한 학습방법을 광학 관련 수업에 적용하는 것이 중점적이었다. 문제의 시작은 학습자들이 1차 광원과는 달리 2차 광원인 물체에서 나오는 빛을 물리적인 실체로 인정하지 않는다는 것이다. 광학 관련 실험에서 물체를 점광원의 집합체로 간주하며 물체의 한 점에서 발산하는 빛은 사방으로 퍼진다는 것을 강조하고 이해하게 한다. 그러나 학습자들은 보이지 않는 빛이 물체의 한 점에서 사방으로 퍼져 나간다는 것을 관찰하지 않고 이해하기가 어렵다. 이를 이해시키기 위하여 물체의 한 점에서 사방으로 퍼져 나가는 광선들을 작도하는 도해적인 방법으로 학습자들에게 이해하도록 강요하지만 그리 효과적이지 못하다는 보고들이 있다. 모든 광학 현상은 광원에서 시작한다. 그러나 이에 대한 연구는 소홀히 해왔다. 이 연구는 광학 관련 학습자들의 비과학적인 개념들을 과학 개념들로 변환시키기 위한 광원의 개발과 적용에 대한 것이다.

Keywords:
광학 관련 개념, 광원, 개발, 적용

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2016.10.19 - 2016.10.21

검전기 실험이 보여줄 수 있는 것 : 아인슈타인 vs. 과학교과서

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Abstract:

학생들이 자연이라는 실재와 그 이면의 규칙들에 생생하게 다가가도록 교육하는 것은 물리교육학자와 현장의 교사에게 숙명과도 같은 과업일 것이다. 그러나 학생들은 물리학을 공부하면서 자연에 대한 호기심을 느끼기보다는 물리를 추상적이고 따분한 것, 내 삶과는 관계 없는 것으로 여기고 있어 안타까울 때가 있다. 이러한 문제 의식을 바탕으로 본 연구에서는 아인슈타인이 일반인을 대상으로 집필한 '물리이야기' 책에서 검전기 실험을 어떻게 소개하고 있는지 그 설명 방식과 강조점 등을 분석하였다. 그 내용을 간략히 요약하면 다음과 같다. 첫째, 검전기 실험과 같은 매우 간단한 실험에서조차 자연에 집중하도록 하고, 자연을 호기심과 탐구의 대상으로 여길 수 있도록 교육할 수 있다는 가능성을 보았다. 둘째, 가설을 설정하고 현상을 설명한 후 더 나아가 그 한계까지도 제시하는 실제 과학의 연구과정을 따라가 볼 수 있도록 학생을 안내할 수 있음을 보았다. 셋째, 과학에서 이론의 역할이 무엇인지 생각해 볼 수 있도록 하는 방법을 제안하였다. 넷째, 과학 이론이 기존의 실험을 설명하는 것을 넘어서 새로운 발견으로까지 이끌어야 한다는 방향을 제안하였다. 더불어 본 연구에서는 현재 학교 현장에서 사용되고 있는 교과서들이 검전기 현상을 어떻게 설명하고 있는지 대조 분석하였다. 우리는 본 연구에서 검전기 실험에 관한 아인슈타인의 설명 방식과 기존의 교과서들의 설명 방식을 비교 분석함으로써 이처럼 간단한 물리현상을 통해서도 학생들이 자연을 생생하게 만나고, 자연의 실재에 다가갈 수 있도록 도울 수 있다는 가능성을 보았다. 이러한 연구 결과가 향후 교재 집필에서뿐만 아니라 학교 수업 방식의 질적인 향상에 있어서도 기여할 것으로 기대한다.

Keywords:
검전기 실험, 교과서, 자연, 실재, 아인슈타인

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-te.003*
2016.10.19 - 2016.10.21

조건의 이해가 강조된 물리문제해결에서 나타나는 대학생들의 조건 이해 유형 및 모니터링 정확성 분석

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Abstract:
조건의 이해가 강조된 물리문제해결에서 나타나는 대학생들의 조건 이해 유형 및 모니터링 정확성 분석 정이석, 윤성현* 한국교원대학교 물리교육과, 충청북도 청주시 28173 요 약 성공적인 문제해결을 위해 문제에 주어진 조건을 잘 이해하고 자신의 문제해결과정을 지속적으로 점검하는 것은 중요하다고 알려져 있다. 이에 본 연구에서는 문제에 주어진 조건의 확인, 확인한 조건의 중요성 인식, 정확한 조건해석이나 조건을 고려한 문제해결의 시도 등의 유무에 따라 분류한 학생들의 조건이해유형과 자신의 답에 대한 확신판단을 통한 모니터링 정확성을 분석하는데 그 목적이 있다. 이 연구를 위해 물리교육전공 대학생 25명을 대상으로 조건이 전형적인 문제, 조건이 불충분한 문제, 조건이 암시적인 문제, 핵심변수가 2개인 문제로 구성된 검사도구를 투입하였고 검사지 작성이 끝난 후 면담을 실시하였다. 본 연구에서는 학생들이 작성한 검사지와 면담의 내용을 바탕으로 학생들의 조건이해유형 및 모니터링 정확성을 분석하여 그 결과에 대해 논의하고자 한다.   * 교신저자: shyoon@knue.ac.kr

Keywords:
1

KPS 한국물리학회
The Korean Physical Society

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-te.004*
2016.10.19 - 2016.10.21

특수상대론에서 광속 불변에 관한 교재 설명과 교사, 학생들의 이해 비교

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Abstract:
2009개정교육과정부터는 물리1에서 시공간의 구조라는 대 단원 속에 아인슈타인의 특수상대성 원리와 일반상대성 원리를 각각 2~3차시에 걸쳐 가르치게 되어있다. 20세기에 등장한 이론이고 실생활의 제품에 많이 적용되고 있는 이론으로 특수상대성 이론에서는 '빛의 속도 일정, 시간지연, 길이수축, 동시성, 질량-에너지 동등성'이라는 특수상대성 원리의 핵심 개념을 교육과정에서 다루고 있다. 하지만 이 내용이 갑자기 교육과정에 들어오면서 학생은 물론 교사의 이해 단계에서부터 많은 어려움을 가져왔다. 한편, 아인슈타인은 일반인을 위한 'Evolution of Physcis'라는 책에서 왜 상대성이론이 나올 수 밖에 없었는지 역학에서부터 상대론이 나오기까지의 과정을 하나하나의 논리로 연결하여 설명하고 있다. 이론이 나오고 100년이 지난 지금, 학교 현장에서 상대론을 가르치며, 얼마나 논리적 비약이 없이 받아들일 수 있는 개념이 되었는지, 아니면 우려했던 지식의 암기와 문제풀이를 위한 과정이 되버렸는지 파악하고자하였다. 이를 위해 상대성 이론의 핵심 배경이 된 빛의 속도 일정이라는 개념을 상대론을 배우고 들어온 예비교사 3명, 현직교사 3명을 면담하여 교과서의 전개방법과 이해정도를 아인슈타인이 설명한 방법과 비교하며 분석하였다.

Keywords:
특수상대성 이론, 2009 개정 물리1

2016 KPS Fall Meeting, 2016년 가을 학술논문발표회 및 임시총회 P2-te.005
2016.10.19 - 2016.10.21

항공 우주 분야의 STEAM 프로그램 적용 사례

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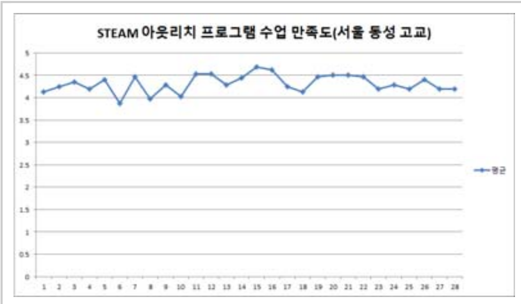

Abstract:
미국 NASA 교육 자료의 우수한 STEM 프로그램을 활용하여 창의적으로 STEAM 프로그램을 개발하여 국내의 초중고 학생들에게 항공 우주 분야의 기초 물리, 관성 모멘트, 비행 속도, 빅데이터등을 다루어 STEAM(융합 인재 교육) 적용하여 다양한 콘텐츠를 활용하여 시범 수업을 운영하였습니다. 활용 만족도 설문 조사를 실시하여 분석한 결과 높은 만족도를 얻을 수 있었습니다. 미국의 STEM 프로그램과 한국의 STEAM 프로그램을 서로 비교 분석하여 체계적인 STEAM 프로그램을 개발하여 다양하게 적용하였으며 체계적으로 프로그램을 만들 수 있으면 학교 현장에서 매우 활용할 수 있을 것으로 기대됩니다

Keywords:
STEAM, STEM, 물리 교육

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2016.10.19 - 2016.10.21

Actual Experiment of Observation of Compass Needle around Magnet in Primary School Science

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Abstract:

Observation of the movement of compass needle around magnet and current-carrying straight lines and circular coils have been carried out in the 6th grade primary school science curriculum revised 2009. In this unit, the magnetic field, the lines of magnetic force, Ampere law, the relation of between rotation angle of compass needle and magnetic field were introduced. The equipment had been devised to accomplish the experiment about magnetic field. The magnitude of the magnetic field are depended on the coil carrying current, the distance between measure point and the coil, the coil turns, and the geometric shape of coils. The magnitudes of magnetic filed in primary school have been conventionally measured with compass. Due to the influence of geomagnetism, the rotated angles of compass needle are not linearly depended on the coil currents. To show the linear dependent of magnetic field strengths on currents for the magnetic field experiments using compass, the data are analyzed in this work.

Keywords:
Compass, Magnetic Field