구두발표논문 초록

■ SESSION: D [DF1]
4월 17일(목), 12:30 - 14:30
장 소: 101호

DF-01(초) **Electron transport in one-dimensional system** 김 남, 김 종기, 우 병칠, 김 진희, 서 민기[1], 정 윤철[1], 김 소라[2], 이 정오[2], 김 주진[2](*한국표준과학연구원 나노소자연구단 [1]부산대학교, 물리학과. [2]전북대하교, 물리학과.*) We will present experimental results on electron transport in one-dimensional system including nanowires as well as quantum point contact made of GaAs/AlGaAs hetero junction. At low temperatures two distinctive features appear which cannot be observed for classical macroscopic systems. One is phase coherent phenomena and the other is Coulomb blockade (CB) effects. The first one is related with the wave property of electron such as Aharonov-Bohm effects, Fano interference, and Fabry-Perot interference. On the other hand the CB effects are related to the particle side of electron. Using CB effects, electrons can be controlled one by one as integer number, leading to applications for single electron transistor and single electron pump device.

DF-02(초) **Quantum transport in electron interferometers** 정 윤철, 장 동인[1], 김 경락[2], 이 후종[1], 강 기천[2], 서 민기, HEIBLUM Moty[3], NEDER Izhar[3], OFEK Nissim[3](*부산대학교, 물리학과. [1]포항공대, 물리학과. [2]전남대학교, 물리학과. [3]Weizmann Instatute of Science.*) Introduction about solid state electron interferometers will be given together with brief summary on various interferometers from simple quantum ring to Mach-Zehnder interferometer. Recent results on eletron interferomets, such as two particle interference and qauntum complementarity, will be reviewed.

DF-03(초) **Quantum transport and electro-optical properties of semiconductor nanowires** 도 용주(*포항공과대학교 신소재공학과 반도체나노막대연구단*) Chemically grown semiconductor nanowires can provide a promising platform to study various quantum phenomena in low dimensional system. Hugh versatility in composition of nanowires and relatively simple fabrication process make nanowire devices promising for research in the fields of quantum information and computation. In this talk, I will focus on the experimental realization of mesoscopic Josephson field-effect transistor, formed with a nanowire bridging two superconducting electrodes. Here the electronic transport is mainly determined by the coupling strength between the nanowire and electrodes, exhibiting universal conductance fluctuations and Coulomb blockade oscillations. In addition to the quantum interference/confinement effects, the electro-optical properties of the individual nanowires are also explored, as a first step towards the possibility to control the optoelectronic response at the single-quantum level.

■ SESSION: D [DF2]
4월 17일(목), 12:30 - 14:30
장 소: 102호

DF-04(초) **Bio-Soft Condensed Matter** SUNG Wokyung (*Dept of Physics, POSTECH, Pohang.*) The biological systems in nano and cellular scales are characterized by their unusual susceptibility to thermal fluctuations and biases, due to structural connectivity and weak electrostatic interactions therein. I will introduce this soft-condensed matter nature of the systems and discuss how nature manipulates diverse fluctuations and their coupling to give rise to self-organization that underlies in biological processes.

DF-05(초) **Single Molecule Study: Real-Time Observation of RecA Filament Nucleation and Dynamics** 주 철민(*서울대학교*) The RecA protein helps maintain genomic integrity through recombination. Using new single-molecule fluorescence assays and hidden Markov modeling, we first show the most direct evidence that a RecA filament grows and shrinks primarily one monomer at a time and only at the extremities. Both ends grow and shrink, contrary to expectation, but a higher binding rate at one end is responsible for directional filament growth. Next, we estimate that about five monomers are sufficient for filament nucleation. We further find that the nucleation is likely to occur through the binding of a pre-assembled oligomer rather than the simultaneous binding of several monomers, using a vesicle encapsulation assay.

DF-06(초) **이미징과 바이오멤스 기술을 이용한 T 세포간의 상호작용 연구** 도 준상(*포항공대 기계공학과/시스템생명공학부.*) T 세포는 특정 병원균에 대한 면역반응의 시작에 있어서 중요한 역할을 하는 면역세포이다. 면역세포들은 병원균의 침입을 감시하고 병원균의 침입 발견 시 빠르게 대응하기 위하여 우리 몸의 곳곳을 순찰하여야 하기 때문에 다른 세포들에 비하여 훨씬 더 역동적인 특성을 가진다. 그렇기 때문에 면역세포간의 상호작용이나 면역세포와 다른 세포의 상호작용이 인체 내부에서 어떻게 일어나는가를 연구하기 위해서는 관심이 있는 세포들의 움직임을 인체 내에서 실시간으로 관찰하는 것이 필요하다. 이러한 조직내에서의 세포의 동적 거동을 관찰하기 위하여 최근들어 많이 사용되고 있는 현미경이 two-photon 현미경이다. Two-photon 현미경은 조직에 흡수나 산란이 적게 되는 적외선 레이저를 사용하기 때문에 깊은 조직 (~ 500 μm)안에서 일어는 세포들의 움직임을 관찰하는데 유리하다. 이렇게 관찰한 세포들의 상호작용이 가지는 생물학적인 의미를 이해하기 위해서는 우리가 관심이 있는 세포들이 조직내에서 가지는 미세환경 (microenvironments)을 모사하는 환경을 배양용기상에서 조성해 줄 필요가 있다. 이러한 미세 환경을 가공하는데 유용한 도구가 BioMEMS (BioMicroElectroMechanical Syatems) 기술이다. 본 연구에서는 우선 특정 병원균에 대한 면역반응이 시작하는 림프절(lymph node)에서의 T세포간의 상호작용을 two-photon 현미경을 이용하여 관찰하였다. 병원균의 침입이 없을때에 비하여 병원균의 침입이 있을 때 그 병원균에 대하여 반응을 하는 T세포들간의 접촉시간이 크게 증가하는 것을 볼 수 있었다. 이러한 T 세포간의 접촉이

가지는 생물학적인 의미를 분석하기 위하여 활성화가 된 T 세포들을 다양한 숫자의 T 세포들을 수용할 수 있는 microwell에 넣고 T 세포간의 접촉에 의한 상호작용이 T세포의 생존과 증식에 있어서 어떠한 영향을 미치는가를 관찰하였다. 고립된 T 세포에 비하여 다른 T 세포와의 접촉이 허용된 T 세포들의 경우 생존과 증식에 있어서 유리한 것으로 나타났다. 이러한 결과는 기존의 면역반응에 있어서 간과하던 T 세포들간의 상호작용이 면역반응을 조절하는데 있어서 중요한 역할을 할 수 있다는 것을 보여준다.

DF-07(초) **Enhanced *Caenorhabditis elegans* locomotion in a structured microfluidic environment** PARK Sungsu(*Division of Nano Sciences (BK21), Ewha Womans University, Seoul, Korea 120-750.*) Behavioral studies of *Caenorhabditis elegans* traditionally are done on the smooth surface of agar plates, but the natural habitat of *C. elegans* and other nematodes is the soil, a complex and structured environment. In order to investigate how worms move in such environments, we have developed a technique to study *C. elegans* locomotion in microstructures fabricated from agar.When placed in microfluidic chambers containing an array of posts, we discovered that worms are capable of a novel mode of locomotion, which combines the fast gait of swimming with the more efficient movements of crawling. When the length of the worms "resonated" with the periodicity of the postarray, the microstructure directed the swimming and increased the speed of *C. elegans* ten-fold. We found that mutants defective in mechanosensation (*mec-4*, *mec-10*) or mutants with abnormal waveforms (*unc-29*) did not perform this enhanced locomotion and moved much more slowly in the microstructure. These results show that the microstructure can be used as a behavioral screen for mechanosensory and uncoordinated mutants. It is likely that worms use mechanosensation in the movement and navigation through heterogeneousenvironments.

■ SESSION: D [DA1]
4월 17일(목), 14:30 - 16:10
장 소: 101호

DA-01 **메모리의 개발 경향과 미래 메모리 소자에 대한 전망** 정 홍식(*삼성전자 반도체연구소ATD팀.*) 반도체 메모리 소자는 1970년 Intel에서 1kb DRAM이 개발된 이래 Shrink 기술을 기반으로 폭발적인 성장을 이루었고, 우리 나라가 세계 1위의 메모리 생산국이 되었다. DRAM의 경우 집적도가 3년마다 4배씩의 성장을 이루었고, DRAM 단위 cell 소자의 크기는 지난 20년 동안 1/1200만큼 급격히 감소하였고 최근 DRAM의 Design rule은 50~60nm 수준으로 nano 기술의 영역에 도달하였다. 이처럼 메모리 기술은 Shrink 기술을 발판으로 급격한 발전을 거듭하여 왔으나, 점점 Shrink 기술이 어려워짐으로 인해서 이에 대한 극복 기술의 개발이 필요하게 되었다. 또한 IT 산업의 발전으로 다양한 응용에 이용한 할 수 있는 새로운 특성을 갖는 메모리에 대한 요구가 급증하여서 많은 연구가 진행되고 있으며 그 중 일부는 이미 상업화 단계에 돌입한 기술도 있다. 본 발표에서는 기존 메모리의 Shrink 한계를 극복하는 기술과 새로운 특성을 가지는 신메모리 기술과 특성에 대해 논의하여 향 후 미래 메모리 소자 기술에 대한 전망을 하고자 한다.

DA-02 **Ab initio studies of structural and electronic properties of the crystalline $Ge_2Sb_2Te_5$** LEE Geunsik, JHI* Seung-Hoon(*Department of Physics, Pohang University of Science and Technology, Pohang 790-784.*) We study the atomic structure, the electronic and optical properties of $Ge_2Sb_2Te_5$ in two different crystalline states of cubic and hexagonal structures with the use of *ab initio* pseudopotential density functional method. It is found that electronic and atomic structures are very sensitive to the layer sequence in the two phases. The proximity of vacancy layer to Ge-layer leads to the splitting of Ge-Te bond length, which in turn affects the electronic and optical properties. The effect of Te-*d* orbitals is also investigated with respect to structural properties.

DA-03 **Mott metal-insulator transition and switching in VO_2** KIM Hyun-tak, LEE Young wook, KIM Bong-jun, CHAE Byung-gyu, YUN Sun jin(*ETRI.*) As experimental evidence of the Mott metal-insulator transition (MIT) for VO_2 ($3d^1$, half filling) known as a representative Mott insulator, the MIT oscillation, a movement of the MIT critical temperature, the spectroscopic analysis on existence of a strong correlation, a disagreement of the MIT and the structural phase transition are shown. Furthermore, we also show examples of eletrostatic discharge with a high power and optical switching by using a MIT device.

■ SESSION: D [DS1]
4월 17일(목), 14:30 - 16:15
장 소: 105호

DS-01 **거대 연구시설에 대한 정부의 정책과 전략** 이 석래(*교육과학기술부거대과학협력과.*)

DS-02 **방사광가속기 이용연구** 이 기봉(*포항공대 물리학과.*) 포항가속기연구소가 설립된 지 20년이 되었으며 이용자들에게 포항방사광가속기(Pohang Light Source: PLS)를 이용하기 위한 빔타임을 개방하기 시작한지 13년째이다. PLS는 국내 최초의 거대과학 연구시설로서 건설당시 많은 우려가 있었으나, 지난 20년간에 걸친 건설과 운영기간동안 국내의 방사광 이용 연구자들과 함께 발전해 왔다. 국내 이용자들의 방사광을 이용한 연구 현황과 빔라인에 대한 수요, 그리고 국제적인 방사광 분야의 발전방향을 살펴본다. 또한 이에 대응하기 위한PLS의 바람직한 향후 발전계획에 대해 언급한다.

DS-03 **중성자산란 이용 연구** 이 창희(*한국원자력연구원 중성자과학연구부.*) 한국원자력연구원에서 건설, 운영하는 연구용 원자로 하나로(HANARO)는 1985년 착수, 1995년 첫임계 이후 10년 이상의 가동 실적을 갖는 고중성자속 연구로로서 응집물질 분야 전반의 연구에 이용 가능한 중성자 산란 분야는 이 연구로의 주요 이용분야의 하나이다. 하나로 이전의 연구로부터의 역사

적 경과와 최근까지의 이용 추이 및이용자 그룹과 시설 현황, 특히 중성자 유도관을 적용한 냉중성자 연구시설 구축 관련한 노력을 소개하고 시설에서 조망하는 장기 전망과 발전 전략을 간략히 소개한다.

DS-04 **고자기장과 고압 극한환경 연구** 강 원(*이화여자대학교 물리학과*) 응집물질물리학을 위한 실험연구에 사용되는 극한환경 중에서 고자기장 시설과 고압시설에 대하여 소개한다. 이들 시설은 아직 국내에 설치되어 있지 못하므로 외국에서 운용되고 있는 사용자 설비를 중심으로 소개하고자 한다.

DS-05 **초고전압 투과전자현미경(HVEM)의 운영 및 활용 현황** 김 윤중(*한국기초과학지원연구원 전자현미경연구단*) 2003년 말 대덕연구단지의 한국기초과학지원연구원(기초연)에 설치되어 2004년 4월부터 국가적 공동이용시설로 운영을 시작한 초고전압 투과전자현미경(HVEM)은 2년간의 1단계 운영을 성공적으로 마치고 현재 3년간의 2단계 운영을 수행하고 있다. 초기 운영은 장비의 안정화와 이용자의 확산에 중점을두었고, 2단계 운영은 국가적 핵심과학기술 분야의 지원을 활성화 하는데 초점을 맞추고 있다. 특히 나노-바이오 융합 분야의 연구지원을 강화하고 있다. 그 동안 의생물 분야에서는HVEM의 고투과력(1.25 MV)과 고경사기능을 이용한 전자 토모그래피 작업이 주류를 이룬 반면, 재료 분야에서는 고분해능(0.12 nm)과 고투과력이 동시에 필요한 작업이나 HVEM에 부착된 에너지 여과장치를 이용하여 화학분석을 함께 수행하는 작업이 주류를 이루었다. 기타 고에너지 전자빔 조사작업, 변온 시료지지대를 이용한 고온 및 저온에서의 물질의 상전이 연구, 그리고 인장 시료지지대를 이용한 파괴인성 연구도 수행되었다. 정규 운영 후 약 4년간의 HVEM 활용 현황과 대표적 활용 예를 소개한다.

DS-06 **과학비즈니스벨트 연구시설** 홍 승우(*성균관대학교 물리학과*) 국제과학비즈니스벨트를 간단히 소개하고 국제과학비즈니스벨트의 핵심 요소인 기초과학연구소의 중요 시설로 고려될 수 있는 것에 대하여 살펴본다.

DS-07 **국외 시설에 대한 조망과 우리의 접근** 박 제근(*성균관대학교, 물리학과*) 응집물질물리학을 위한 거대 연구시설에는 방사광가속기, 중성자산란 연구시설, 초고전압 전자현미경, 고압-고자기장 시설 등 개인 연구실에서 설치와 운영을 맡을 수 없으면서 다양한 연구 분야에서 활용되는 많은 장비를 모두 포함한다. 최근 전 세계적으로 이런 거대 연구시설을 이용한 연구들이 응집물질물리 분야에서 늘어나고 있으며, 이런 연구를 소위 'small sciences at big facilities'라고 부른다.이런 시설은 특성상 이용자 중심으로 운영되고 자연스럽게 서비스 개념에 기반을 두게 된다. 또한 이들 시설의 경쟁력은 한 국가에 국한해서 측정할 수 없고, 적어도 여러 국가를 포함하는 지역이나 더 넓은 의미의 지역들의 유사장비와의 경쟁력을 상대비교해서 건설되고 운영되어야 한다. 이런 측면에서 현재 우리나라에 건설되고 운영되는 장비와 앞으로 건설예정인 시설들은 모두 적어도 아시아-오세아니아의 지정학적인 경쟁력을 가지도록 준비되고 운영되어야 한다고 본다. 이번 발표에서는 주로 방사광가속기와 중성자산란 연구시설을 중심으로 이런 목적의식을 가지고 아시아-오세아니아 지역의 거대 연구시설을 조망해보려 한다. 그리고 이를 통하여 우리나라의 거대 연구시설의 장기적인 전략을 어떻게 수립해야 하는 지를 모색해 보고자 한다.

D

■ SESSION: D [DG1]
4월 17일(목), 16:30 - 18:10
장 소: 101호

D-01 **Electromigration of oxygen vacancy in metal-oxides: First-principles study** JEON Sang Ho, PARK Bae Ho, HAN Seungwu[1](*Department of Physics, Konkuk University.* [1]*Department of Physics, Ewha Womans University.*) The oxygen vacancy, which is a fundamental defect in oxides, plays a critical role in defining many electrical properties of oxides ranging from ionic conducitivities to leakage behaviours. As such, to control the density and spatial distribution of the oxygen vacancy has often been an important goal in many researches on electronic devices, particularly for high-density devices such as high-k based complementary metal-oxide semiconductors or resistance-change random access memories (ReRAM), a candidiate next-generation nonvolatile memory. The distribution of oxygen vacancies can be controlled by applying electrical bias because a charged oxygen vacancy carry a positive charge. However, the understanding of the electromigration of oxygen vacancies is far from being complete, and it is poorly understood how the activation energy is affected by the field. In this presentation, we present first-principles studies on the migration of the oxygen vacancy in several metal oxides, such as MgO, BaO, and $SrTiO_3$. To simulate a charged vacancy, we construct slab models of metal oxides and introduce dopants with a differing valency. The migration barrier is calculated using the dimer method under an external field. We will discuss on how the barrier is affected by the dielectric constants and local bonding configurations.

D-02 **Structural and magnetic properties of c(2×2) MnCu alloy on Cu(001)** KIM Dongyoo, HONG Jisang (*Department of Physics, Pukyong National University.*) Based on full-potential linearized augmented plane wave (FLPW) method, we have investigated the structural and magnetic properties of one monolayer of surface alloy ultra-thin MnCu/Cu(001) film. In these days, the magnetic ground state of MnCu/Cu(001) system is still a controversial issue. For instance, several theoretical researches claimed ferromagnetic ground state. Some experimental studies reported FM and AFM ground state. Also, very recently, experimental study using X-ray magnetic circular dichroism (XMCD) technique suggested the paramagnetic ground state. Our calculated result shows that the surface alloy has a stripe type antiferromagnetic (AFM) ground state. We expect that this result can explain the recent experimental result for paramagnetic ground state. Also, the surface alloy has a buckling feature. The surface Mn atom is 0.25 Å higher than that of neighboring Cu atom in the magnetic ground state.

D-03 **Density-functional theory and model-potential study of multiferroic $BiFeO_3$** 신 영한, 이 병주, 장 현명, RAPPE Andrew M.(*포항공과대학교, 신소재공학과.*) Bismuth ferrite ($BiFeO_3$) is a typical multiferroic material which has a coupling between electric polarization and magnetization. $BiFeO_3$ is ferroelectric with Curie temperature of 1103 K and exhibits antiferromagnetic behavior with Neel temperature of 643 K. The average crystal lattice of $BiFeO_3$ is a rhombohedrally distorted perovskite structure, which belongs to the space group *R3c*. We study the basic electrical and structural properties of $BiFeO_3$ using density-functional calculations within the general gradient approximation. The couplings among electric polarization, magnetization, and octahedral tilt angles are revealed, and they are used to make a atomic potential model based on the bond-valence model.

D-04 **Electric polarization enhancement in the site-disordered multiferroic $CoCr_2O_4$ crystal.** KIM Ingyu, OH Yoon Seok, CHUN Sae Hwan, KIM Kee Hoon, LEE Jun-Sik[1], KO Kyung-Tae[1], PARK Jae-Hoon[1](*CSCMR &FPRD, School of physics and astronomy, Seoul National University. [1]Department of Physics, POSTECH.*) Multiferroic materials, in which electric polarization P is actuated by small magnetic field H, can be useful in realizing future ferroelectric devices controlled by H. However, P value thus produced is still much lower than that of the conventional ferroelectric materials. Therefore, to find a way of enhancing P value in many multiferroic materials recently studied can be important to utilize them in real applications. According to the spin current model [1], the cobalt chromite $CoCr_2O_4$ with the spinel structure is expected to have spontaneous P under a spiral ordering temperature T_S. Herein, we have grown three kinds of single crystals of $CoCr_2O_4$ by use of different growth conditions, i.e., the flux melting method with slow (F1) and fast (F2) cooling conditions and the chemical vapor transport method (CVT). In all the crystals, P along [-110] is observed below T_S=25-27K and it increases to saturate under magnetic field H~1 T applied along [001]. According to the temperature-dependent magnetization and heat capacity data, the CVT sample has the most clear transition feature at T_S as well as at the lock-in transition temperature located around ~14 K, while the F1 has the least clear feature. Furthermore, according to the X-ray absorption spectra, the F2 and F1 crystals have increasing Co^{3+} L-edge absorption while the CVT sample has no corresponding absorption intensity. These results indicate that the F1 sample has the largest A and B site mixing and the CVT sample is close to be an ideal normal spinel compound. On the other hand, we find that the F1 has the largest saturated magnetic moment ~ 0.6 μ_B and the saturated P ~ 2.0 $\mu C/m^2$ while the CVT sample has the smallest magnetic moment ~ 0.2 μ_B and saturated P ~ 1.0 $\mu C/m^2$ Therefore, the A and B site disorders in the spinel $CoCr_2O_4$ can be an effective way to increase P as well as the magnetic moment. The possible physical origin for this behavior is discussed based on the Yafet-Kittel ordering pattern of the ferrimagnetic ground state [2].

[1] H. Katsura et al.,Phys. Rev. Lett. 95, 057205 (2005).[2] Y. Yafet et al., Phys. Rev. 87, 290 (1952).

D-05 **Investigation of a coexistence of three directional magnetic domains by PHE measurement in (Ga,Mn)As ferromagnetic semiconductor** CHUNG Sun-jae, KIM Jungtaek, SON Hyunji, LEE Sanghoon, LIU X.[1], FURDYNA J. K.[1](*Physics Department, Korea University, Seoul 136-701, KOREA. [1]Physics Department, University of Notre Dame, Notre Dame, IN 46556, USA.*) The magnetization reversal process of GaMnAs epilayer has been studied using Planar Hall Effect (PHE). The field scan of Planar Hall Resistance (PHR) data shows interesting magnetization switching behavior depending on the applied field angle. For example, while the PHR exhibits clear two-step switching behavior between well defined two magnetization directions when the magnetic field is applied away from magnetic easy axis, the magnetization reversal process is significantly different by showing the decrease of PHR amplitude in the process when the field direction is in the critical angle near the easy axis. The critical angle set the criterion for clockwise (CW) to counter-clockwise (CCW) rotation of magnetization during field scan. It was also observed that the transition widths of PHR (dR_{PHR}/dH) near 1st and 2nd switching fields (H_{sw1} and H_{sw2}) strongly depend on the applied field angle (φ_H). While a dR_{PHR}/dH is larger near H_{sw1} than that near H_{sw2} in the region $0°<\varphi_H<30°$ and $70°<\varphi_H<90°$, the opposite tendency is observed for the other angle region. Though these phenomena are usually observed in magnetization reversal process of (Ga,Mn)As ferromagnetic films, the detail mechanism is not clearly understood yet. We have adapted the Stoner-Wohlfarth (SW) model,[1] Cowburn's model,[2] and the formation of multi-domain state to explain the observed phenomena in PHR [3] By considering the coexistence of three magnetic domains along different directions during the transition, we are able to explain the observed behavior of PHR in GaMnAs films.

Reference [1] E. C. Stoner and E. P. Wohlfarth, Philosophical Transactions of the Royal Society of London Series a-Mathematical and Physical Sciences 240, 599 (1948). [2] R. P. Cowburn, S. J. Gray, J. Ferre, J. A. C. Bland, and J. Miltat, Journal of Applied Physics 78, 7210 (1995). [3] D. Y. Shin, S. J. Chung, S. Lee, X. Liu, and J. K. Furdyna, Physical Review Letters 98, 047201 (2007).

D-06 **Orbital Ordered Phases of Mn_3O_4 and MnV_2O_4 Investigated by NMR** SHIM Jeong Hyun, LEE Soonchil, KATSUFUJI Takuro[1](*Department of Physics, KAIST. [1]Department of Physics, Waseda University.*) Compared to spin and charge, investigating orbital state is relatively difficult because it requires higher sensitivity of microscopic experimental tools. In the present study, we have demonstrated that the orbital state of Mn_3O_4 can be determined by a field-angle resolved NMR technique and the technique also applied to the investigation of MnV_2O_4 that was reported to have a strong orbital influence to spin and lattice. The orbital ordered phase of MnV_2O_4 has been controversial, because lattice symmetry alone can not determine the orbital states of

V^{3+} ions. From our NMR results, we found that the orbital configuration of MnV_2O_4 appears to support the Motome's antiferro-type model.

D-07 **Nuclear spin coupling and coherence in metallic Si:P** JEONG minki, SONG Myeonghun, UENO Tomohiro[1], MIZUSAKI takao[2], SASAKI yutaka[3], MATSUBARA akira[3], CHIBA meiro[4], LEE soonchil(*KAIST, Dept. of Physics.* [1]*Kyoto Univ., School of Health Sciences.* [2]*Toyota Physical and Chemical Research Inst..* [3]*Kyoto Univ., LTM Center..* [4]*Fukui Univ., Dept. of Applied Physics.*) Phosphorus-doped silicon (Si:P) naturally simulates a silicon-based nuclear spin quantum computer, where ^{31}P nuclear spins serve as qubits. We investigated ^{31}P nuclear spin dynamics in metallic Si:P using NMR under extreme conditions of magnetic fields around 7 T and very low temperatures down to 44 mK. In contrast to the conventional belief that temperature-independent dipolar interaction determines transverse (spin-spin) relaxation rate $1/T_2$ at low temperature, we observed strong enhancement of $1/T_2$ as cooled below 1.5 K. More surprisingly, the enhancement suddenly stopped around 600 mK and $1/T_2$ remained almost constant down to the lowest temperature. We discuss some possible sources for this unusual spin dynamics.

D-08 **Half Semimetallic Antiferromagnetism in the Sr_2CrTO_6 System, T=Os, Ru** LEE K.-W., PICKETT W. E.[1](*Department of Display and Semiconductor Physics, Korea University, Jochiwon,.* [1]*Department of Physics, University of California, Davis, CA 95616, USA.*) Double perovskite Sr_2CrOsO_6 is (or is very close to) a realization of a spin-asymmetric semimetallic compensated ferrimagnet, according to first principles calculations. This type of near-half metallic antiferromagnet is an unusual occurrence, and more so in this compound because the zero gap is accidental rather than being symmetry determined. The large spin-orbit coupling (SOC) of osmium upsets the spin balance (no net spin moment without SOC): it reduces the Os spin moment by 0.27 μ_B and induces an Os orbital moment of 0.17 μ_B in the opposite direction. The effects combine (with small oxygen contributions) to give a net total moment of 0.54 μ_B per cell in \scoo, reflecting a large impact of SOC in this compound. This value is in moderately good agreement with the measured saturation moment of 0.75 μ_B. The value of the net moment on the Os ion obtained from neutron diffraction (0.73 μ_B at low temperature) differs from the calculated value (1.14 μ_B). Rather surprisingly, in isovalent Sr_2CrRuO_6 the smaller SOC-induced spin changes and orbital moments (mostly on Ru) almost exactly cancel. This makes Sr_2CrRuO_6 a "half (semi)metallic antiferromagnet" (practically vanishing net total moment) even when SOC is included, with the metallic channel being a small-band-overlap semimetal. Fixed spin moment (FSM) calculations are presented for each compound, illustrating how they provide different information than in the case of a nonmagnetic material. These FSM results indicate that the Cr moment is an order of magnitude stiffer against longitudinal fluctuations than is the Os moment.

■ SESSION: D [DG2]
4월 17일(목), 16:30 - 17:55
장 소: 102호

D-09 **Evalution of semiconducting/metallic ratio of single-walled carbon nanotubes** 민 경인, 노 희석[1], 김 기강[2], 최 수봉[3], 이 영희[2], 김 종수[4], 변 지수[4], 오 명규[4], 정 문석[4](*광주과학기술원, 고등광기술연구소/전북대학교, 물리학과.* [1]*전북대학교 물리학과.* [2]*성균관대학교, 물리학과.* [3]*서울대학교, 물리학과.* [4]*광주과학기술원, 고등광기술연구소*) 본 연구에서는 Arc-discharge로 합성된 single-walled carbon nanotubes(SWCNTs) pristine 시료와 열처리 산처리를 통하여 정제한 시료들의semiconducting/metallic 구성 비율을 UV-VIS-NIR absorption spectroscopy를 이용하여 계산하였으며 이 결과를 700~900 nm 사이에서 파장변조가 가능한 cw-Ti:sapphire 레이저를 이용한 파장 변조 공명라만산란 방법으로 검증하였다. Absorption spectroscopy 분석결과 산처리등의 정제과정을 통하여 semiconducting SWCNTs의 구성 비율이 감소하는 현상을 발견하였으며, 파장변조 공명라만산란실험에서도 정제과정에 따라semiconducting SWCNTs의 peak가 사라지는 현상을 동일하게 관측하였다.

D-10 **The role of vacancies in the superplastic deformation of single-wallcarbon nanotubes** ALEX Taekyung Lee, KANG Yong-Ju, CHANG Kee Joo, LEE In-Ho[1](*Dept. of Physics in KAIST.* [1]*KRISS.*) Carbon vacancies are one of the most common defects in carbon systems like carbon nanotubes and graphene. These defects can be easily generated by ion or electron irradiation, and they significantly affect the structural, electronic, and mechanical properties. We perform first-principles theoretical calculations to study the atomic structureand energetics of vacancy defects in armchair and zigzag nanotubes, whichare formed by removing carbon atoms up to six. We find that the stability of vacancy structures is determined by three majorfactores: (i) the saturation of dangling bonds, (ii) alignment of reconstructed bonds in pentagons, and (iii) orientation of missing atoms. Based on the results of calculations, we discuss the role of vacancies in the formation of metal-semiconductor junctions and the motion of kinks observed in the superplastic deformation of carbon nanotubes.

D-11 **First-principles Study of Hydrogen Adsorption on Hexagonal Silicon Nanotubes** RYOU Junga, HONG Suklyun, KIM Gunn[1](*Department of Physics and Institute of Fundamental Physics, Sejong University, Seoul.* [1]*BK21 Physics Research Division and Institute of Basic Science, Sungkyunkwan University, Suwon.*) We perform the first-principles calculations of geometrical and electronic structure of hydrogen molecule adsorbed on hexagonal single-walled silicon nanotubes (SiNTs). The adsorption behaviors of hydrogen molecule on SiNTs are investigated. The binding energies for the most stable physisorbed configurations are calculated to be less than 0.1 eV. We also consider the encapsulation of H_2 molecule in tip-opened SiNTs. Then, the energy barriers are investigated for dissociation of H_2 molecules on the SiNT and for H_2 penetration into the

tip-opened one. Finally, the possibility of SiNTs as hydrogen storage materials is discussed.

D-12 **Effects of Atomic-Scale Defects on the Electronic Structure of the Dirac Fermions in Graphene** RYU Byungki, KANG Joongoo[1], BANG Junhyeok, CHANG Kee Joo(*Department of Physics, KAIST. [1]NREL.*) We perform both perturbation theory and local-density-functional calculations to study the effects of atomic-scale defects, such as carbon-vacancies,displaced carbon atoms, and Stone-Wales defects, on the electronic structure of the Dirac fermions in graphene.The degeneracy at the Dirac point can be removed by atomic-scale defects which break the sublattice symmetry, resulting in the energy-gap opening. In the dilute limit, according to the perturbation theory, the amount of the energy-gap is proportional to the density of identical defects, while the degeneracy of the Dirac point is nearly recovered if physically equivalent defects are distributed, with similar concentrations. For the defects considered here, our first-principles calculations, which use supercell geometries for different defect concentrations, confirm the results of the perturbation theory. Our results indicate that the effect of atomic-scale defects on the low-energy band structure of real graphene would be very small, since physically equivalent defects are nearly uniformly distributed.

D-13 **Measurement of Thermal Conductivity of the Individual Single Crystalline Bi Nanowire using MEMS Structure** ROH Jong Wook, CHEN Renkun[1], LEE Seunghyn, HAM Jin Hee, HOCHBAUM Allon I.[2], HIPPALGAONKAR Kedar[1], YANG Pei Dong[2], KIM Woochul[3], MAJUMDAR Arun[1], LEE Wooyoung (*Department of Materials Science and Engineering, Yonsei University, Seoul, Korea. [1]Department of Mechanical Engineering, University of California, Berkeley, California, USA. [2]Department of Chemistry, University of California, Berkeley, California, USA. [3]School of Mechanical Engineering, Yonsei University, Seoul, Korea.*) Ever since the thermoelectricity has been discovered, there have been many researches to maximize the thermoelectric figure of merit ($ZT=S^2\sigma/\kappa$) for thermoelectric cooling and power generation. However, increasing the figure of merit in the bulk materials is difficult because the three parameter S, σ and κ are dependent of each other. In these situations, over the last decade, with the development of nano technology, it is found that novel man-made nano materials such as nanowire and nanotube have shown promising properties as thermoelectric materials. Especially, Bi nanowire is predicted as one of ideal thermoelectric nano materials because of its small effective mass and large thermoelectric power, and small thermal conductivity[1]. However, to the best of our knowledge, there have been no reported experimental results on the thermal conductivities of Bi nanowires. In this work, we have investigated the thermal conductivity of an individual Bi nanowire.In growing Bi nanowires by stress-induced method, a Bi thin film was first deposited on a thermally oxidized Si (100) substrate in a dc/rf magnetron sputtering system with a basal pressure of 4×10^{-8} Torr. Interestingly, after heat treatment of as-grown films at 270 ˚C for 10 hours, uniform and straight Bi nanowires with high aspect ratio were found to be extruded from the surface of the as-grown films. TEM observation shows that the Bi nanowire was single crystalline. We have used the microdevice to measure the thermal conductivity of an individual suspended Bi nanowire. The microdevice was designed to make the heat generated by micro coil integrated in the suspended membranes[2].The measured thermal conductivity value for 105 nm and 225 nm diameter nanowire is 2.5 W/m-K and 3.0 W/m-K at room temperature, respectively. These values are much lower than that for bulk Bi (k for bulk Bi ≈ 8 W/m-K). And we also find that the thermal conductivity is dependent on the diamenter of nanowire. This result reveals the thermal conductivity can be suppressed by phonon-boundary scattering and modification of phonon dispersion[3,4].

References [1] M G. Kanatzidis *et al,* (Ed.), Chemistry, Physics, and Materials Science of Thermoelectric Materials, Kluwer Academic/Plenum Publisher, New york.(2003) [2] L. Shi, D. Li, C. Yu, W. Jang, D. Kim, Z. Yao, P. Kim, and A. Majumdar*, J. Heat Transfer,* 125, 881 (2003) [3] G. Chen and A. Shakouri, *J. Heat Transfer*, 124, 242 (2002) [4] A. Balandin and K. L. Wang, *Phys. Rev. B,* 58, 1544 (1998)

D-14 **Surface Analysis of Ferroelectric PZT Nanotubes Synthesized by Using Porous Alumina Membrane and Spin-Coating Technique** BU Sang Don, JEONG Keum Ok, KIM Jong Ok, HAN Jin Kyu(*전북대학교, 물리학과.*) We present a surface investigation of $Pb(Zr_{0.52},Ti_{0.48})O_3$ (PZT) nanotubes prepared in a porous alumina membrane (PAM) which shows that the interaction between the PZT precursor and the PAM results in the formation of lead aluminate ($PbAl_{12}O_{19}$). In order to investigate the surface characteristics of the PZT nanotubes, the nanotubes residing in a PAM is selectively etched in 5 wt% phosphoric acid solution as a function of etching time of 1 to 15 h. Field emission transmission electron microscope of PZT nanotubes etched for 1 h suggests that they are surrounded by the amorphous alumina which can be regarded as alumina/PZT bilayer nanotubes. When they are etched further for 15 h, the alumina appears to be removed completely. On the other hand, element quantification using scanning transmission electron microscope and energy dispersive X-ray spectroscopy reveals that the alumina is present, though negligibly small. Lattice fringe analysis of the PZT nanotube walls indicates that the alumina from the PAM is incorporated into the PZT nanotubes to form alumina/PZT composite such as lead aluminate.

D-15 **Study on Physical Properties of Graphene by Using Lateral Force Microscopy and Force Spectroscopy** SEO Yongho, PARK Sang-Do, EOM Jonghwa, OH Youngman(*Sejong Univ..*) We prepared graphene flakes on Si wafers which were covered with silicon oxides. By using atomic force microscope (AFM), the thickness and morphology of the graphene flakes were measured. The frictional force between a tip on the AFM cantilever and the graphene were measured by lateral force microscopy. The resultant force was larger than that between the Si and the tip, and

smaller than that between a graphite (multilayer of graphene) and the tip. The force spectroscopy was employed to study van der Waals force between the graphene and the tip, also.

■ SESSION: D [DI1/EI2]
4월 17일(목), 16:30 - 17:40
장 소: 301호

DI-01 **The Perfect Lens: Resolution Beyond the Limits of Wavelength** Sir PENDRY John(*Imperial College.*) The lens is one of the most basic tools of optics but the resolution achieved is limited, as if the wavelength of light defined the width of a pencil used to draw the images. This limit intrudes in all kinds of ways. For example it defines the storage capacity of DVDs where the laser can only 'see' details of the order of the wavelength. Two type of light are associated with a luminous object: the near field and the far field. True to its name the far field escapes from the object and is easily captured and manipulated by a lens, but high resolution details are hidden in the near field and remain localised near the source and cannot be captured by a conventional lens. To control the near field we have developed a new class of materials with properties not found in nature. These new materials derive their properties not from the atomic and molecular constituents of the solid, but from microstructure which can be designed to give a wide range of novel electromagnetic properties. The lecture will describe the new materials and the principles behind them and show how they may be used to control and manipulate the near field. Finally a prescription will be given for a lens whose resolution is unlimited by wavelength provided that the ideal prescription for the constituent materials is met.

DI-02 **Superfocusing of terahertz waves** 박 규환(*고려대학교 물리학과*) 최근 금속 나노구조를 이용하여 빛을 집속하거나 제어하는 기술이 활발히 연구되고 있다. subwavelength scale의 구멍과 같은 구조가 공명을 일으키는 경우 임피던스 매칭을 통해 투과도를 크게 높일 수 있으며 optical antenna 역할을 하도록 제작하는 것이 가능하다. 본 발표에선 다양한 구조의 optical antenna에 대해 이론적 근거와 테라헤르쯔 영역에서의 최근 연구 결과 및 응용에 대해 소개한다.

■ SESSION: D [DG3]
4월 18일(금), 09:00 - 10:25
장 소: 101호

D-16 **Magnetic properties of Cu doped ZnO: X-ray magnetic circular dichroism and magneto-optical kerr effect** HONG jisang(*Pukyong National University.*) Using the full potential linearized augmented plane wave (FLAPW)method, the magnetic properties of Cu doped ZnO have been exploredwith 8.3% Cu concentration varying the relative position betweentwo Cu atoms. We have found that the Cu atom has a magnetic momentof 0.6 mu_B and the Cu doped ZnO displays half metallic feature.and the small spin polarized state in oxygen atoms is observed. Ithas been realized that the most stable state is achieved when the Cudopants are placed mostly closely, not in the uniformly distributerdstructure. Through the X-ray magnetic circular dichroism study, wehave found that the spin polarized Cu atom has well separated Ledges with single peak feature. Moreover, the magneto-optical kerreffect (MOKE) has been explored. The calculate MOKE signal isdependent on the Cu dopant position and the magnitude of kerr angleis about 0.4 degree

D-17 **Correlation between Magnetic Property and Structural Change in 3*d* Transition Metal Alloy Films on W(110)** LEE Hangil, VESCOVO Elio[1](*포항가속기연구소, 빔라인부.* [1]*NSLS.*) The correlation between magnetic properties and structural change for Fe based alloys ($Fe_{1-x}Ni_x$, $Fe_{1-x}Co_x$, $Fe_{1-x}V_x$,and $Co_{1-x}V_x$) films grown on W(110) substrate has been investigated using magnetic linear dichroism (MLD). Through the spectral analysis for W_{MLD} and A_{MLD}, we found that local magnetic moment is indispensable to the structural transition andsurface magnetic moment depends on crystallographic anisotropy.

D-18 **Annealing effects on the multiferroic property in a hexaferrite $Ba_{0.5}Sr_{1.5}Zn_2Fe_{12}O_{22}$ single crystal** CHAI Yisheng, CHUN Sae Hwan, OH Yoon Seok, KIM Ingyu, KIM Kee Hoon(*Department of Physics and Astronomy, Seoul National University.*) Recently, hexaferrite $Ba_{0.5}Sr_{1.5}Zn_2Fe_{12}O_{22}$ is reported to have a magnetic –field (*H*)-induced ferroelectric order stabilized in a concurrent helical spin ordered phase (intermediate-III) [1]. Such a phase persists to above room temperature so that this compound possesses a good potential to be utilized in magnetoelectric devices near 300 K. However, the low resistivity above 130 K and the required $H \sim 1$ T hinders its application at room temperature and lower field regions. To improve this limitation, we have carefully investigated the annealing effects on the resistivity values and the temperature vs field phase diagram of an as-grown $Ba_{0.5}Sr_{1.5}Zn_2Fe_{12}O_{22}$ single crystal. We find that by rapidly quenching the sample from 900°C after 8 days annealing in an O_2 gas flow, the resistivity at room temperature increases by an order of magnitude and the band gap value extracted from its temperature dependence increases by about 80%. More surprisingly, the ferroelectric phase boundaries in the quenched sample expand to both low- and high- H regions. Both observations appear to be closely related to recent theoretical studies by K. Knížek *et al.* [2,3]; tuning the fraction γ of Zn in the tetrahedral site of the spinel sublattice can make the system from metallic to insulating as well as to ferroelectric. Therefore, our findings imply that the annealing process has significantly modified the γ value to improve the insulating properties as well as the ferroelectric phase space. The method presented here, through further optimization, may constitute one practical way to achieve the room temperature multiferroic devices based on the hexaferrite system.

[1] T. Kimura *et al.*, Phys. Rev. Lett. 94, 137201 (2005).[2] P. Novák *et al*. Phys. Rev. B, 76, 024432 (2007).[3] K. Knížek *et al*. Phys. Rev. B, 73, 153103 (2006)

D-19 **Broad Raman Scattering Spectrum Due to Magnetic Ordering in Hexagonal $HoMnO_3$ Films** NGUYEN Thi Minh Hien, CHEN Xiang-bai, LUC Huy Hoang[1], LEE D.[2], JANG S. Y.[2], NOH T. W.[2], YANG In Sang[3](*Department of Physics, Ewha Womans Univ.. [1]Faculty of Physics, Hanoi National uni. of Education.. [2]Department of Physics and Astronomy, Seoul National Univ.. [3]Department of Physics, EWha Womans Univ.*) We present studies concerning temperature dependent (15-300K) Raman scattering in hexagonal $HoMnO_3$ films, which were growth on Pt(111)//Al_2O_3 (0001) substrate by laser ablating deposition method. We found, in addition to the usually reported phonon vibrations in the frequency range below 700 cm^{-1}, there exist several broad peaks above 700 cm^{-1}, which located at ~ 761, ~ 934, ~ 1120 and 1405 cm^{-1}. We investigated the dynamics of these broad peaks in different thickness $HoMnO_3$ films. The peak frequencies, full-width-at-the-half-maximum (FWHM), and the normalized intensities of these peaks show anomalous behavior at the magnetic ordering temperature T_N (~75 K). Our Raman results indicate that these broad peaks have origin of magnetic ordering.

D-20 **Raman spectra of the layered squaric acid ($H_2C_4O_4$) below and above the antiferroelectric phase transition and phase diagram** LEE Kwang-Sei, SEO Jeong-Ah[1], HWANG Yoon-Hwae[1], KIM Hyung Kook[1], LEE Cheol Eui[2](*Inje University, Department of Nano Systems Engineering. [1]Pusan National University, Department of Nano Materials. [2]Korea University, Department of Physics.*) Raman spectra of polycrystalline squaric acid ($H_2C_4O_4$) were measured in the frequency shift region of 150 - 4000 cm^{-1} below and above the antiferroelectric phase transition (T_c = 373 K). No marked changes of internal vibrations of the $H_2C_4O_4$ molecule in crystal were observed up to 473 K, indicating that the symmetry of the $H_2C_4O_4$ in the antiferroelectric phase persisted to the paraelectric phase.

D-21 **Extraction of the self-energy and pairing function from ARPES experiments for high T_c superconductors.** YUN Jae Hyun, CHOI Han-Yong, KONDO Takesi[1], KAMINSKI Adam[1], VARMA C. M.[2](*Department of Physics and Institute for Basic Sciende Research, SungKyunKwan University, Suwon 440-746, Korea. [1]Ames Laboratory and Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA. [2]Physics Department, University of California, Riverside, California 92507, USA.*) We report the self-energy and pairing function extracted from the angle resolved photo-emission spectroscopy (ARPES) experiments for the optimally doped Bi2Sr2CaCu2O8+δ (Bi2212) high T_c superconductors. In this analysis, we assume that the self-energy has no momentum dependence and pairing function has the d-wave form. Then, the self-energy at a chosen energy may be obtained by fitting the momentum distribution curve of the ARPES intensities to the Lorentzian form along the nodal cut where the pairing function vanishes. For the pairing function, we will use the relation that the normalized momentum integrated intensity is equal to the superconducting density of states. We will show how the self-energy and pairing function evolve as the temperature is lowered below T_c.

D-22 **Broadband Electron Spin Resonance at Low frequency Without Resonant Cavity** 장 지훈, 서 병진[1], BORSA Ferdinando[2](*국민대학교, 물리학과. [1]카톨릭대학교, 물리학과. [2]University of Pavia, Department of Physics.*) We have developed a non-conventional broadband ESR spectrometer operating continuously in the frequency range from 0.5 GHz to 9GHz. Dual antenna structure and the reflection-less microwave environment differentiate the setup from the conventional one and enable broadband operation with any combination of frequency or magnetic field modulation, frequency or magnetic field sweeping. Its operation has been tested by performing measurements on a DPPH (1,1-diphenyl-2-picrylhydrazyl) sample and by measuring the wide line of the single molecular magnet, V6, in solid state at low temperature.

■ SESSION: D [DG4]
4월 18일(금), 09:00 - 10:40
장 소: 102호

D-23 **Theoretical Investigations on the Photocatalytic Activity of TiO_2 Surfaces** 공 기정, 박 찬현, 장 현주, 백 진욱, 문 상진(*한국화학연구원*) Materials have been currently sought for use in the photo-induced decomposition of water on crystalline electrodes. In particular, since about 1971, when Fujishima and Honda reported their work on a photoelectrochemical cell possessing an anode of TiO_2, [1] TiO_2 has continuously used to hold a dominant position in photocatalysis. By performing the first-principles electronic structure calculations, we have investigated the materials properties of the most abundant forms of TiO_2, i.e., Rutile and Anatase phases. The experimentally determined band gaps are 3.0 and 3.2 eV for Rutile and Anatase phases, respectively. In spite of higher band gap, only the Anatase phase shows photocatalytic decomposition of water. Comparing the electronic structure stable surfaces of each phase, [2] we have successfully explained the differences in photocatalytic activities. [1] A. Fujishima and K. Honda, Nature 238, 37 (1972) [2] U. Diebold, Surf. Sci. Rep. 48, 53 (2003)

D-24 **First-principles study of oxygen vacancy segregations at metal-HfO_2 interfaces.** CHO Eunae, LEE Choong-Ki[1], KIM Yong-Sung[2], HAN Seungwu(*Department of Physics, Ewha Womans University, Seoul 120-750, Korea. [1]Department of physics, Ewha womasn university, Seoul 120-750, Korea. [2]Korea Research Institute of Standards and Science, Daejeon 305-340, Korea.*) The introduction of high-*k* dielectrics in combination with metal gates is essential for continued scaling of field effect transistors (FETs). However, there

exist several technical issues that should be addressed to further improve the reliability of devices employing high-*k* dielectrics. For instance, it has been reported that the flat-band voltage shifts sizably after post-deposition annealing. This instability is more pronounced for metal gates with large work functions used in *p*-type FET. So far, various origins of the shifts in flat-band voltage have been speculated and the mechanisms based on electrically active oxygen vacancies provide most consistent explanations. In this presentation, motivated by mounting evidence of a critical role by oxygen vacancies, we carry out first-principles calculations on oxygen vacancies close to the metal-oxide interface. As a model system to carry out calculations, we use monoclinic-HfO_2 (001) surface interfaced with various metals such as Pt, Mg, Al, Ti, and Ag, representing a wide range of work functions. Our results indicate that the oxygen vacancy has a strong tendency to segregate to the interface. The amount of energy lowered by the segregation is broadly proportional to the work function of electrodes, which is explained by the orbital energies of defect states around the vacancy site. The computed valence-band offsets are found to increase as the oxygen vacancies accumulate at the HfO_2-metal interface. Based on the computational results, we explain the thermal instability of effective work functions in p-type FET.

D-25 **First-principles Calculation of Capacitance Including Interfacial Effects** HAN Seungwu, LEE Bora(*Department of physics, Ewha Womans University.*) Recent experiments indicate that the dielectric constants of thin film oxides are strongly affected by interfaces between metals and oxides. In particular interface effects can dominate the performance of electronic devices employing oxide materials with a nanometer thickness. Therefore, systematic studies on interface effects are very important for materials selection and process design of advanced electronic devices. In this presentation, we study on local dielectric constants in metal-oxide interfaces within the first-principles framework. Firstly, we introduce an efficient method to calculate local dielectric constants by employing slab models exposed to the vacuum.[1] The static as well as optical dielectric constants are obtained from the change in electrostatic potentials upon the application of external electric fields. Our method can be easily adopted using conventional codes such as VASP or Quantum-ESPRESSO without any modification of the codes. We apply this method to investigate interfacial dielectric constants in (Pt, Ni, Al)/HfO_2(100) interfaces. We consider both oxygen-rich and Hf-rich interfaces. It is found that the dielectric properties are significantly affected by metallization of interfacial layers.[1] B. Lee, C. -K. Lee, J. Lee, C. S. Hwang, and S. Han, Journal of Applied Physics 103, 024106 (2008). *Corresponding author: hansw@ewha.ac.kr

D-26 **Effect of Quantum Well States on the Formation of MnCu c(2x2) Surface Alloy** 김 원동, 김 일유[1], 민 철희[2], 김 형도[3], 황 찬용[3], 조 은진[1], 황 찬용(*한국표준과학연구원 [1]전남대학교 물리학과. [2]서울대학교 물리학과. [3]포항가속기연구소*) The formation of quantum well states in metallic thin films under a certain boundary condition cause the sharp change in the intensity of electron density of states(DOS) at Fermi level of the thin films as the film thickness varies. This thickness dependence of DOS at Fermi level is the origin of quantum sized effects found in many physical properties of the metallic thin films. In this study, we investigate the effect of the quantum well states in the Cu/fcc Co(001) system on the formation of a surface alloy. It is well known that deposition of a half monolayer Mn on theCu(001) leads to the formation of a very stable single layer MnCu c(2x2) surface alloy, and the origin of this process has been attributed to the magnetic energy of enhanced surface mangetic moment of Mn atoms. In this experiment we first deposited 8 ML Co atoms on the Cu(001) surface to construct the fcc Co(001) and then deposited the Cu atoms with various thicknesses to form quantum well states. Then, we measured the Low Energy Electron Diffraction(LEED) pattern after depositing a half monolayer Mn atoms on the Cu/fcc Co(001) system. The detailed structures of Mn deposited Cu/fcc Co(001) sytem were analyzed by dynamic LEED method. In addition we also performed the photoemission spectroscopy experiment on the Mn-deposited Cu/fcc Co(001) system to reveal the change in the electronic structure caused by the formation of surface alloy

D-27 **STM investigation of Sn/Ge(111)-3x3 at low temperature** MORIKAWA Harumo, 박 홍선, 오 덕만, 염 한웅(*연세대학교 물리 및 응용물리학과, 원자선 원자막 연구단*) One of the most controversial issues on surface science is the nature of the Pb and Sn induced 1/3 monolayer phases on Ge(111) and Si(111) at low temperature(LT). These surfaces have √3x√3 reconstructions at room temperature (RT), and transit into 3x3 phases by cooling, except Sn/Si(111). The origin of the transition has been debated widely, and it is now believed as an order-disorder type where the adsorbates fluctuate at RT between the two positions which are shifted to the surface normal direction but freeze to form the 3x3 structures at LT.[1] Recent debates on the 3x3 phases are moving to the atomic structure. One 3x3 unit contains three adsorbates, one of which appears to be bright (high) and the other two, dark (low) in the filed state scanning tunneling microscope (STM) images. This contrast is inverted in the empty state, which has made it difficult to determine by STM the ratio of the up and down atoms, namely, 1-up 2-down (1U2D) or 2-up 1-down (2U1D). Although x-ray diffraction studies gave a 1U2D model, core-level photoemission studies supported the other one.[2-5] The 3x3 surfaces also have attracted interest because of the phase transition into another √3x√3 phase which was recently found on Sn/Ge(111) by STM and electron diffraction at below 25 K.[6] The transition was decided as a metal-insulator type by photoemission, and thus predicted as a Mott transition. The Mott ground state was also predicted on Sn/Si(111).[7]In order to settle the above mentioned structural issue of the 3x3 phase and to reveal the detailed nature of the new √3x√3 phase, we have performed a detailed STM/S investigation of the Sn/Ge(111) surface between 77K and 4K. First, we have found that the 3x3 surface appears as a 2U1D pattern even in the filled state at a low sample bias (Vs) region of Vs>-0.1V, as opposed to the previous knowledge of the fil-

led state images in the 1U2D pattern. The empty state images always showed the 2U1D pattern up to Vs=2.5V. The appearance of the 2U1D pattern in both filled and empty states cannot be generated by the 1U2D model and deny the possible electronic origin for the appearance of the 2U1D in the empty state. We have found through a detailed STS study that the 1U2D pattern has a purely electronic origin due to the Sn dangling bond state.At 4K, the √3x√3-like STM images were obtained in the filled state, in accord with the previous report. However, the empty state kept the 2U1D 3x3 pattern even at this temperature and a clear metallic nature of the surface was found in the STS I-V curves, contrary to the Mott transition predicted before. We have found that the √3x√3-like appeared in the filled state because of the reduction of the density of state in the dangling bond state. The transition at a very low temperature is a 3x3-to-3x3 transition, for which the Sn dangling bonds are responsible, and is not a Mott transition. A theoretical study is highly required for the transition. [1] F. Ronci et a., PRL 95, 156101 (2005) and references therein [2] J. Zhang et al., PRB 60, 2860 (1999). [3] O. Bunk et al., PRL 83, 2226 (1999). [4] M. E. Davila et al., PRB 70, 241308(R) (2004). [5] T-L. Lee et al. PRL 96, 146103(2006). [6] R. Cortes et al., PRL96,126103(2006) [7] S. Modesti et al., PRL 98, 126401 (2007).

D-28 **Investigation Study of Solitons on Si(100) using Fast Pulse and Pattern Search Algorithm** JUNG woo-jin(*Department of Physics and IPAP, Yonsei University..*) We used scanning tunneling microscopy to study solitons made up of phase kinks that result in inducing local Si(100)-p(2×2) structure in the ground state of Si(100)-c(4×2). Solitons were very stable at T ~ 4.6 K under low bias scanning condition. We were able to create and erase a single bi-soliton, bound state of a soliton and an anti-soliton, reversiblely by applying voltage pulse. In order to investigate the bi-soliton production mechanism, we developed a fast pulse and detection algorithm. Our algorithm is capable of detecting not only a single bi-soliton, but also multiple solitons produced as a function of a voltage pulse with user-controlled bias, width and shape at high speed, thus enabling the collection of statistics within a resonable time frame. The statistical production rate showed that the bi-soliton production is not induced by tunneling electrons.

D-29 **Water adsorbates terminating atomic wire on the vicinal Si surfaces; Si(557)-Au and Si(553)-Au** 강 필규, 양 경득, 신 진성, 염 한웅(*연세대학교 물리 및 응용물리학과 원자선 원자막 연구단*) Low dimensional structures generated by metal adsorption on semiconductor surfaces exhibit a variety of exotic physical phenomena and have the potential application in nano and molecular devices. Especially, Au on vicinal Si(111) is fascinating due to one dimensional (1D) structures with tailored electronic band structures. Among the atomic chain structures on the vicinal Si surfaces, Si(557)-Au and Si(553)-Au may be the prototypical systems with characteristically different step and band structures [1,2]. In common, however, the Si(557)-Au and Si(553)-Au surfaces have a lot defects, which can influence the local structures [3, 4]. In Si(557)-Au, actually, some vacancy defect on the step-edge induces a local x2 lattice distortion in the neighboring sites. In Si(553)-Au, it was reported that there is a defect mediated CDW condensation, which is similar to the case of Sn/Ge(111)-r3x r3 [5]. Despite the critical effects of defects, however, the origins and structures of various defects were not clear. In this work, we investigate various defects on Si(557)-Au and Si(553)-Au using scanning tunneling microscopy (STM). Based on the apparent shape of STM images, we classified the type of defects on the Si(557)-Au. Additional dose of water molecules on Si(557)-Au and Si(553)-Au clearly shows gradual increase of the density of specific defects, termed W (water-induced), which can be assigned as the adsorption of water molecules. Comparing with the previous structure model, we suggest the configuration of the adsorbed water molecules. The result shows that the defect-generation reaction involves one H_2O molecule that dissociatively adsorbs on the dangling bonds of the step-edge Si chain. [1] J. R. Ahn *et al.,* Phys. Rev. Lett. 91, 196403 (2003).[2] J. R. Ahn *et al.,* Phys. Rev. Lett. 95, 196402 (2005). [3] H. W. Yeom *et al.,* Phys. Rev. B 72, 035323 (2005). [4] K. D. Ryang *et al.,* Phys. Rev. B 76, 205325 (2007). [5] H. H. Weitering *et al.,* Science 285, 2107 (1999).

D-30 **Dielectric function of Al_2O_3/SiO_2 thin films on Si determined by analyzing of reflection electron energy loss spectra** TAHIR D, LEE E.K, PARK K.H, KANG H.J(*충북대학교*) The dielectric function for Al_2O_3/SiO_2 thin films on Si were carried out by using of reflection electron energy loss spectra. Experimental cross section obtained from reflection electron energy loss spectroscopy were compare with theoretical inelastic scattering cross section deduced from the simulated energy loss function (ELF) by using QUEELS-ε(k)-REELS software. We compare ELF of Al_2O_3/SiO_2 thin films before and after annealing at temperature 1200℃ for 30 sec. The bandgap and plasmon peak position change to higher energy loss position. Good agreement between the experimental and fitting results gives confidence in the accuracy of the determined inelastic mean free path and dielectric function. The QUEELS-ε(k)-REELS software providing the real and the imaginary part of the dielectric functions in term of set of Drude-Lindhard oscillators.

■ SESSION: D [DG5]
4월 18일(금), 09:00 - 10:30
장 소: 105호

D-31(초) **Study of supercooled and supercompressed liquids using electrostatic levitation and dynamic diamond anvil cell.** 이 근우, 이 병찬[1], KELTON K. F.[2], YOO Choong-Shik[3](*한국표준과학연구원. [1]경희대학교. [2]Washington University. [3]Washington state University.*) Relationship between local order of liquids and nucleation barrier has been important topic to understand supercooling or supercompressing phenomenon of liquids, and related subjects (e.g.,

(nano)crystallization, glass transition, material synthesis and so on.). The difficulty of studying this topic is how to supercool or supercompress liquids, since such metastable liquids easily crystallize due to heterogeneous nucleation site from impurities (e.g., container wall) when temperature of the liquids decreases below their equilibrium melting temperature. The problem has been resolved by the aid of electrostatic levitation (ESL) and dynamic diamond anvil cell (dDAC) techniques for supercooling and supercompressing, respectively. ESL provides containerless environment making supercooling, and dDAC does fast compressing achieving supercompressing. Using these techniques, the relation of the local order of those liquids and nucleation barrier was studied. In this talk, it will be shown that metallic liquids dominantly possess icosahedral order which gives high nucleation barrier for simple crystal phase, but lower barrier for icosahedral quasicrystals phase, supported by thermodynamic (i.e., nucleation) and synchrotron x-ray diffraction studies. On the other hand, supercompressed liquid water with fast compression transforms metastable ice VII phase in stable ice VI phase observed by time-resolved Raman scattering and optical image, which shows the effect of compression rate on phase transformation. Additionally, it will be demonstrated that fast compression rate can affect crystal morphology during crystal growth, and molecular dynamics.

D-32 **Stable Freestanding Thin Films of Pure Water** WEON Byung Mook, JE Jung Ho, HWU Yeukuang[1], MARGARITONDO Giorgio[2](*POSTECH.* [1]*Academia Sinica.* [2]*EPFL.*) Obtaining water microstructures, of great interest for science and technology, is very difficult because of low viscosity and high surface tension. We report the first examples of stable freestanding thin films of pure water by X-ray bombardment of small liquid volumes in capillary tubes. A detailed characterization with phase-contrast radiology demonstrates a lifetime beyond 1 hour with no chemical stabilizer for micron-thickness films with half-millimeter-level diameter. This can be attributed to the interplay of two X-ray effects: water evaporation and surface charging. This work suggests a novel use of X-ray-induced stabilization which enables to form very stable, freestanding, pure water films without any stabilizer.

D-34 **NbC와 NbN 화합물의 전자 구조와 탄성 계수에 대한 제일원리 계산 연구** 장 윤희, 김 한철[1](*한국표준과학연구원.* [1]*숙명여자대학교*) 전이금속 탄화물(carbide)과 질소화물(nitride)은 철강 산업에서 유용한 물질로 관심을 끌고 있다. 특히, NbC와 NbN와 같은 나이오븀 화합물들은 철강 내에서 극도로 낮은 용해도를 가지며 grain boundary에 위치하기 때문에, 과도한 grain growth를 막아주는 역할을 한다. 이런 특성을 이용하면, 매우 미세한 grain 크기를 가지는 균일한 합성 철강을 만들 수 있고, 또한 강도를 향상시킬 수 있는 장점이 있어서 최근 다양한 연구가 진행 중에 있다. 기존의 NbC와 NbN에 대한 이론 물성 연구는 주로 full-potential linearized augmented plane wave (FLAPW) 방법을 이용하여 진행되었기 때문에 [1], 결정 결함과 같은 큰 규모의 계산을 필요로 하는 연구는 희박한 실정이다. 이 발표에서는 철강 화합물에 대한 대규모 물성 모사를 하기 위한 초기 단계로서, NbC와 NbN의 전자구조와 탄성계수에 대한 제일 원리 슈도포텐셜 계산 결과에 대해 논의할 것이다. [1] T. Amriou, B. Bouhafs, H. Aourag, B. Khelifa, S. Bresson, and C. Mathieu, Physica B, 325, 46 (2003). *이 연구는 POSCO 기술연구소 전산모사연구회의 지원을 받아 이루어졌다.

D-35 **Kinetic roughening in vapor deposition polymerization** INJAE Lee, MIRA Yun, SANG-MIN Lee, JA-YEON Kim(*Chonbuk National Univeristy, Department of Physics.*) The surface morphologies of poly(chloro-p-xylylene) films withthicknesses ranging from the sub-nanometers to a few micrometers weremeasured using atomic force microscopy and analyzed within the framework of the dynamic scaling theory. The thickness dependence of theinterface width showed three characteristic regimes during filmgrowth: the rapid growth in the early stage, followed by a valleyfilling regime resulting in actual reduction of the roughness, andfinally a crossover to a local diffusion-driven steady growthregime. We attribute this rich growth behavior to the strong-polymer-polymer interactions and the characteristics of the vapor-deposition polymerization process which involves initiation andpropagation reactions on a clean substrate.

D-36 **Let DNA (Deoxyribonucleic Acid) magnetize.** LEE Chang Hoon, KWON Young-Wan[1], CHOI Dong-Hoon[1], JIN Jung-Il[1](*Chosun University, Dept. of Polymer Science &Engineering.* [1]*Korea University, Dept. of Chemistry.*) In this study, we paid our attention to magnetize the natural DNAs. To accomplish this task, diverse attempts were used.

■ SESSION: D [DG6]
4월 18일(금), 09:00 - 10:25
장 소: 301호

D-37 **First principles study of hydrogen storage in non-transition metal decorated graphitic materials** 김 규봉, 지 승훈, 박 노정[1](*포항공과대학교 물리학과.* [1]*단국대학교 응용물리학과.*) Hydrogen has been considered an ideal material that can replace fossil-based fuels as its byproduct is simply water without emitting green house gases. Recently, transition metal (TM)-dispersed porous materials have been suggested as plausible candidates for hydrogen storages that possess optimal hydrogen binding characteristics. A serious problem in this approach is that TM atoms tend to aggregate instead of being atomistically dispersed, which results in the deterioration of hydrogen uptake. Here we study the hydrogen adsorption on non-transition metal (NTM) atoms dispersed on graphene using ab initio methods. We observe that the clustering energy of NTM atoms is much smaller than that of TM atoms, which indicates that NTM can be almost free of clustering on graphene. We also study hydrogen adsorption on those NTM atoms to find comparable storage capacity to that in TM dispersed graphene.

D-38 **First-principles Study of Binding Geometries and Wetting Properties of Metal Nanoparticles on Carbon Nanotubes and Graphene** SUNG Dongchul, HONG Suklyun, LIM Seokho[1], PARK Noejung[1], MOON Seongho[2](*Department of Physics and Institute of Fundamental Physics, Sejong University, Seoul.* [1]*Department of Applied Physics, Dankook University, Yongin-si, Gyeonggi-do.* [2]*Samsung Electronics Co., Yongin-si, Gyeonggi-do.*) We have performed density functional theory calculations to investigate adsorption geometries and binding strengths of metal nanoparticles (Al, Au, Pd, Pt, Ti) on carbon nanotubes (CNTs) and graphene. Adsorption energetics depends not only on the type of element but also on the size of particles. We show that accumulated aluminum and gold nanoparticles are likely to form a (111)-like metal surface, where the metal-carbon bond becomes energetically unstable. Meanwhile, the palladium, platinum, and titanium particles strongly chemisorb on the nanotube surface inducing severe reconstructions. We discuss that the boron doping substantially increases the Al binding strength on the surface of CNT or graphene.

D-39 **Origin of Enhanced Field Emission Characteristics After Plasma Treatment of Multiwalled Carbon Nanotube Array** LEE Kyu, SEONG CHU Lim, CHOI Young Chul[1], LEE Young Hee(*Department of Physics, Center for Nanotubes and Nanostructured Composites, Sungkyunkwan Advanced Institute of Nanotechnology, Sungkyunkwan University, Suwon 440-746, Republic of Korea.* [1]*Display 3 Group, Corporate R &D Center, Samsung SDI, Yongin 446-577, Republic of Korea.*) Field emission properties of chemical vapor deposition-grown multiwalled carbon nanotubes (MWCNTs) with plasma treatment have been investigated. Origin of the enhanced field emission current was interpreted in terms of surface morphology of MWCNTs, work function, field enhancement factor, and emission area. Contrary to the general belief, the change in the work function was negligible independent of the plasma treatment time, whereas the field enhancement factor decreased with increasing plasma treatment times. We found that the number of emittable MWCNTs played a dominant role in the current enhancement.

D-40 **Coherent G-mode Oscillations in Single-walled Carbon Nanotubes via the Spectrum-resolved Detection** 김 지희, 김 창섭, 이 기주, 임 용식[1], J. Kono[2](*충남대학교.* [1]*건국대학교.* [2]*Rice University, USA.*) 단일벽 탄소나노튜브 물질에서 펨토초티타늄 사파이어 레이저를 이용하여 결맞는G-mode 신호의 진폭변화에 대해 분석해보았다 여기 펄스는 700-900 nm의 넓은 영역을 갖고 12 fs 의 극초단 펄스폭을 갖고 있으며, 탐침 펄스의 파장은 10 nm 간격의 BandPassFilter로 선택하는 다색 여기-탐침 방법을 사용하여 단일벽 탄소나노튜브의 여러가지 포논 모드 중 높은 주파수 영역에 해당하는G-mode를 측정할 수 있었다. G-mode 격자진동의 소멸시간은 약1.65 ps에 해당하며, G-mode 진폭은 중심파장인 800 nm를 기준으로 하여 긴 파장과 짧은 파장에서의 그 변화가 다른 것을 확인 할 수 있었는데 이러한G-mode의 포논 진동 진폭변화를 결맞는 반스톡스 라만 분광(Coherent anti-Stokes Raman scattering, CARS) 혹은 결맞는 스톡스 라만 분광(Cohterent Stokes Raman scattering, CSRS)을 이용하여 분석, 설명하고자 한다.

D-41 **Fabrication and characterization of Multi-Walled Carbon Nanotube/polycarbonate composite by a precipitation method** GENG Hong-Zhang, RA Eun Ju, SO Kang Pyo, BAE Jung Jun, AN Kay Hyeok, LEE Young Hee(*Center for Nanotubes and Nanostructured Composites, Sungkyunkwan Advanced Institute of Nanotechnology, Sungkyunkwan University, Suwon 440-746, Korea.*) Multi-walled carbon nanotubes (MWCNTs)/polycarbonate (PC) composites were fabricated by a precipitation method in order to form conducting pathways at low CNT loading in PC matrix. It was found that the addition of MWCNTs could lead to a drastic increase in PC conductivity. The effects of temperature on the dispersion of MWCNTs in PC matrix and electrical properties were investigated by changing the solution temperature while stirring process. The resistivity of MWCNT/PC composite decreased with increasing the dispersion temperature until about 120℃ and increased at high temperature. High temperature and long time of annealing MWCNTs led to increase the resistivity of MWCNT/PC composite. The obtained MWCNT/PC composites possessed good electrical properties and low percolation threshold around 0.5 wt.%. They have a large potential to be applied as electrostatic discharge, electromagnetic interference, electronic components, self-controlled heaters, over-current protectors and other various applications.

D-42 **Electronic properties of small bundles of carbon nanotubes: response to external electric fields** KIM Gunn, BUONGIORNO NARDELLI Marco[1], BERNHOLC Jerzy[1] (*Department of Physics, Sungkyunkwan University.* [1]*Department of Physics, North Carolina State University, USA.*) A bundle of carbon nanotubes can be metallic and/or semiconducting tubes.The intertube interaction between the carbon nanotubes (CNTs) may lead to electrical transport properties unexpected from individual nanotubes.Motivated by this question, we performed {\it ab initio} electronic structure calculations for bundles consisting of two- and three-CNT bundles.The density functional theory (DFT) within the local density approximation (LDA) is employed.Screening of electric fields by nanotubes breaks the tube symmetry and can enhances the intertube interaction,which makes electronic band structure be changed.We found that this change in the electronic structure is sensitive to the field direction.The small bundle of CNTs show interesting phenomena resulting from electrostatic screening, intertube interaction, and charge transfer between the tubes.

D-43 **Formation of Zr-Nanoclusters on a Substrate for Vortex Pinning in a Superconducting film** YOO Jaeun, LEE SangMoo, JUNG YeHyun, RHEE JunKyu, KWAK Kisung, YOUM Dojun, AHN ChiWon[1](*Korea Advanced Institute of Science and Technology (KAIST).* [1]*National NanoFab Center.*) Study on vortex pinning in superconducting materials is interesting and important especially for superconducting wire application. Our ultimate goal is to improve magnetic properties of critical current employing artificial pinning centers in superconducting films. As a first step, formation of Zr nanoclusters on Si or $LaAlO_3$ substrates using a nano-

cluster deposition system (Mantis Deposition Ltd. Nanosys 500) was studied. In the system, Zr atoms were generated by DC magnetron sputtering, and the Zr nanoclusters were formed through condensation of the sputtered Zr atoms in a cooling zone. The density and size of the Zr nanoclusters were controlled by varying sputtering power, Ar/He mixed gas flow, and the length of the cooling zone. About 10 nm diameters of Zr clusters were obtained when the pressure of Ar/He mixed gas for sputtering was 190 mTorr, sputtering power was about 30 W, and the length of the cooling zone was 48 mm. The density of the clusters on Si substrates under the same conditions was about $4.2\times10^{14}/m^2$ when thickness monitor indicated 1 Å, which was located in the vicinity of the aperture for the cluster injection, and 5 cm apart from the substrate. This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD) (KRF-2007-313-C00201)

■ SESSION: D [DG7]
4월 18일(금), 11:00 - 12:20
장 소: 102호

D-44(초) **High Pressure research program at Pohang Accelerator Laboratory: structural evolution of ZnO nanorods at high pressure condition upto ~20GPa** LEE Dong Ryeol, LEE Hyun Hwi, CHOI Jae-Young(*Pohang Accelerator Laboratory.*) Structural evolution and phase transition of ZnO nano-powder and nano-rods are investigated under high pressure condition upto ~20GPa using diamond-anvil cells (DAC) at new wiggler beamline-5A (HFXS: High Flux X-ray Scattering) at Pohang Accelerator Laboratory (PAL). The wiggler has 28 multi-poles and provides both ~30 times higher flux of x-rays and monochromatic beam of high energy upto 22keV that cannot be achieved using bending magnet beamlines. These probing x-rays are focused using vertical focusing mirror and sagittal crystal of Si-monochromator, and finally collimated to 150(horizontal) x 100(vertical) um^2 in size. This high quality x-ray beam satisfies DAC researches and high pressure research program is successfully running at beamline-5A. DAC is mounted on the motorized sample stage of kappa-type diffractometer. For diffraction experiments systems, both an online 2D-image plate detector (Mar 345) and scintillation counter are available. In a remote lab affiliated to the beamline, a pressure calibration system using laser ruby- fluorescence measurement has been installed and and EDM machine for micro-drilling on a metal gasket is also equipped for diamond anvil cell works. Recent results on high-pressure of nanostructures will be also briefly introduced.

D-45 **Fabrication of Large-area Mesoporous TiO2 Nanotube Arrays on Stainless Steel Mesh** QIU (추) Jijun(지준), HE Weizhen[1], 박 세정[1], 김 형국[2], 황 윤희[2](*부산대학교, 유전체물성연구소(나노과학기술대학 소속). [1]부산대학교 나노과학기술대학 나노융합기술학과. [2]부산대학교 나노과학기술대학 나노정보소재학과.*) We present herein a simple method named the double-template-assisted sol-gel method for fabricating mesoporous TiO2 nanotube arrays. Poly(ethylene glycol) dissolved in TiO2 sol was used as a soft template to form mesopores on the walls of TiO2 nanotube arrays, which were obtained from ZnO nanorod-hard templates by dip-coating approach. The microstructure of mesoporous TiO2 nanotube arrays can change from end-opened to end-closed by adjusting the dip-coating cycle number. This paper gives a simple and universal way to produce mesoporous TiO2 nanotube electrodes with high specific surface area for dye-sensitized solar cells.

D-46 **Effect Of Atomic Hydrogen Treatment On Capacitance-Voltage Characteristics Of Metal-Oxide-Semiconductor Containing Si Nanocrystals** LEE Tae-Ha, YOON Jong-Hwan(*강원대학교, 물리학과.*) It is well known that defects at the Si/SiO_2 interface have deleterious effects on the electrical and optical properties of Si nanocrystals embedded in an SiO_2 matrix. These interfacial defects are believed to quench visible luminescence by acting as nonradiative recombination centers. It is well known that photoluminescence- quenching defects are effectively passivated by thermal annealing in atomic hydrogen. In addition, charge trapped at defects in the vicinity of planar Si/SiO_2 interfaces results in a shift in the threshold voltage in metal-oxide-semiconductor (MOS) transistors. In this work we have investigated the effect of atomic hydrogen exposure on the capacitance-voltage characteristics of MOS containing Si nanocrystals in oxide layer. Hydrogen treatment is shown to significantly result in a shift in the flatband voltage toward positive direction. This is likely to be due to a reduction of defect density by hydrogen passivation.

D-47 **Structural and Magnetic Properties of Small Gd and Fe Clusters** KIM Gunn, PARK Yongjin, HAN Myung Joon[1], YU Jaejun[1], LEE Young Hee(*Department of Physics, Sungkyunkwan Unversity. [1]Department of Physics and Astronomy, Seoul Natioanl University.*) To examine the geometric structure and magnetic characteristics of small metal clusters consisting of Gd and/or Fe, we performed first-principles pseudopotential calculations based on the LDA+*U* method. The total energy results reveal that for Gd_2, the bond length is 2.9 Å and the magnetic moment is 9.00 μ_B/atom, which means that the ferromagnetic (FM) configuration is the ground state. According to our analysis of the orbital-decomposed moment, the large magnetic moment of 9.00 μ_B/atom is attributed to the increase of the contribution of electrons in 5d orbitals. On the other hand, the bond lengths of Gd_3 and Gd_4 are all about 3.3 Å and their total magnetic moments are 18.0 and 32.0 μ_B, respectively, corresponding to 8.0 μ_B/atom. Gd_4 prefers to form a tetrahedral structure rather than to form a planar structure. We have also investigated small Gd-Fe clusters such as GdFe, Gd_2Fe, $GdFe_2$, Gd_3Fe, Gd_2Fe_2 and $GdFe_3$. The geometric structure and magnetic properties of these clusters will be discussed in the presentation.

D-48 **Time-Resolved Spectroscopy of CdSe QDs by Surface Conditions** 양 호순, 김 상민, 홍 경수[1](*물리학과. [1]한국기*

초과학지원연구원 부산센터) 반도체 양자점은 size-confinement 효과로 입자의 크기를 변화를 통하여 발광의 파장을 변화시킬 수 있다. 특히 CdSe 양자점은 가시광선 영역내의 모든 발광을 얻을 수 있는 장점으로 많은 연구가 이루어지고 있다. 화학적 콜로이드 방법으로 제작된 반도체 양자점의 경우 균일한 크기를 가지는 장점이 있지만 합성 과정에서 사용되는 유기물등이 양자점의 표면에 붙어 deep-trap-levels을 생성하여 양자점의 표면 상태가 복잡하게 된다. 양자점의 표면 상태는 양자점 발광의 세기와 광학적 양자효율(Quantum Yield)와 직접적으로 관계가 되므로 본 연구에서는 다양한 표면 상태를 가진CdSe 양자점을 화학적 콜로이드방법으로 제작하여 양자 효율의 변화를 측정하였다 또한 time-resolved spectroscopy 측정을 통하여 표면 상태가 발광에 미치는 영향을 연구하였다. 한편, CdSe보다 에너지 밴드갭이 더 큰 ZnS를 이용하여 CdSe양자점의 표면 주위를 capping한 core/shell 형태의 CdSe/ZnS양자점을 합성하여 위와 같은 실험을 통하여 비교 분석하였다.

■ SESSION: D [DI2]
4월 18일(금), 11:00 - 12:50
장 소: 101호

DI-03 **Superconducting transition-edge sensors** IRWIN Kent(*NIST.*) Superconducting films biased in the narrow transition region between the normaland superconducting state are extremely sensitive detectors of particles andelectromagnetic radiation. They can be lithographically fabricated and read outwith superconducting integrated circuit multiplexers, making it possible toimplement large-format imaging arrays. Superconducting bolometer transition-edgesensor arrays have been demonstrated to be a powerful technology for thedetection of photons from millimeter waves through to gamma rays and forparticles such as dark matter and alpha particles. I will discuss the developingof superconducting transition-edge sensors, highlighting applications inastronomy and nuclear non-proliferation. I will also discuss the multiplexedSQUID circuits used to read out large-format arrays, including low-frequency dcSQUID multiplexers and the recent development of non-dissipative rf SQUID multiplexers operated at microwave frequencies.

DI-04 **Magnetic calorimeters for particle detection** KIM Yong-Hamb(*한국표준과학연구원*) Metallic magnetic calorimeters (MMCs) are one of the cryogenic particle detectors which have demonstrated their extreme energy resolution and various applications in many research fields. MMCs utilize a dilute concentration of magnetic ions in a metallic host as a micro structured temperature sensor. The temperature change originated from particle absorption results in the change of magnetization which is directly measured by a SQUID susceptometer. Because of their wide operating temperatures and many tuning parameters MMCs are useful in the detection which requires absorbers with large heat capacity. I will talk about the recent progress in MMC development together with the energy resolution and the inherent noise. I will also discuss a possible use of this technique to identify and measure alpha emitting radionuclides.

DI-05 **Development of the Si-N membrane microcalorimeter for small heat capacity measurements of solids with enhanced accuracy at 20-700 K** KIM Kee Hoon(*Department of Physics and Astronomy, Seoul National University.*) The Si:N membrane calorimeter fabricated by the MEMS/NEMS technique is becoming an indispensable asset for investigating small heat capacity of solids in a micro- and nano-meter length scale. On the other hand, the critical test for the accuracy in the measured small heat capacity by use of various types of the micro- and nano-calorimeter appears to be still lacking. In this presentation, we summarize our efforts to test critically the accuracy of several microcalorimeter designs by use of a clever measurement scheme, so-called the-curve-fitting-method, and to provide general design considerations to achieve the accuracy in the measurement of the heat capacity via the microcalorimeter. The new type of the microcalorimeter with enhanced accuracy thus achieved is installed to a commercial cryostat (PPMS, Quantum Design) for automatic measurements of heat capacity between 20 and 350 K, and, to a home-made tube furnace calorimeter for those between 300 and 700 K. In the both low and high temperature regions, we use the curve-fitting-method by considering double relaxation times. We further explain how the CFM can be used to accurately measure heat capacity in a constant temperature mode below 350 K, and introduce a new method of slow temperature-ramping-mode above 300 K. The measurement accuracy is found to be ~10^{-6} J/K at temperatures 20-700 K. Based on those newly established schemes, we present our recent investigation results on the phase transition features observed in several specimens: the melting transition (at ~430 K) of a ~10 μg Indium piece, the amorphous-cubic transition (at ~413 K) of phase change memory films, and the magnetic transition (at ~50 K) of spin frustrated multiferroic crystals with a ~10 μg weight. Works done in close collaboration with Jae Wook Kim, Hyung Joon Kim, P. D. A. Mann, K. S. Suh, and Y. D. Park

DI-06 **Quantitative Temperature and Thermal Property Measurement Using Scanning Thermal Microscope** KWON Ohmyoung(*Department of Mechanical Engineering, Korea University, Seoul 136-701, Korea.*) Scanning Thermal Microscope (SThM) measures local temperature and thermophysical properties by bringing a sharp temperature sensing tip in close proximity to a sample surface. If it is used with the proper understating of the dominant physics involved in the measurement, SThM can be a quite effective tool in micro/nano-scale science and engineering, because of its excellent spatial resolution. In this talk, most recent issues in local temperature and thermal property measurement are discussed.First, the difficulties in the quantitative temperature measurement using SThM lie in the fact that heat is transferred not only through the tip-sample contact point but also through the air between the sample and the SThM probe. In order to get over these difficulties, we

suggest a double scan technique that can isolated the signal due to the heat transfer through the tip-sample contact by subtraction of air conduction signal obtained from 'lift mode' scan. Second, the 2w method, a newly developed AC mode local thermal property imaging technique with nanoscale spatial resolution, is presented. We experimentally demonstrate that the 2w method can map out the local thermal property of a sample by monitoring the amplitude of the 2w signal from the thermocouple junction of a probe heated by an AC current. By comparing with the thermal property images obtained by other methods, we show that the 2w method using the point-heating and point-sensing scheme is the most suitable for the nanoscale thermal property imaging.

■ SESSION: D [DF4]
4월 18일(금), 11:00 - 12:55
장 소: 301호

DF-08(초) **금속 및 금속실리콘 단결정 나노선의 합성, 특성분석 및 응용** 김 봉수(*KAIST 화학과*) FCC 구조를 가지고 있는 금속 나노선은 반도체 나노선과는 달리 마땅한 촉매가 없어서 합성하기 어렵다. 이들의 순수한 단결정 나노선을 합성하는 방법을 소개한다. 이들을 이용하면 플라즈모닉 소자 및well-defined SERS 센서를 제작할 수 있다. 금속실리콘 나노선은 흥미로운 자성특성을 가지고 있으며 이들을 이용하여 스핀트로닉 소자를 제작할 수 있다. 이러한 다양한 나노선의 합성 방법 및 새로운 응용 방향을 제시한다.

DF-09(초) **Transport through gate-all-around silicon nanowire field effect transistors fabricated by top-down CMOS processes** 황 성우(*고려대학교 전기전자전파공학부*) 본 논문에서는 재래식 CMOS공정으로 제작된 지름 수nm의 gate-all-around 실리콘 나노와이어FET의 여러가지 전자 수송 현상에 대하여 논의한다. 이 소자들은 저온에서 단전자 터널링 현상을 보여주고 있으며 이는 기존의 transconductance로부터 와이어의 게이트 커패시턴스를 추출하는 방법과는 별개의 게이트 커패시턴스 추출을 가능하게 해 준다. 또한 단전자 터널링의 주기 변화로부터 인공원자로서의shell filling상태를 파악할 수 있다. 이 소자들은 상온에서ballistic transport를 보여주고 있다. 상온 ballistic transport는 여태까지 CNT에서만 관찰되었고, 반도체 나노와이어에서는관찰된 예가 없다.

DF-10(초) **Si nanowires: synthesis, functionalization, and applications** 박 원일(*한양대학교 신소재공학부*) Silicon nanowires (SiNWs) have become the focus of intensive research as one of the most technologically important building blocks. In particular, millimeter-long SiNWs whose lengths extend over macroscopic length scales and reach the size of integrated systems, could be exploited as the basis for complex electronic circuits and functional nanosystems by the direct integration of a number of device elements into a single nanostructure. Here I will present the approach to synthesize the millimeter-long SiNWs, and to functionalize the NW surfaces for device applications. Quantitative analysis showed that NW growth can be continued at a high growth rate of ~31 μm/min without terminating VLS process for 1-hr, and the longest ones reached 3.5 mm and their aspect ratios extend up to ~100,000 while the diameters are uniform along the wires. In addition, electrical doping was introduced during the synthesis, and transport measurements of the wires demonstrated uniform field-effect transistor (FET) properties over the entire lengths of these nanowires. We converted the multiple FETs into biological sensor arrays by functionalizing SiNW surfaces with monoclonal antibodies (mAbs), and studied the multiplexed electrical detection of cancer markers. Finally, SiNWs were further coupled with functional oxides to demonstrate non-volatile memory devices.

DF-11(초) **Local luminescence studies of ZnO nanostructures and devices** 박 지용(*아주대학교 물리학과*) Cathodoluminescence (CL) characterization in a scanning electron microscope is a powerful tool for studies of the optical properties of nanostructures with its high spatial resolution. In this talk, CL studies of ZnO nanostructures with diameters of 30-100 nm will be discussed. CL emission images as well as spectrum from individual ZnO nanowires as small as 20nm of diameter can be obtained. Simultaneous CL and electrical transport characterizations enable us to correlate their optical and electrical properties. The results demonstrate that local luminescence characterizations can provide information about inhomogeneities in electrical and optical properties among ZnO nanostructures.

DF-12(초) **Low temperature fabrication of magnetic element-doped ZnO nanowires using Bi** 김 동언(*POSTECH 물리학과*) The nanostructure of zinc oxide has aroused great interest because of its intriguing optical functions based on its wide band-gap of 3.37 eV. A prominent feature of ZnO is its large excitonic binding energy _60 meV_ at room temperature, which leads to extreme stability of excitons,1 and enables devices to function at a low threshold voltage. To date, a variety of methods have been developed to synthesize ZnO nanostructures. Most of all, the ZnO nanostructures used in these applications have been fabricated at high temperatures. The growth temperatures were not less than 400 °C. Such a high temperature is disadvantageous, for example, in the fabrication of nanophotonic integrated circuits because thermal drift causes inconvenience for the manipulation of size and position of nanomaterials. A low-temperature process is therefore desirable for nanostructures. In this talk, we demonstrate that various ZnO nanosturcutres such as nanowires, nanobelts, bicrystal nanowires, magnetic nanowires of ZnO can be fabricated by using Bi at a temperature as low as 250°C and discuss their structural and physical properties.

DF-13(초) **Ferromagnetism in substitutionally Mn doped Ge nanowires and their gate potential responsibility** 최 헌진(*연세대학교 신소재공학부*) Diluted magnetic semiconductors (DMSs), which transform spin-frustrated semiconductors to ferromagnets by magnetic doping, have garnered much interest due to their potential

for introducing a spin degree of freedom into semiconductors, an important step toward developing spintronics. Room temperature ferromagnetism, which originates froma carrier mediated interaction among localized spin moments is an essential feature to realize DMS based spintronics. While ferromagnetism has been reported thus far in many DMSs, there is significant debate over the possible magnetic impurity phase separation and uncertainty of magnetic interactions. This talk will focus on on room temperature ferromagnetism of Mn doped Ge nanowires. Structural and magnetic characterization clearly shows that the magnetism originates from substitutionally doped Mn2+ ions. Electrical characterization of a nanowire field effect transistor showed the real-time gate-dependent hysteresis that may due to formation of the acceptor level of Mn between the electron trap levels of Ge, resulting in Mn hole generation in the band gap.

DF-14(초) **Si1-xGex alloy nanowires as nanophotonic components: their recent developments of growth and optical characterizations** 조 문호(*POSTECH 신소재공학과.*) Silicon is an intrinsically inefficient light-emitter due to overwhelming non-radiative recombination of electron-hole pairs across its indirect energy-band gap, thus impose fundamental barriers for their developments into appropriate photonic components. Nevertheless it has been suggested that one promising strategy to enhance luminescence efficiency from Si is to increase the overlap of the electron and hole wavefunctions by spatially confining electron-hole pairs in matter at the nanometer scale. In this talk, we discuss our recent research efforts to develop optoelectronic components based on single-crystalline Si-Ge alloy nanowires. We first report catalytic growth of single-crystalline Si1-xGex alloy nanowires, whose relative composition is controllably tuned over the entire composition range. We then present experimental demonstration of the band-gap modulation from near infrared to visible regions with alloying of Si and Ge, and their spatial confinement at the nanometer scale. We also discuss experimental issues related to local optical measurements in individual nanowire scales.

■ SESSION: E/D [EF1]/[DF3]
4월 17일(목), 12:30 - 13:50
장 소: 103호

EF-01 **Recent progress in ferroelectric films for memory applications** ISHIWARA Hiroshi(*Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, Yokohama, 226-8502, Japan.*) Ferroelectric random access memory (FeRAM) is one of the most promising non-volatile memories, because of its low power consumption and operation speed as fast as DRAM. At present, many chips are being mass-produced mainly for non-contact IC card applications and the maximum memory capacity of commercially available FeRAM is 4 Mb. However, there are still reliability issues in high-density integration of FeRAM cells. Thus, in this presentation properties of inorganic and organic ferroelectric thin films are discussed mainly from viewpoints of FeRAM applications. There are two types in the cell structure of FeRAM. One is a 1T1C-type (capacitor-type) cell and the other is a 1T-type (FET-type) cell. Each cell in the former type has one transistor and one ferroelectric capacitor and data storage operation is similar to that of DRAM. At present, only this type of FeRAM is commercially available. On the other hand, each cell in the latter type is composed of a single ferroelectric-gate FET (field effect transistor) and stored data can be read out non-destructively. First, properties of $BiFO_3$ (BFO) films formed by chemical solution deposition are discussed. BFO is a promising candidate for realizing the high-density 1T1C-type FeRAM, because its remanent polarization is as large as 90 mC/cm^2. It was found in the $BiFeO_3$ films that the leakage current at high electric field decreased significantly by substituting Mn atoms for Fe atoms. In the films with Mn concentration of 3 to 5at%, well saturated hysteresis loops in *P-E* (polarization vs. electric field) characteristics were observed at room temperature. Co-substitution of La and Ni atoms was also effective in decreasing the leakage current in BFO films.Then, properties of organic ferroelectric thin films suitable for fabricating ferroelectric-gate FETs (field effect transistors) are discussed. It was found in capacitors with a 60nm-thick P(VDF+TrFE) (polyvinyliden fluoride-trifluoroethylene) film that the remanent polarization was as large as 11.9 mC/cm^2 and the coercive voltage was as low as 2 V. It was also found that the polarization reversal time in these capacitors was faster than 1 ms. Finally, MFIS diodes were fabricated by depositing a P(VDF+TrFE) film on a Ta_2O_5/Si structure and well saturated hysteresis loops were obtained in *C-V* measurement.

1) S.K.Singh, H.Ishiwara, and K.Maruyama, *Appl. Phys. Lett.*, 88, 262908 (2006).2) S.Fujisaki, H.Ishiwara and Y.Fujisaki, *Appl. Phys. Lett.*, 90, 162902 (2007).

EF-02 **Performance Enhancement of EPC C1G2 UHF RFID Tag by Ferroelectric Memory Technology** HONG Suk-Kyoung(*R&D Division, Hynix Semiconductor Inc., Kyoungki-Do, 467-701.*) RFID (radio-frequency identification) system using UHF band (860-960 MHz) has attracted a great attention for the applications to track and trace assets or goods. A passive (batteryless) RFID tag, which is a key component in the system, consists of a transponder chip and an external antenna for communicating with a reader or interrogator. For UHF band applications, the communication distance between RFID tag and reader is a key performance index and should be as long as 1 meter or above. However, the energy received by the tag is generally less than 60-100 μW. Such a small energy supply requires the function of the tag to be as simple as possible so that its power consumption can be considerably reduced. Fast transaction time is also necessary to prevent data from tearing during writing in some track and trace applications. Considering these requirements, ferroelectric memory (FeRAM) technology is believed to be a solution because it has advantages of both low voltage and fast write/read operation. Recently, we have developed a passive-type FeRAM-embedded RFID tag satisfying the specification of EPC Class1 Generation2. The transponder for the RFID tag is implemented with 0.25-μm one-poly four-metal standard logic CMOS technology with addition of a FeRAM and Schottky diodes. Thanks to ultra low power design architecture and novel chip integration scheme for memory and RF analogue front-end utilizing PZT-based ferroelectric technology, the chip size as small as 620x710 um^2 and the communication distance as long as 3m or above has been achieved in the FeRAM-embedded UHF RFID tag.

EF-03 **Ferroelectric-Gate Field Effect Transistors Using Ferroelectric Organic materials for Non-Volatile Memories** PARK Byung-Eun(*School of Electrical and Computer Engineering University of Seoul, 90 Jeonnong-dong, Dongdaemoon-gu, Seoul, 130-743, Korea.*) In this work, we attempt to apply organic ferroelectric materials to the MFS-FETs structures. Our previous study, the MFS-FETs with inorganic ferroelectric materials showed the poor interfacial quality, forming a transition layer and inter-diffusion at interface. In order to solve these problems, the MFS-FETs are fabricated by using organic ferroelectric materials such as PVDF and PVDF-TrFE copolymer. The organic ferroelectric thin films are prepared by sol-gel method and their ferroelectric properties are studied to examine the possibility of the application to the ferroelectric random access memory (FeRAM). The PVDF and PVDF-TrFE solution were spin-coated on p-type silicon (100) and dried on hot plate in air. In order to characterize the electrical properties, The MFS structures were produced by evaporation of Au electrodes. The C-V (capacitance-voltage) measurements show the hysteresis loop with clockwise, which indicate the ferroelectric behavior of the organic ferroelectric thin films. With these results above, the Fe-FETs were fabricated using Au/organic ferroelectric thin film/Si structures. From drain current (I_D) versus gate voltage (V_G) characteristics of the fabricated Fe-FETs, the obtained threshold voltage shift (memory window) of the device shows the ferroelectric nature of organic thin films. The I_D versus V_D characteristics of the fabricated the Fe-FETs show typical n-channel FETs current-voltage characteristics.

■ SESSION: E [EI1]
4월 17일(목), 12:30 - 16:00
장 소: 301호

E

EI-01 **Power-Law Scaling Behavior of Barkhausen Avalanches in 2D Ferromagnets** SHIN S.-C., RYU K.-S, KIM D.-H.[1], IM M.-Y.[2], LEE S.-H.[3], AKINAGA H.[4](*Department of Physics and Center for Nanospinics of Spintronic Materials, KAIST, Daejeon 305-701, Korea.* [1]*2Department of Physics, Chungbuk National University, Chungbuk, Korea.* [2]*1Department of Physics and Center for Nanospinics of Spintronic Materials, KAIST, Daejeon 305-701, Korea; Center for X-ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA94720, USA.* [3]*1Department of Physics and Center for Nanospinics of Spintronic Materials, KAIST, Daejeon 305-701, Korea.* [4]*Nanotechnology Research Institute, NAIST, Tsukuba, Ibaraki 305-8562, Japan.*) The magnetization under an applied field around the coercivity reverses with a sequence of discrete and jerky jumps, known as the Barkhausen effect. Recently, interest in the Barkhausen effect has grown as it is a good example exhibiting dynamical critical scaling behavior, evidenced by experimental observation of a power-law distribution of the Barkhausen jump size. So far, most studies have been carried out on 3D bulk samples by a classical inductive technique and very few experiments have been done on 2D systems mainly due to the low signal intensity of the inductive method. In this talk, we will present critical scaling behavior of Barkhausen avalanches of various 2D ferromagnetic thin films investigated via time-resolved magneto-optical microscopy, enabling to directly image Barkhausen avalanches at criticality.[1] A statistical analysis of the fluctuating size of Barkhausen jumps from numerous repetitive experiments shows a power-law scaling behavior in the 2D ferromagnetic systems. In 2D Co films. the critical exponent is found to be ~ 1.33 independent of a film thickness from 5-50 nm. Strikingly, the power-law distribution in 2D MnAs films is found that the critical exponent varies continuously from 1.32 to 1.04 as the temperature increases.[2] This is the first time to observe that the scaling behavior of the Barkhausen criticality of a given ferromagnetic film is experimentally tuneable by varying the temperature (not dimensionality). We also report a universal scaling behavior of the first arrival time of a traveling magnetic domain wall into a finite space-time observation window, which can be explained by the random-walking model.[3] 1. S-C Shin, et al. J. Appl. Phys.(invited) 103, 07D907 (2008).2. K-S Ryu, et al. Nature Physics 3, 547 (2007).3. M.-Y. Im, et al. Phys. Rev. Lett., in press (2008).

EI-02 **Role of the spin-torque in the MgO based magnetic tunnel junctions** SUZUKI Y., KUBOTA H.[1], FUKUSHIMA A.[1], NOZAKI T.[2], YAKUSHIJI K.[1], NAGAHAMA T.[1], YUASA S.[1], ANDO K.[1](*Graduate School of Engineering Science, Osaka University, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan; NanoElectronics Research Institute, National Institute of Advanced Industrial Science and Technology, Tsukuba 305-8568, Japan.* [1]*NanoElectronics Research Institute, National Institute of Advanced Industrial Science and Technology, Tsukuba 305-8568, Japan.* [2]*Graduate School of Engineering Science, Osaka University, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan.*) Magnetic tunnel junctions (MTJs) with an MgO barrier[1-3] are known as such devices that show large resistance chagne (up to about 500%) at RT by an application of small external magnetic field. The has already found an application as a reading sensor in the magnetic hard disk drive. In addition, recent investigations showed that the magnetization of the device can be switched by so-called "spin-torque" that is exerted by a direct current [4]. This spin-injection magnetization switching (SIMS) technique[5,6] attract much attention since it may offer an energy saving writing method for the magnetoresistive RAM (MRAM). In our group, we have developed a method to measure the spin-torque by using the "spin-torque diode effect" [7]. To measure the effect we apply rf current to a MTJ and observe dc voltage across the device. The rf current introduces a spin-toruqe to the magnetic moment and excites an FMR. By FMR the magnetization, thus the resistance of the MTJ, oscillates and rectifies applied rf current. Therefore, the rectified dc voltage can be a measure of the torque. In the talk, spin-torques in the MTJs are discussed in detail metioning about spin-transfer torque and field like torque[8]. In addition, some interesting behavior of the MTJs under an interplay of the spin-torque and large TMR effect will be discussed. Acknowkedgiments: We would like to acknowledge to Dr. H. Maehara, Dr. K. Tsunekawa, Dr. Y. Nagamine, Dr. D. D. Djayaprawira, and Dr. N. Watanabe of Canon ANELVA Corporation for their collaborations. Part of this work was carried out with the financial support of NEDO, the SCOPE project of MIC, and a Grant-in-Aid for Scientific Research (A) (No. 19206002) of JSPS. *References:[1] S. Yuasa, et al., Jpn. J. Appl. Phys. Part 2, 43, L588 (2004), and S. Yuasa, et al., Nature Mat. 3, 868 (2004).[2] S. S. P. Parkin et al., Nature Mat. 3, 862 (2004)[3] D. D. Djayaprawira et al., Appl. Phys. Lett. 86, 092502 (2005).[4] H. Kubota et al, Jpn. J. Appl. Phys, 44, L 1237 (2005).[5] J. C. Slonczewski, J. Magn. Magn. Mater. 159, L1 (1996), and L. Berger, Phys. Rev. B 54, 9353 (1996).[6] E. B. Myers, et al., Science 285, 867 (1999).[7] A. A. Tulapurkar, et al., Nature, 438, 339 (2005).[8] H. Kubota et al., Nature Physics 4, 37 (2008).

EI-03 **RF noise measurement of magnetic tunnel junctions with MgO barrier** PARK Seungyoung, JUNG Myung-Hwa[1](*Quantum Material Research Team, Korea Basic Science Institute (KBSI), Daejeon 305-333.* [1]*Quantum Material Research Team, Korea Basic Science Institute (KBSI), Daejeon 305-333; Department of Physics, Sogang University, Seoul, Korea*) In tunneling magnetoresistive devices, it has been recently pointed out that high-frequency resonant peaks are observed in addition to 1/f noise, shot noise, etc. Since the high-frequency peaks are found even at zero field and at very low current level, they are believed to be related with thermal fluctuations of magnetization, and thus they are named to be RF noise. In order to investigate if the RF noise is related with thermal fluctuations of magnetization, we have studied the temperature dependence of RF noise signals up to 20 GHz. It demonstrates that the RF noise comes from the thermal fluctuation

of magnetization but it depends additionally on the field strength. Furthermore, we have examined the magnetic field and current dependence of RF signals.. The magnetic field dependence of RF peaks can be understood by considering the magnetization data. The current dependence of RF peaks can be interpreted as the influence of spin transfer torque on the magnetization fluctuations.

EI-04 **Current-induced magnetization dynamics in nanomagnet** ONO Teruo(*Institute for Chemical Research, Kyoto University, Uji 611-0011, Japan.*) The manipulation of magnetization by spin currents is a key technology for future spintronics. The underlying physics is that spin currents can apply a torque on the magnetic moment when the spin direction of the conduction electrons has a relative angle to the local magnetic moment. This leads us to a general concept that any type of spin structure with spatial variation can be excited by a spin-polarized current in a ferromagnet. We confirmed this concept for two typical noncollinear spin structures: magnetic domain wall (DW) [1]-[5] and magnetic vortex [6], [7]. [1] A. Yamaguchi *et al.*, Phys. Rev. Lett. 92, 077205 (2004).[2] A. Yamaguchi *et al.*, Appl. Phys. Lett. 86, 012511 (2005).[3] A. Yamaguchi *et al.*, Jpn. J. Appl. Phys., 45, 3850 (2006).[4] A. Himeno *et al.*, Appl. Phys. Lett. 87, 243108 (2005).[5] H. Tanigawa *et al.*, Appl. Phys. Express 1, 011301 (2008).[6] S. Kasai *et al.*, Phys. Rev. Lett. 97, 107204 (2006).[7] K. Yamada *et al.*, Nature Materials 6, 269 (2007).

EI-05 **Role of bound magnon in magnetic domain wall motion in ferromagnetic nanowires** KIM Tae-Suk, IEDA J.[1], MAEKAWA S.[1](*ACPTP, POSTECH, Pohang, Korea; IMR, Tohoku Univ., Sendai, Japan.* [1]*IMR, Tohoku Univ., Sendai, Japan.*) We report on our quantum description of the domain wall motion in a ferromagnetic nanowire under spin current. Bound magnon, which is the zero mode of domain wall, is found to play a dominant role in domain wall dynamics.Bound magnon acquires its inertia by the hard axis anisotropy and is a free particle even under spin current. We also find that the spin wave spectrum is independent of the domain wall velocityunder spin current.

EI-06 **Current-induced magnetic domain wall motion in a nanowire with the perpendicular magnetic anisotropy** JUNG Soon-Wook, KIM Woojin[1], LEE Taek-Dong[1], LEE Kyung-Jin[2], LEE Hyun-Woo(*Postech.* [1]*KAIST.* [2]*Korea University.*) The current-induced motion of magnetic domain walls carries great potentials for applications such as nano-scaled logic and memory devices. To achieve this goal, a large reduction in the threshold current density for the domain wall motion is highly desired. We examine theoretically the current-induced magnetic domain wall motion in a nanowire with the perpendicular magnetic anisotropy and show that the threshold current density can be drastically reduced when both the width and thickness of the nanowire are tuned to proper values. We found that the anisotropy can suppress an energy cost that the spin transfer torque has to overcome and make fast domain wall motion possible at orders of magnitude smaller current densities. This scheme can be implemented with existing nanofabrication technologies at room temperatures

EI-07 **Electrical control of Curie temperature in (Ga,Mn)As** MATSUKURA F., CHIBA D., NISHITANI Y.[1], ENDO M.[1], OHNO H.[1](*Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University; ERATO Semiconductor Spintronics Project, Japan Science and Technology Agency.* [1]*Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University.*) The nature of carrier-induced ferromagnetism of (Ga,Mn)As [1] enable us to control its Curie temperature T_C electrically, through the modulation of its hole concentration p in field effect transistor (FET) [2]. In this work, we have investigated T_C and its change of the magnitude, DT_C, of (Ga,Mn)As in FETs as a function of channel thickness t [3] and Mn composition x [4]. We grew (Ga,Mn)As with t = 3.5, 4.0, 4.5, and 5.0 nm with a fixed x = 0.065, and (Ga,Mn)As with t = 4.0 or 4.5 nm with various x from 0.027-0.200. We processed the samples into FETs with Hall-bar geometry, and measured the temperature dependence of anomalous Hall resistance to determine T_C under gate electric fields $|E|$ up to 5 MV/cm.The results show higher T_C but smaller DT_C for (Ga,Mn)As with larger t and x, and the linear relationship between DT_C/T_C and Dp/p. [1] T. Dietl, H. Ohno, F. Matsukura, J. Cibert, and D. Ferrand, Science 287, 1019 (2000).[2] D. Chiba, F. Matsukura, and H. Ohno, Appl. Phys. Lett. 89, 162505 (2006).[3] M. Endo, D. Chiba, Y. Nishitani, F. Matsukura, and H. Ohno, J. Supercond. Nov. Magn, 20, 409 (2007).[4] Y. Nishitani, D. Chiba, F. Matsukura, and H. Ohno, J. Appl. Phys. 103, 07D139 (2008).

■ SESSION: E [EF2]
4월 17일(목), 14:30 - 16:00
장 소: 103호

EF-04 **On-Film Formation of Bi Nanowires with Extraordinary Electron Mobility** SHIM Wooyoung, HAM Jinhee, LEE Seunghyun, ROH Jong Wook, JEON Kye Jin, LEE Wooyoung(*Department of Materials Science and Engineering, Yonsei University, 134 Shinchon, Seoul 120-749, Korea.*) The search for new growth methods for one-dimensional (1D) structures with nanometer diameters, such as nanowires, continues to be of central importance in nanoscience and nanotechnology, since they have great potentials for understanding their unusual quantum properties and for use in nanoscale devices. In particular, bismuth (Bi) nanowires have been of great significance in nanophysics to both theorists and experimentalists, as Bi is known to be a Group V semimetallic element that exhibits unusual transport properties due to its highly anisotropic Fermi surface. Single-crystalline Bi nanowires have motivated many researchers to investigate novel quasi-one-dimensional phenomena such as the wire-boundary scattering effect and quantum confinement effects due to their electron effective mass (~0.001

m_e), which is the smallest of all known materials. Moreover, single-crystalline Bi nanowires are expected to usher in new class of thermometric devices with high thermoelectric figure-of-merit (*ZT*) values. Here, a novel stress-induced method to grow semimetallic Bi nanowires along with an analysis of their transport properties is presented. Single crystalline Bi nanowires were found to grow on as-sputtered films after thermal annealing at 270 ˚C. This was facilitated by relaxation of stress between the film and the thermally oxidized Si substrate that originated from a mismatch of the thermal expansion. The diameter-tunable Bi nanowires can be produced by controlling the mean grain size of the film, which is dependent upon the thickness of the film. Four-terminal devices based on individual Bi nanowires were found to exhibit Shubnikov-de Haas oscillation (SdH) as well as very large transverse and longitudinal ordinary magnetoresistance (OMR), indicating high-quality, single crystalline Bi nanowires. Unusual transport properties, including a mobility value of 76,900 cm^2/Vs and a mean free path of 1.35 μm in a 120-nm Bi nanowire, were observed at room temperature.

EF-05 **금 나노입자를 이용한 발광 고분자 나노튜브의 발광 특성 향상** 박 동혁, 조 은혜, 김 미경, 김 미숙, 주 진수, 김 대철[1], 송 후근[1], 김 정용[1](*고려대학교 물리학과.* [1]*인천대학교 물리학과.*) 금 나노입자를 이용하여 발광 고분자 나노 물질의 발광 특성을 크게 향상시켰다. 발광 고분자 나노 물질은 나노 직경을 가지는 다공성 무기 배경 물질을 이용하여 전기화학 중합방법을 통해서 polythiophene (PTh)와 그 유도체인 Poly (3-methylthiophene) (P3MT) 나노튜브를 합성하였다. 금 나노 입자는 $HAuCl_4 \cdot 3H_2O$ 응 사용하여 지름이 약3~5 nm로 형성하였다. 금 나노입자가 흡착된 나노튜브의 합성 여부를 전자주사 현미경(SEM)과 투과 전자 현미경 (TEM) 및 고분해능 투과 전자 현미경 (HR-TEM)을 이용하여 확인하였다. 합성된 나노튜브의 광학적 구조적 특성을 확인하기 위해서 자외선 흡수(UV/Vis absorption), 광발광 (PL), X 선 회절 (XRD) 실험을 수행하였다. 자체 제작된 원자력 현미경 (AFM)과 레이저 공초점 현미경(laser confocal microscope, LCM)를 사용하여 합성된 나노 튜브의 한가닥 발광 및 라만 특성을 관찰하였다. 광발광 특성 향상을 표면 플라즈몬 공명 (Surface Plasmon Resonance, SPR) 에 의한 현상으로 해석하였다.

EF-06 **Modulation of opticacal properties of single-walled carbon nanotubes by AuCl3** KIM Ki Knag, BAE Jung Jun, KIM Soo Min, AN Kay Hyeok, BAE Dong Jae, LEE Young Hee(*Department of physics, Sungkyunkwan university.*) The optical band gap engineering of single-walled carbon nanotubes(SWCNTs) is an important issue for the application optical-nanoelectronic deivces. We have intoduced the selectively optical band gap engineering of SWCNTs by AuCl3. We found that a oprical band gap engineering of both metallic and semiconducting nanotubes depends strongly on the concetration of AuCl3. The electrons near the fermi level of metallic nanotubes were removed initially at low concetration in the Raman spectra, followed by subsequent removal of semiconducting subband E11S and E22S level in UV-Vis-NIR spectrum. With increasing the concetration further, E11M of metallic nanotubes was supperssed. Also, new peak around 1.1 eV in the UV-Vis-NIR spectra were induced by higher doping level. due to the downshifts of Fermi level of SWCNTs. This phenomena was confirmed by the XPS spectra and Raman spectra.

EF-07 **A Controlled Synthesis and the Optical Properties of Hybrid In_2O_3/Ag Nanochains and Nanoparticles: Surfaced Plasmon Resonance and Enhanced Raman Scattering** 강 대준, DU Jimin[1], 차 승남[2](*성균관대학교 물리학과/성균관대학교 성균나노과학기술원.* [1]*성균관대학교 성균나노과학기술원.* [2]*삼성종합기술원.*) The hybrid In_2O_3/Ag nanochains and nanoparticles were synthesized by homogeneous reaction of $In(NO_3)_3$ and $AgNO_3$ without and/or with Polyvinylpyrolidon (PVP) in 6 mL of ethylene glycol solution at 230 °C for 20 hrs and then annealing at 450 °C for 5 hrs was carried out. The compositions of the resultant In_2O_3/Ag nanochains and nanoparticles were confirmed by X-ray Diffraction (XRD), X-ray Photoemission spectroscopy (XPS) and Energy Dispersive Spectroscopy (EDS), respectively. The morphologies were investigated with Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and High Resolution Transmission Electron Microscopy (HRTEM) images. On the basis of our experiments results, the surfactant-induced formation mechanism is proposed to account for their growth processes. And In_2O_3/Ag nanochains and nanoparticles were shown surface plasmon resonance with the broad absorption bands and nanoparticles exhibit a broad absorption band and enhanced Raman scattering signal due to the formation of the local electrical field at the interfaces between Indium oxide and silver. Furthermore, In_2O_3/Ag nanochains show stronger intensity of surfaced enhanced Raman scattering than that of In_2O_3/Ag nanoparticles because In_2O_3/Ag nanochains display the crinkled characteristics, preferably leading to the huge local electrical field. In addition, the calculation was carried out using the density function theory to confirm the variation of the band structure and density of states of hybrid In_2O_3/Ag in comparison with pure In_2O_3 compounds.

EF-08 **A Technique to Produce Well Conducting and Mechanically Secure MWNT Attached AFM Tips** 안 상정, 강 영호, 최 진호[1], 박 병천, 김 달현, 최 재혁, 류 준[2](*표준과학연구소.* [1]*표준과학연구소, 충남대학교 전자공학과.* [2]*충남대학교 전자공학과.*) Multiwall carbon nanotube (MWNT) attached atomic force microscope (AFM) tips (MWNT tips) have been demonstrated useful in various applications. One of them is AFM lithography. Good conducting and mechanically well-attached MWNT tips are needed for such application. However producing MWNT tips with these qualities are still technically unsolved problem. Our MWNT tips were produced by hydrocarbon-deposition-attachment and were tested to be mechanically well-attached by stress-testing in a scanning electron microscope. However characterizing the conductance of MWNT tips was nontrivial: Our MWNT tips usually did not make good electrical contacts to gold electrode because of thin and rough amorphous carbon layer on MWNT that was unintentionally deposited during the attachment. We found that good contacts can be made if more amorphous carbon layer is deposited to form thick

and smooth amorphous carbon layer on MWNTs either by amorphous carbon layer transformation into conducting or by amorphous carbon layer peel-off which exposed bare MWNT surface. MWNT tips with exposed MWNT surface were well-conducting showing the well-known high-current-flowing capacity and the stepped-cutting behavior of bare MWNTs. Peeling-off behavior of thick amorphous carbon layer may be utilized in producing good conducting and securely attached MWNT tips that are useful for application.

■ SESSION: E [EF3]
4월 18일(금), 09:00 - 10:45
장 소: 106호

EF-09 **Development of ultra-coherent electron beam and its application to electron microscopy** CHO B., ISHIKAWA T., OSHIMA C.(*Kagami Memorial Laboratory for Material Science and Technology, Waseda University, 2-8-26 Nish-waseda, Shinjuku-ku, Tokyo 169-0051, Japan.*) Coherence is one of the most fundamental concepts of wave physics including physical optics and quantum mechanics. In classical terms, "highly coherent waves" means that the waves vibrate in unison for a long period of time over a wide space. The highly coherent electron beam from field emitters is the cornerstone for the atomic resolution electron microscopy and electron interferometry. By reducing the electron source size, decreasing the energy width of the beam, or cooling down the source, we have developed ultra-coherent electron beams. The coherency of electron beam has been evaluated by measuring its energy width DE or by monitoring the electron interference patterns generated from the beam. Superconducting niobium field emitters emitted monochromatic electron beam of DE≈20 meV.[1] Conventional tungsten field emitters produced more highly coherent electron beams at low temperature, generating the best electron interference pattern.[2,3] Carbon nanotubes emitted mutually coherent multiple electron beams from separated emission sites at pentagon carbon rings.[4] The enhancement of coherency at low temperature and the mutual coherence of multiple electron beams demonstrated the direct relationship between the coherency of electron beam and the original electronic states. Very highly collimated and coherent electron beam was extracted from single atom electron sources.[5] Field emitters operating under extreme high vacuum (XHV) in a 10^{-10} Pa range produced the most stable electron beam whose current fluctuation was dominated by the inherent quantum shot noise, allowing the lowest frequency shot noise measurement below 10 Hz.[6] A single atom electron source showed a suppression of the shot noise of beam current under XHV, indicating strong quantum correlation between electrons.[7] To utilize the ultra-coherent electron beam, we have developed a versatile low-energy electron microscope equipped with a single-atom source electron gun[8] and an optimized electron optics. The microscope was designed to function as a scanning electron microscope (SEM), a scanning transmission electron microscope (STEM) and an electron diffraction microscope. SEM and STEM images are shown and preliminary diffraction images of thin samples are presented. The oversampling method is suggested to retrieve the structural information of nano objects form the low-energy diffractogram. [1] K. Nagaoka *et al*, Nature 396, 557(1998). [2] B. Cho *et al.*, Phys. Rev. Lett. 92(24), 246103(2004).[3] B. Cho *et al.*, Appl. Phys. Lett. 91, 163102 (2007). [4] C. Oshima *et al.*, Phys. Rev. Lett. 88, 038301(2002). [4] E. Rokuta *et al.*, Appl. Surf. Sci. 251, 205(2005). [6] B. Cho *et al.*, Appl. Phys. Lett. 91, 051916 (2007). [7] B. Cho, Unpublished [8] T. Ishikaw *et al.*, Appl. Phys. Lett. 90, 143120 (2007). *Corresponding author's e-mail address: blcho@waseda.jp

EF-10 **잉크젯 프린팅에 의해 제작된 TIPS-pentacene 유기박막트랜지스터** 임 종선, 임 현석, 김 지수, 이 학성, 윤 성철, 이 재민, 김 동욱, 이 창진(*한국화학연구원*) 기존 유기박막트랜지스터(OTFT)에서 사용되는 유기반도체는 전하이동도가 1 cm^2/V·s 이상인 pentacene가 사용되었고 박막을 형성하기 위해 열진공증착 방법에 의해 제작하였다. 최근에 저비용/대면적이 가능한 용액공정으로OTFT를 제작하는 연구가 활발히 진행되고 있고, 용액공정이 가능한 여러 가지 유기반도체 재료의 합성이 보고되고 있다. 본 연구에서는 잉크젯 프린팅 방법으로 OTFT를 제작하였고 이때 사용한 유기반도체는 용액공정이 가능한TIPS-pentacene을 이용하였다. OTFT에 사용되는 TIPS-pentacene을 용매에 녹인 용액과 그 용액에 바인더 및 p-type 첨가제를 섞어 잉크젯 프린팅으로 제작하여 OTFT의 전기적 특성을 비교하였다.

EF-11 **순열합성법으로 제작한 In-Ga-Zn-O 채널을 가진 투명 박막 트랜지스터 제작 및 특성 조사** MOON Joon Chul, SHIN Yung Su, LEE Gi Yong, LEEM Young Chul, JU Honglyoul, PARK Chang Woo[1](*연세대학교, 물리학과.* [1]*한밭대학교, 응용화학생명공학부.*) 다시료 동시 제작법인 순열합성법으로 화학적 성분이 서로 다른In-Ga-Zn-O 채널을 가진 다수의 투명 박막 트랜지스터 (TTFT)를 동시에 제작하고In의 성분 변화에 따른 특성을 체계적이고 종합적으로 조사하였다. TTFT 특성은 제작 조건 및 열처리 조건에 크게 의존하고 In/(In+Ga+Zn) 비에 체계적인 관계가 있음을 확인하였다. In 성분비가 증가할수록 소자의 켜짐 (On) 전류 값 증가하였으나 켜짐/꺼짐 (on/off) 전류 비와 문턱 전압은 감소하였다. 전하 유동도는 모든 TTFT는 5 cm2/V·s 이상의 큰 값을 가지고 있었고 In 비가 60% 비가 TTFT의 경우 ~13 cm2/V의 큰 값을 가지는 것으로 나타났다. 본 연구를 통하여 순열합성법은 TTFT 소자 특성 최적화 및 새로운 채널 물질 제작에 매우 효과적인 방법임을 확인하였다.

EF-12 **금속-절연체-금속 소자에서의 계면상태에 따른 터널 barrier 특성 연구** IM HYUNSIK, JUNG HYUNTAE, KIM YONGMIN, JUNG KYOOHO, JUNG WOONG, KIM HYUNGSANG[1](*동국대학교 반도체과학과.* [1]*동국대학교 물리학과.*) We have studied transport in Al and Nb based metal-insulator-metal tunnel junctions. Deposition of Al and Nb thin films is done using angle evaporation through a suspended mask formed in a Ge layer supported by a thermally stable polymer while the tunnel barrier is formed by thermal oxidation of the bottom Al layer. After oxidation, we deposit Al or Nb top layer. We measure the

current-voltage (I-V) characteristics of the junctions in the wide range of temperatures, 25mK ~ 300 K. Comparing the measured I-V characteristics with the modeled ones using transfer matrix technique and Simmon's image force correction. We extract basic junction parameters, such as the barrier height and width. The measured and modeled I-V curves are in good agreement in the entire range of temperature. When Nb is deposited directly on the Al oxide layer, the potential barrier becomes asymmetric and its height is significantly lower than that of the Al/AlO_x/Al junction. We also discuss the subgap leakage of ourjunctions when the temperature is lowered below the superconducting transition temperature.

EF-13 **Construction of a 2-Layer Animal PET system**
HONG Seong Jong, KWON Sun Il[1], ITO Mikiko[2], YOON Hyun Suk[3], LEE Geon Song[4], SIM Kwang-Souk[2], PARK Kwang Suk[4], RHEE June Tak[5], LEE Jae Sung[1](*Institute of Radiation and Medicine, Seoul National University College of Medicine.* [1]*Department of Nuclear Medicine, Seoul National University College of Medicine.* [2]*Department of Physics, Korea University.* [3]*Department of Medical Science, Seoul National University College of Medicine.* [4]*Department of Biomedical Engineering, Seoul National University College of Medicine.* [5]*Department of Physics, Konkuk University.*) Improving spatial resolution without sacrificing sensitivity is one of the most challenging goals for small animal PET scanners. To meet the challenging goals, we are constructing a 3-layer animal PET system which can provide depth of interaction. The 3-layer animal PET system distinguishes signals of outer $L_{0.9}$GSO from those of $L_{0.2}$GSO using the different timing characteristics and signals of inner $L_{0.9}$GSO from those of outer $L_{0.9}$GSO using the charge-division algorithm. The cross section area 1.5 × 1.5 mm^2 of all the crystals is chosen to obtain a ~3 mm^3 volume resolution at the center of the scanner. The proposed system consists of 6 Hamamatsu H9500 PMTs and about 15,000 crystals. As an intermediate step to the 3-layer PET system, we built the construction of the 2-layer PET system with 6 H9500 PMTs each of which is mounted with 29x29 and 28x28 $L_{0.9}$GSO crystals. We present the construction and the characteristics of the 2-layer PET system.

EF-14 **Metal Oxide Nano-Material Gas Sensor for Environmental Monitoring System**
문 승언, 이 홍열, 이 재우, 박 종혁, 박 소정, 곽 준혁, 맹 성렬, 박 강호, 김 종대, UDREA Florin, MILLNE W. I.(*한국전자통신연구원*) Environmental monitoring sub-system has been developed using gas sensor module, Bluetooth module and PDA phone. The gas sensor module consists of NO2 or CO gas sensor and signal processing chips. Gas sensor is composed of the micro-heater, sensing electrode and sensing material. Metal oxide nano-material was selectively deposited on a substrate with micro-heater and was integrated to the gas sensor module. The change in resistance of the metal oxide nano-material due to exposure of oxidizing or deoxidizing gases is utilized as the principle of this gas sensor operation mechanism. This variation detected in the gas sensormodule was transferred to the PDA phone by way of Bluetooth module. Metal oxide nano-material was chosen because of its high sensitivity and small size We developed metal oxide nano-material gas sensor with CMOS compatible process. Due to their performance, such as, high sensitivity, ultra small size and low power consumption, they can be used personal environmental monitoring, ubiquitous sensor network, smart home system, etc.

■ SESSION: E [EF4]
4월 18일(금), 11:00 - 12:45
장 소: 104호

EF-15 **Advances in quantum photonic science : metamaterials comprising spin-photonic crystals**
이 영백(*한양대학교 양자 광기능 물성 연구센터 / 물리학과*) A representative item, in the field of photonics aiming at ultrafast devices, is photonic crystals (PC) which are a new-concept material or structure to control the propagation of light in various ways. Furthermore, even spin PC (SPC) and metamaterials such as left-handed materials (LHM) appear recently, where magnetic components are also included in the basic periodic arrangement of nonmagnetic ones to be controlled magnetically as well. The interest in photon-spin interaction is grown, but the basis is not solid yet. It is a crucial time to promote this kind of research, and this chance hopefully provides an opportunity for it. Progresses at the Quantum Photonic Science Research Center, the Center of Excellence in this area, are presented, emphasizing those in SPC and LHM.

EF-16 **Hybrid single-nanowire photonic crystal structu**
PARK Hong-Gyu(*Department of Physics at Korea University.*) Research on two different kinds of materials will be presented in this talk: photonic crystals and II-VI / III-V direct band gap semiconductor nanowires. Both materials can be used as efficient multicolor light sources in light emitting diodes (LEDs) or electrically driven lasers. Based on the ideas of photonic crystal band gap and cavity/waveguide, photonic crystal structures have many exciting optical applications such as low-threshold lasers, highly-efficient LEDs and low-loss waveguides. Unique ideas to realize the current injection laser structure will be introduced in my talk. Significantly, I will demonstrate the first electrically driven photonic crystal laser. Moreover I will present recent work on direct band gap semiconductor nanowire with diameter of ca. 100 nm. II-VI / III-V semiconductor nanowires can be grown by the vapor-liquid-solid (VLS) method and characterized using the transmission electron microscope (TEM). Nanowire based LEDs and waveguides will be discussed. Semiconductor nanowires with direct band gaps are combined with photonic crystal structures to make a cavity or waveguide for photonic functional devices or nanophotonic integrated circuits. The hybrid photonic systems that combine chemically synthesized single nanowire emitters with lithographically defined photonic crystals exploit unique strengths of bottom-up and top-down approaches and thereby open new opportunities in nanophotonics from efficient and localized light sources to integrated optical processing.

EF-17 **Low-threshold Photonic Crystal Laser and High-Q Cavity** RYU Han-Youl(*Department of Physics, Inha University.*) Photonic crystals are representative nano-photonic structures and expected to play an important role in the future optical integrated circuit. In this talk, we will introduce experimental demonstration of novel laser operations and theoretical investigation of high quality-factor (Q) resonant modes in the photonic crystal nano-cavity structures. Photonic crystal lasers were fabricated in the form of two-dimensional photonic crystal air-bridge slab structures made of InGaAsP materials emitting at 1.55 mm, and lasing characteristics were investigated by optical pumping. When the nano-cavity was introduced in the air-bridge slab structure, low-threshold lasing action has been realized by room-temperature pulse pumping. High-Q resonant modes were analyzed by numerical optimization based on the finite-difference time-domain method, and the Q of >10^6 has been obtained in a wavelength-sized photonic crystal cavity. After introducing the achievements reported by our group, recent development of photonic crystal lasers and high-Q photonic crystal cavity modes will be reviewed.

EF-18 **Simultaneous RGB lasing in a single-pitched cholesteric liquid crystal system** HA Na Young*, JEONG Soon Moon[1], ISHIKAWA Ken[1], TAKEZOE Hideo[1], NISHIMURA Suzushi[2], SUZAKI Goroh[2](*Dept. of Organic and Polymeric Materials, Tokyo Inst. of Tech., 2-12-1 O-okayama, Meguro-ku, Tokyo, Japan *Present address: Dept. of Physics, Ajou Univ., 443-749 Suwon, Korea.* [1]*Dept. of Organic and Polymeric Materials, Tokyo Inst. of Tech., 2-12-1 O-okayama, Meguro-ku, Tokyo, Japan.* [2]*Central Tech. Research of Lab., Nippon Oil Co., 8 Chidori-cho, Naka-ku, Yokohama 231-0815, Japan,.*) According to Fermi's 'golden rule', one of optimum conditions to enhance the emission rate is ascribed to a high photonic density of state. At the defect modes in the photonic band gap (PBG), the group velocity approaches zero, and the resulting long dwell times of emitted photons support stimulated emission. Here we demonstrated simultaneous RGB lasing in a new cholesteric liquid crystal (CLC) system showing simultaneous red, green, and blue reflections or multiple PBGs. The multiple reflectors could be realized typically by using thin isotropic films and polymeric CLC films with a single pitch. In order to demonstrate simultaneous multi-colored lasing by a single optical pumping, we also investigated an energy transfer between fluorescence dyes in an active medium, i.e. nematic LC layer sandwiched in between two multiple reflectors.

■ SESSION: E [EF5]
4월 18일(금), 11:00 - 12:30
장 소: 106호

EF-19 **Electromagnetic response of representative metamaterial structures** LAM V. D., KIM J. B., LEE S. J., LEE Y. P.(*Quantum Photonic Science Research Center and Department of Physics, Hanyang University, Seoul, 133-791 Korea.*) We investigated systematically the electromagnetic behavior of representative magnetic metamaterials for providing a negative magnetic permeability, starting from the early invented split-ring resonator (SRR) structure with one gap to the SRR with two gaps, and then the cut-wire pair (CWP) structure. Subsequently, the left-handed (LH) behavior of combined structure of CWP and continuous wire was also experimentally studied. It was found that the SRR and the CWP structures exhibit both magnetic and electric resonances while the combined structure yields a LH behavior. Until the width of cut-wire pair increases to be merged with the adjacent continuous wire, in other words, to form the so-called fishnet structure, the LH behavior is kept to be observed. These structures were designed, built, and measured in the microwave frequency range.

EF-20 **Positron-annihilation Induced Auger Electron Spectroscopy (PAES) Study of Metal and Semiconductor Surfaces** 김 재홍, 양 태건, 이 병철[1], 이 종용[2](*한국원자력의학원 가속기이용기술개발팀.* [1]*한국원자력연구원.* [2]*한남대학교, 광전자물리과.*) Since the presence of chemical impurities and defects at surfaces and interfaces greatly influence the properties of various semiconductor devices, an unambiguous chemical characterization of the metal and semiconductor surfaces becomes more important in the view of the miniaturization of the devices towards nanometer scale. Among the various conventional surface characterization tools, Electron-induced Auger Electron Spectroscopy (EAES), X-ray Photoelectron Spectroscopy(XPS) and Secondary Ion Mass Spectroscopy (SIMS) are being used for the identification of the surface chemical impurities. In this talk, a novel surface characterization technique will be introduced. Positron-annihilation induced Auger Electron Spectroscopy (PAES) provides a unique method for the analysis of the elemental composition of the top-most layer. In PAES, monoenergetic positrons of a few eV are implanted to the surface under study and these positrons become thermalized near the surface. A fraction of the thermalized positrons trapped at the surface state annihilate with the neighboring core-level electrons, creating core-hole excitations, which initiate the Auger process with the emission of Auger electrons almost simultaneously with the emission of annihilation gamma-rays. Thus, PAES experiments can be used to selectively obtain chemical information from the topmost atomic layer with eliminating large secondary electron background. Recently, high flux low-energy positron beam system is considered by using an electron accelerator at KAERI. [1] Alex Weiss, Rulon Mayer, Mohammed Jibaly, Chun Lei, David Mehl and K.G. Lynn, Auger-Electron Emission Resulting from the Annihilation of Core Electrons with Low-Energy Positrons, Phys. Rev. Lett. 61 2245-48(1988).

EF-21 **시간 분해 레이저 분광학에 의한 $YVO_4:Eu^{3+}$ 박막의 형광 동역학 특성** 장 경혁, 김 은식, 시 량, 정 중현, 서 효진 (*부경대학교*) Pulsed Laser Deposition로 만들어진 $YVO_4:Eu^{3+}$ 박

막의 형광 동역학 특성을 시간 분해 레이저 분광학 방법으로 조사하였다. 사용된 레이저 파장은Nd:YAG 266 nm, 355 nm 였으며 시료의 측정온도는15 K 에서 실온까지 였다. 266 nm, 355 nm 레이저 여기에 의한 방출스펙트럼은 $^5D_3$, $^5D_2$, $^5D_1$, $^5D_0$ 준위에서 ^7F_J (J=0, 1, 2…6) 준위로 전이하는 형광을 관측할 수 있었다. 266 nm 여기 에너지는 VO_4^{3-} 흡수 밴드와 잘 일치 하여 Eu^{3+} 로의 에너지 전달을 통하여 강한 형광을 방출한다. 본 연구에서는 시간분해 형광 스펙트럼을 측정하여$^5D_3$, $^5D_2$, $^5D_1$, $^5D_0$ 의 각각의 준위로부터 ^7F_J (J=0,1,2..) 준위로 방사 전이하는 형광스펙트럼을 분리할 수 있었다. VO_4^{3-} 흡수 밴드 끝 단과 일치하는 355 nm 에너지는 온도가 증가할수록 포논의 도움으로 방출스펙트럼의 세기가 저온에서보다 실온에서 더 높은 사실을 확인하였다. Eu^{3+}로 에너지가 전달되지 않고 직접 방출하는 매우 짧은 수명시간을 가진 호스트의 VO_4^{3-} 방출 밴드를 확인하였다. 본 연구에서는 박막의 실험 결과를 $YVO_4:Eu^{3+}$ 단결정, 미세결정, 나노 입자의 결과와 비교 분석한다.

EF-22 **Hard x-ray lithography using sectioned multi-layer x-ray masks** LEE SU YONG, CHO IN HWA, KANG HYON CHOL[1], NOH DO YOUNG(*광주과학기술원, 신소재공학과.* [1]*광주과학기술원, 고등광기술연구소*) We have investigated the hard x-ray lithography using sectioned multi-layers as x-ray photon masks. The hard x-rays (below 2Å) have been recognized as promising lithography light that can fabricate nano-scale patterns overcoming the diffraction limit. The diffraction limit ~λ/4 is much shorter than typical nano-scale length scale due to the short x-ray wavelength rather. Especially, hard x-rays strongly penetrate most materials, which makes patterning possible in non vacuum environment. In this study, we report the fabrication of 100nm scale line patterns on spin-coated photo resists. Sectioned multi-layers with 100nm width and 200nm pitch were used as patterning masks, and ZEP520A was used as photo resist. The patterns formed by the hard x-ray lithogratphy were characterized by SEM.

EF-23 **Finite Size Effect on Hydrogen Sensing Performance in Single Pd Nanowires** JEON Kye Jin, LEE Eunsong-yi, JEUN Minhong, CHO Chunghwan, LEE Young Taek, LEE Wooyoung(*Department of Materials Science and Engineering, Yonsei University.*) Single Pd nanowire hydrogen sensor was fabricated and hydrogen concentration was detected in the commercially interesting region. The Pd nanowire was grown by electrodeposition in the nanochannels of an anodized aluminium oxide (AAO) template. Lithographic processes are devised to pattern 4-point electrodes on single Pd nanowires that have been removed from the alumina template.Finite size effect on hydrogen sensing performance was studied. The sensitivity was not dependent on diameter of nanowire, but response time decreased with decrease diameter. It was correspondent well with the result of numerical simulation that calculate spatial and temporal hydrogen concentration of palladium nanowires based on rate equation and diffusion equation.

■ SESSION: E [EF6]
4월 18일(금), 13:00 - 14:30
장 소: 103호

EF-24 **Interlayer Diffusion in Alq_3 Based Organic Light Emitting Device with Annealing Dependence** LEE Young Joo, KIM Jinwoo[1], KIM Hyunjung(*Department of Physics, Sogang University.* [1]*Department of Materials Science and Engineering, Gwangju Institute Science and Technology.*) We studied the process of interlayer diffusions thermally induced in organic light emitting devices (OLEDs) having multilayered structure of [LiF/tris-(8-hydroxyquinoline) aluminum (Alq_3)/N,N0-Bis(naphthalen-1-yl)-N,N0-bis (phenyl)benzidine (NPB)/copper phthalocyanine (CuPc)/indium tin oxide (ITO)/SiO_2 on a glass] as a function of annealing temperature and annealing time by synchrotron X-ray scattering. Annealing temperature was varied from room temperature to 220 °C and annealing time was varied from 15 minutes to 4 hours. The results show that the interlayer diffusion occurs between LiF, Alq_3 and NPB layers as well as between Alq_3 and NPB in 15 minutes annealing at 120 °C. Such interlayer diffusion causes the diffusion layers at the interfaces of LiF/Alq_3/NPB. Interlayer diffusion is enhanced along the increase of annealing time and saturated after 4 hours in annealing at 120 °C. This study was supported by Korea Science &Engineering Foundation and Seoul Research &Business Development program (10816) and by Korea research Foundation.

EF-25 **Surface Oxidation of the Advanced High Strength Steel (AHSS)** 김 태철(*POSCO Technical Research Laboratories, Automotive Steel Products Research Group.*) Advanced high strength automotive steel is required of the excellent mechanical property but also the distinguished surface quality. Usually the mechanical strength of steel can be increased by alloying of Si, Mn elements in steel. However, surface segregation of Si, Mn can deteriorate in wetting between liquid Zn and solid steel surface due to formation of Si-Mn surface oxide during annealing. To examine the effect of alloying elements (Si, Mn) in wetting and surface property, we investigate the influence of the dew point in reducing atmosphere and annealing condition. At lower dew point (<-40 °C), the steel surface is covered with Si rich surface oxide and appears poor wettability with Zn via formation of bare spot. In contrast, at higher dew point (>-40 °C), the Mn rich surface oxide is formed on steel surface and also the Zn wetting property is improved. The control of dew point is a method for improving of the Zn coated AHSS surface by changing surface oxide species.

EF-26 **CoFe/FePt Exchange Spring Films for Magnetic Recording Media** LEE Nyun Jong, AHN Jae Young, KIM Tae Hee(*Department of Physics, Ewha Womans University.*) FePt is a leading candidate for future extremely high density magnetic recording media, due to its very high values of K_u. However, this very high anisotropy give films with very high coercivity, too high for reliable recording using conventional write heads. Hard magnetic / soft

magnetic bilayers could be an excellent solution to tailor their magnetic properties according to the specific requirements, thereby enabling efficient recording. In this work, we investigated the temperature-dependent magnetic response of exchange-coupled FePt/CoFe bilayers. The hard magnet films, such as FePt, were prepared beyond the soft magnetic layer (CoFe) of a material having a B2 ordered crystalline structure by using UHV-MBE deposition technique. In order to have the B2-phase of CoFe films, the epitaxial MgO(100) film was deposited as a buffer layer beyond the bare Si(100) substrate. Our results open intriguing possibility for media applications for high density magnetic recording. This research was supported by a grant from the Fundamental R&D Program for Core Technology of Materials funded by the Ministry of Commerce, Republic of Korea.

EF-27 **A Study on Energy Beam Treatment effect of IZO (indium-zinc-oxide) Thin Films -IZO 박막의 Energy Beam 처리에 의한 특성변화에 관한 연구** 남 상훈, 송 기문[1], 정 상헌[2], 김 용환[3] (*건국대학교 대학원 첨단응용학과 석사과정.* [1]*건국대학교 대학원 첨단응용학과주임교수.* [2]*(주)인포비온 디스플레이 연구소 주임 연구원.* [3]*(주)인포비온 대표이사.*) 가시광 영역에서의 높은 투과도와 낮은 전기 비저항을 갖는 ITO(indium-tin oxide)박막은 현재 가장 많이 사용되고 있으나, 높은 열처리 온도(200 ~ 500℃)로 인한 문제 등으로 인하여 다양한 응용분야로의 적용에 걸림돌이 되고 있다. 현재 이러한 문제점을 지니는 ITO를 대체할 목적으로 IZO(indium-zinc-oxide) 박막이 본격적으로 연구되고 있으며, 많은 연구결과들로부터 IZO박막은 추가적인 열처리 과정 없이도 상온 비정질 상태에서 가시광90%이상의 투과도와 $5.0\times10^{-4}\Omega\cdot$cm 이하의 비교적 낮은 전기 비저항을 갖는 것으로 보고되고 있다. 그러나 IZO는 ITO 박막보다 동일 조건에서의 증착 시 전기저항특성이 떨어지는 약점을 지니며 이 약점을 보완하기 위한 후처리 연구들이 진행되고 있다. 현재 진행 중인 후처리연구의 대다수가 Thermal Source를 사용하며, 여러 연구결과들로부터 IZO박막은 400℃이상의 온도에서 처리되는 것으로 보고되고 있으므로, 다른 후처리 Source의 연구 및 개발이 시급한 실정이다. 그러므로 Energy Beam Source를 사용한 후처리 연구는 저온 후처리 공정개발에 있어서 한 가지 대안이 될 수 있을 것이다. 본 연구에서는 상온에서 RF Sputtering을 이용하여 증착된 IZO박막을 Energy Beam을 이용하여 Post Treatment하였다. 박막의 광학적 특성은 Sputtering 조건에서 가스의 조성비 O2/(Ar+O2)=1~0.2%에 따라 차이를 보였으며, 순수한 Ar 분위기 보다 Ar+O2 분위기에서 투과도가 증가하는 특성을 보였다[O2/(Ar+O2)=0.28%]. Beam Treatment된 IZO박막의 전기적특성은 Beam Energy변화와 처리시간의 변화에 따라 특성의 변화를 보였고 Beam Energy의 증가(100 ~ 1500eV)에 따라 박막의 비저항이 낮아지는 특성을 보이다가 일정 Energy 이상에서 반대의 특성을 나타내었으며, 특정시간(1min ~ 30min)에서 낮은 전기 비저항을 갖는 것이 관찰되었다. 이외에 처리 조건 변화에 따른 IZO박막에서의 Surface Roughness &Morphology, Crystallization, Hall effect의 특성들을 관찰하였다.

EF-28 **Direct Imaging of Collapsed Langmuir Monolayers and Multilayer Formation** SEOK Sangjun, KIM Doseok, YOON Jae Jin[1], KIM Tae Jung[1], BYUN Jun Seok[1], KANG Yu Jin[2], KIM Young Dong[1], VAKNIN David[3](*Department of physics and Interdisciplinary Program of Integrated Biotechnology, Sogang University, Seoul, Korea.* [1]*Nano-Optical Property Laboratory and Department of Physics, Kyung Hee University, Seoul, Korea.* [2]*Nano-Optical Property Laboratory and Department of Physics, Kyung Hee University.* [3]*Ames laboratory and Department of Physics and Astronomy Iowa State University, Ames, Iowa 50011, USA.*) *In-situ* imaging ellipsometry was used to monitor Langmuir monolayers of arachidic-acid spread on water and on $CaCl_2$ solution before and after collapse. The Langmuir monolayer was collapsed by compressing it beyond the minimal closely-packed surface molecular area. The ellipsometry images show clear domains of collapsed regions, and analysis of the ellipsometry allowed the determination of thicknesses of these domains. We find that the thickness of collapsed domains, on average, corresponded to tri-layer for monolayers that are spread on water and to bilayer for monolayers spread on $CaCl_2$ solution.

■ SESSION: E [EF7]
4월 18일(금), 13:00 - 14:45
장 소: 104호

EF-29 **Quantum Metamaterials: Challenges and Opportunities** WU J.W.(*Department of Physics, Ewha Womans University, Seoul, Korea.*) Quantum metamaterials research is one of the key area in the fields of physics and materials science. It provides a new paradigm for the 21st century physics and also a major breakthrough for quantum computing which is essential to the simultaneous processing of massive information. The quantum metamaterial structure, where the quantum coherence plays an important role, has emerged as an unavoidable alternative for current highly integrated and high-speed information processing devices. Fabrication by nano-technology and characterization by integrated spectroscopy of these quantum structures are the prerequisite step to understand the fundamental physical processes in order to lay a basis for the next-generation novel quantum devices. The talk will discuss the challenges and opportunities related to the quantum metametarials.

EF-30 **Theoretical study on polarization filters using single negative metamaterials** LEE Byoungho, KIM Kyoung-Youm[1] (*National Creative Research Center for Active Plasmonics Application Systems, ISRC and School of EE, Seoul National University, Seoul, Korea.* [1]*Department of Optical Engineering, Sejong University, Seoul, Korea.*) Artificially structured metamaterials have opened a new era in electromagnetism and the unprecedented design flexibility of them enables us to achieve new electromagnetic devices unimaginable with only conventional positive index medium. Among the various kinds of metamaterials, we are interested in single negative medium (in which only one of permittivity and permeability has a negative value) because it can show the extraordinary characteristics of metamaterials only for one linear polarization component of light while

for the other it acts just as conventional materials. Using this feature, we can implement novel polarization-dependent optical functional devices. Some examples are reported in this presentation, especially those of polarization filters using polarization-dependent waveguide coupling, tunneling induced polarization-dependent lateral shifts, and polarization-dependent complete tunneling.

E

EF-31 **Controlled-NOT gate with all electrically controlled intervalley states of Si quantum dots** AHN Doyeol (*Department of Electrical and Computer Engineering, University of Seoul, Seoul 130-743, Korea.*) Quantum gates based on the spin qubits utilizes the Heisenberg interaction and it is well known that the Heisenberg interaction alone does not give a universal quantum gate because it has too much symmetry. Therefore various schemes were proposed to construct logical qubits involving several spins to encode one logical qubit. Moreover, the necessity of both static and dynamic magnetic fields required for the control of Heisenberg interactions in quantum dots could also be a potential drawback. So it is desirable to find an alternative physical system such that a single physical state constitutes one logical qubit with the possibility of all electrically controlled universal gate operation. Recently we have studied the polarized intervalley states of silicon quantum structures as a new potential candidate for a quantum bit. Here, we present an explicit scheme in which the universal quantum gate such as a controlled-NOT (CNOT) gate with all electrical control can be implemented using the polarized intervalley states of silicon quantum dots. We consider a quantum dot (QD) with the z-direction assumed to be along the Si (001) surface with the ground state associated with doubly degenerate valleys in the absence of the intervalley interaction. The ground state wave function is composed of the linear combination of p-like states, the irreducible representations of Td symmetry of the Si crystal. The voltage applied to the quantum dot through the microwave gate controls the evolution of a polarized state. The operation of two-bit gate is controlled by the Coulomb interaction between electrons each confined to either of coupled quantum dots for the unitary gate. The Coulomb interaction energy depends on the overlap of wave functions of electrons confined to each dots and the overlap of wave functions depends on the voltage applied through the microwave gates on each quantum dots.

EF-32 **Graphene as a Building Block for Quantum Metamaterials** 손 영우(*건국대학교*) In this talk, I will describe recent work on electronic structures of the massless chiral Dirac fermions in various periodic potentials. For specific examples, two novel graphene superstructures are considered: graphene superlattice [1] and epitaxial graphene [2]. For graphene superlattice [1], periodic potentials with nanoscale period are applied to graphene and, by using effective Hamiltonian approaches, the characteristics of its charge carriers are shown to be drastically changed due to their unique chiral nature. Specially, the group velocity of charge carriers is renormalized in a highly anisotropic manner even to a degree that it is not changed at all in one direction but is reduced to zero in another. It implies the possibility that one can make nanoscale electronic circuits out of graphene [3] not by cutting it but by drawing on it in a non-destructive way. For epitaxial graphene [2], by using first-principles calculations, I will report a discovery that a novel interfacial atomic structure occurs between graphene and the surface of silicon carbide, destroying the Dirac point of graphene and opening a substantial energy gap there, which are in excellent agreement with recent experiments. Based on the theoretical studies on graphene superstructures, I will consider a possibility to make prototypical solid state quantum metamaterials based on graphene. [1] C. H. Park, L. Yang, Y.-W. Son, M. L. Cohen, S. G. Louie, Nature Physics, in press (2008).[2] S. Kim, J. Ihm, H. J. Choi, Y.-W. Son, arXiv.org:0712.2897.[3] Y.-W. Son, M. L. Cohen, S. G. Louie, Nature 444, 347 (2006).

■ SESSION: F [FG1]
4월 17일(목), 12:30 - 14:15
장 소: 206호

F-01 **Boundary-induced abrupt transitions in the symmetric exclusion process** HA Meesoon, NAGAR Apoorva[1], PARK Hyunggyu[1](*KAIST, Department of Physics.* [1]*KIAS, School of Physics.*) We investigate the role of the boundary in the symmetric simple exclusion process with competing nonlocal and local hopping events. When open boundary conditions are considered, the system undergoes a first order phase transition from a finite density phase to an empty road (zero density) phase as the nonlocal hopping rate increases for any given input rates at boundaries. Using a self-consistent cluster dynamics analysis, we determine the value of such abrupt nonequilibrium phase transition points as a function of the input rate, which are confirmed by numerical simulations. Our cluster analysis provides a physical insight into the mechanism behind such transitions. It also explains the difference between our finding and the earlier results with periodic boundary conditions where continuous phase transitions has been observed.

F-02 **Relevance of Abelian Symmetry and Stochasticity in Directed Sandpile Models** JO Hang-Hyun, HA Meesoon[1] (*School of Physics, KIAS.* [1]*Department of Physics, KAIST.*) We consider three directed sandpile models without Abelian symmetry on (1+1)-dimensional space, where the topping rule isdeterministic. Based on our numerical results, we revisit the debatable issue of the universality class in directed sandpile models, and discuss the scaling properties of avalanches and the formation of a spatial structure at the self-organized critical (metastable) state with the power-law decaying grain density along the transverse direction. We argue the scaling exponents characterizing the avalanche distributions as well as the scaling relations in terms of the exponents of the underlying particle dynamics.

F-03 **Geometric XY Spins in Hyperbolic Lattice** BAEK Seung Ki, SHIMA Hiroyuki[1], KIM Beom Jun(*Sungkyunkwan University.* [1]*Hokkaido University.*) We study the phase transition of XY model in a hyperbolic planar lattice by Monte-Carlo simulations. The phase difference between two spins is defined with respect to the geodesic connecting them, introducing an additional phase. Such geometrical consideration makes the usual ferromagnetic order parameter unavailable, which deeply relates to the concept of parallelism. We observe that the system may not have a unique ground state in low temperatures and typically exhibits domain-like structures. As the system behaves like a structural glass, we present the measurements of spin-glass order parameters and discuss the transition nature.

F-04 **Undecidability, entropy and information loss in classical physical systems** KIM Sungyun(*아태 이론물리센터*) We investigate how undecidability enters into simulations of classical physical systems, contributing to the increase of entropy and loss of information. We point out that undecidability occurs when we describe a continuous system with finite resolution, while entropy appears when we introduce inconsistency to avoid undecidability. We apply the Shannon entropy to simulations of discretized physical systems and show that under the Liouville flow the entropy always increases or information is always lost both in time-forward and time-backward directions for any finite bit of precision. This is due to the finiteness of information capacity and incompressibility of the probability distribution in Liouville's equation.

F

F-05 **Protein Structure Prediction Using the Hybrid Energy Function, Fragment Assembly, and Double Optimization** 이 주련, 조 광휘, 김 택균(*숭실대학교 생명정보학과*) We perform protein structure prediction by combining a hybrid energy function, fragment assembly, and double optimization. In the hybrid energy function, all the backbone atoms are described explicitly,but the side-chain is modeled as a few interaction centers in order to reduce computational costs. We reduce the search space by using a fragment assembly method, where the local structure of the backboneis obtained from a structural database using similarity of sequence features, and only the global tertiary packing of fragments is determined by minimizing the energy. The structure with the minimum energy is obtained using double optimization, where a combination of backbone fragments with minimum energy is obtained using the conformational space annealing (CSA) method, and the optimal side-chains for a given backbone structure are obtained using simulated annealing. We show the feasibility of our method by performing test predictions on two proteins, 1bdd and 1e0l, that belong to distinct structural classes.

F-06 **Spiral Wave Front Model in Excitable Media with Non-monotonic Dispersion Effects** 권 오규, 김 태윤, 이 경진 (*Center for Cell Dynamics, Korea Univ..*) excitable media의 특징 중 하나로 분산 효과가 있다. 파면간 거리에 따른 파면의 고유한 속도가 주어지는 것이 분산 효과이다. 이 분산 효과의 한 가지 형태는 파면간 거리가 늘어남에 따라 파면의 속도가 증가하는 것이다이를 (1) monotonic 분산 효과라 한다. 또 다른 한 가지는 파면간 거리가 늘어남에 따라 파면의 속도가 줄어드는 영역이 존재하는 형태이다. 이것을 (2) non-monotonic 분산 효과라 한다. non-monotonic 분산 효과를 가진 excitable media에서는 파면간 거리가 일정하지 않은 특이한 주기의 나선 문양들이 발생할 수 있다. 이러한 나선 문양들을 파면만을 기술하는 파면 모델을 통해 연구하였다. 주로 파면간 거리가 두 개의 안정된 값 사이에서 조절 되는 주기의 나선파를 연구하였다.

■ SESSION: F [FG2]
4월 17일(목), 14:30 - 16:15
장 소: 206호

F-07(초) **Cooperative Folding Kinetics of BBL Protein and**

Peripheral Subunit-Binding Domain Homologues 장 익수, 유 우경, 정 광훈[1], 천 무경[2], 허 무영[3], 한 규훈[4], 함 시현[5](*부산대학교, 물리학과.* [1]*부산대학교, 물리학과 및 과학기술부.* [2]*부산대학교, 물리학과 및 University of Cambridge, 화학과.* [3]*부산대학교, 물리학과 및 Harvard University, 화학과.* [4]*한국생명공학연구원, 분자암연구센터.* [5]*숙명여자대학교, 화학과.*) Recent experiments claiming that Naf-BBL protein follows a global downhill folding raised an important controversy as to the folding mechanism of fast folding proteins. Under the global downhill folding scenario not only proteins undergo a gradual folding, but also folding events along the continuous folding pathway could be mapped out from the equilibrium denaturation experiment. Based on the exact calculation using a free energy landscape, relaxation eigenmodes from a master equation, and Monte Carlo simulation of an extended Munoz-Eaton model that incorporates multiscale-heterogeneous pairwise-interactions between amino acids, here we show that the very nature of a two-state cooperative transition such as a bimodal distribution from an exact free energy landscape and biphasic relaxation kinetics manifest in the thermodynamics and folding-unfolding kinetics of BBL and peripheral subunit-binding domain (PSBD) homologues. Our results provide an unequivocal resolution to the fundamental controversy related to the global downhill folding scheme, whose applicability to other proteins should be critically reexamined. (Proceeding of The National Academy of Sciences, USA, 105, 2397-2402, 2008)

F

F-08 **Compressed-Exponential Relaxations by Intra-molecular Structure Change in Super Cooled Liquid Trehalose** SEO JEONG-AH, KATAOKA Kunimitsu[1], HYUN-JOUNG KWON, OHSHIMA Ken-ichi[1], HYUNG KOOK KIM, YOON-HWAE HWANG(*Department of Nanomaterials &BK21 Nano Fusion Technology Division, Pusan National University, Miryang 627-706, Korea.* [1]*Graduate School of Pure and Applied Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305 8573, Japan.*) We investigated the α-relaxations in super cooled liquid trehalose by using photon correlation spectroscopy (PCS). The α-relaxations of super cooled liquid trehalose showed an interesting compressed-exponential relaxation (indicating a fast relaxation than exponential) at the temperatures above 140°C and q^{-1} dependence of its relaxation time indicating an ultraslow ballistic motion which leaded from the local structure rearrangements. In the Raman scattering investigation, we found that the slope change of the Raman shifts of the glycosidic bond vibrational modes at the temperatures ranging around 135~140°C. And at the same temperature range, we also found that the glycosidic bond length and angle changes from the structure refinement by using the X-ray diffraction patters of trehalose powder. From those results, we could conclude that the compressed-exponential relaxation in super cooled liquid trehalose was originated from the local structure rearrangement which was leaded from the glycosidic bond structure change in trehalose molecule.

F-09 **Strange Nonchaotic Firing in the Quasiperiodically Forced Neuron** LIM Woochang, KIM Sang-Yoon[1](*아주대학교 의과학연구소.* [1]*강원대학교 물리학과.*) We numerically study the bursting activity (alternating between asilent phase and a bursting phase of repetitive spiking) in arepresentative Hindmarsh-Rose neuron model. In addition to theusual regular and chaotic burstings, a new type of strangenonchaotic (SN) burstings are found to occur in thequasiperiodically forced case. Using a rational approximation tothe quasiperiodic forcing, the mechanism for the appearance ofsuch an SN bursting attractor is investigated. Thus, a smoothtorus (corresponding to a silent state) is found to transform toan SN bursting attractor through a phase-dependent saddle-nodebifurcation when it collides with an unstable smooth torus. TheseSN bursting states, together with chaotic bursting states, arecharacterized in terms of the interburst interval, the burstinglength, and the number of spikes in each burst. Both burstingstates are found to be aperiodic ones. Consequently, aperidoic``complex" burstings may result from two dynamically differentstates with strange geometry (one is a chaotic state and the otherone is a nonchaotic state).

F-10 **Generalized centrality of complex networks** LEE Sungmin, YOOK Soon-Hyung, KIM Yup(*Kyung Hee University.*) Understanding the "centrality" or "influence" of a vertex and an edge plays an important role to study the dynamical systems on networks as well as topological properties of networks. Several centrality measures have been suggested so far. Among those definitions, two of the well known centralities are the shortest-path betweeness centrality (SPBC) and random walk betweeness centrality. In this study we propose a more generalized centrality based on biased random walks, counting how often a vertex or an edge is traversed by a walker. The biased random walk centrality (BRWBC) is reminiscent of multifractal. We analytically and numerically provide a relationship between BRWBC and SPBC, and show that the SPBC is a special limit of BRWBC. As an application we expect that BRWBC can be also applied to study the hierarchy of complex networks.

F-11 **Magnetization distribution on complex networks** KIM Sang-Woo, NOH Jae Dong(*University of Seoul.*) We study the ferromagnetic Ising model on several networks including the Erdös-Rényi random network and the growing network introduced by Callaway et al. While the former lacks structural correlation, the latteris believed to have a long-range structural correlation. Through extensive Monte Carlo simulations, we investigate the critical behaviors in those networks. Based on the numerical results, we find that the Ising model exhibits distinct critical phenomena depending on structure correlation of underlying networks.

■ SESSION: F [FF1]
4월 17일(목), 16:30 - 18:15
장 소: 206호

FF-01 **Information processing at cell level —smart behaviors in anamoeba of Physarum—** NAKAGAKI Toshiyuki,

SAIGUSA Tetsu, TERO Atsushi[1], KOBAYASHI Ryo[2](*Hokkaido University. [1]Presto JST. [2]Hiroshima University.*) Single-celled organisms might be cleverer than previously thought. Anticipating events are higher functions performed by the brains of higher animals; their evolutionary origins and the way they self-organize, however, remain open questions. Here we show that an amoeboid organism can anticipate the timing of periodic events. The plasmodium of the true slime mold *Physarum polycephalum* moves rapidly under favourable conditions, but stops moving when transferred toless-favourable conditions. Plasmodia exposed to unfavourable (low-temperature and low-humidity) conditions, presented in three consecutive pulses at constant intervals, reduced their locomotive speed in response to each episode. When subsequently subjected to favourable conditions, the plasmodia spontaneously reduced their locomotive speed at the time point when the next unfavourable episode would have occurred. This implied anticipation of impending environmental change. After this behaviour had been evoked several times, the locomotion of the plasmodia returned to normal. However, the anticipatory response could subsequently be induced by a single unfavourable pulse, implying recall of the memorized periodicity. We explored the mechanisms underlying these behaviours from a dynamical systems perspective. Our results hint at the cellular origins of primitive intelligence and imply that simple dynamics might be sufficient to explain its emergence.

References: 1. Tetsu Saigusa, Atsushi Tero, Toshiyuki Nakagaki and Kuramoto Yoshiki : "Aomoebae anticipate periodic events", Physical Review Letters, Vol.100, 018101 (2008) 2. Toshiyuki Nakagaki, Makoto Iima, Tetsuo Ueda, Yasumasa Nishiura, Tetsu Saigusa, Atsushi Tero, Ryo Kobayashi and Kenneth Showalter : "Minimum-risk path finding by an adaptive amoebal network", Physical Review Letters, Vol. 99, 068104 (2007) 3. Toshiyuki Nakagaki &Robert Guy: "Intelligent behaviors of amoeboid movement based on complex dynamicsof soft matter", Soft Matter, Vol. 4, 57-67 (2008)

FF-02 **Single-Vesicle Analysis Reveals Fusion Step-Specific Switching of Complexin Function in SNARE-Mediated Membrane Fusion** YOON Tae-Young, HA Taekjip[1], SHIN Yeon-Kyun[2](*KAIST, Department of Physics. [1]Howard Hughes Medical Institute, University of Illinois at Urbana-Champaign. [2]Iowa State University.*) Ca^{2+}-triggered fusion of synaptic vesicles that underlies inter-neuron communication is mediated by the core fusion machinery, the SNARE complex. Complexin is a major binding partner of the neuronal SNARE complex and has been considered an important fusion regulator. The physiological data on complexin, however, have been at odds with each other, making delineation of its molecular functions difficult. Using the in vitro single fusion assay, we show that high micromolar complexin reduces vesicle docking through a weak interaction with t-SNAREs. Once SNARE complexes are formed, however, this inhibition is switched to stimulation. Complexin promotes membrane fusion by directly interacting with the *trans* SNARE complex, which was hidden in ensemble measurements. Strikingly, complexin further accelerates fusion by two orders of magnitude upon introduction of Ca^{2+}, under a physiologically-relevant lipid composition containing cholesterol. Our approach of dissecting docking and fusion kinetics at the single fusion level provides a unique avenue for studying the function of membrane fusion regulators.

FF-03 **The Pinocchio and reverse Pinocchio effect in the interlocked positive feedback loops** 한 승기, NGUYEN CUONG (*충북대학교, 물리학과*) The positive feedback loops (PFLs) are ubiquitous basic elements in the regulatory biological complex networks. They are responsible for bistability, creating discontinuous output response from continuous input, and are regarded as reliable toggle switches for the all-or-none decision. The PFLs are hooked up together in biological complex networks rather than working alone. In this study, the PFLs are classified into two types, the self-enhancing and self-recovering PFLs, based on their dynamical functions. By interlocking two PFLs, we show how they interact and affect to each other, emerging the Pinocchio and reverse Pinocchio effects. We show that interlocking of PFLs makes a more reliable switch with flexible controllability. Then, a simple model of the cell cycle check point is proposed to illustrate how the cell cycle checkpoint controls the phase transition in response to the urgent signal such as DNA damage or DNA unreplication.

FF-04 **Atomic Susceptometer for Magnetically Labeled Immunoassay** 김 기웅(*한국표준과학연구원, 의료계측연구단*) We propose a novel technique for rapid detection and measurement of biomolecules using an optically pumped atomic magnetometer. With the development of genomics and proteonomics, we get to need the rapid and sensitive detection of proteins, viruses, bacteria, pathogens, and etc. Recently, a magnetoreduction assay method using magnetic nanoparticles emerged and showed the potential of replacing ELISA, the most widely spread technique. Magnetoreduction assay measures the density of target biomolecules from a change of the magnetic susceptibility of clustered and enlarged magnetic nanoparticles. The resolution of magnetoreduction assay is mainly restricted by the sensitivity of the magnetometer in the system. In this study, we introduce a design of an ultra high sensitive magnetic susceptometer based on an optically pumped atomic magnetometer to measure the susceptibility change of the magnetic nanoparticle solution containing biotargets. With the adoption of the atomic magnetometer, the expected resolution can be drastically improved; 10-million times better than in a conventional inductive susceptometer. We also introduce several possible applications of the novel system such as Malachite green detection.

■ SESSION: F [FF2]
4월 18일(금), 11:00 - 12:45
장 소: 206호

FF-05 **디엔에이를 이용한 나노입자의 결정화** 박 성용

(*University of Rochester, Department of Biostatistics and Computational Biology.*) 디엔에이와 같은 생체 고분자를 나노입자와 같은 물질에 연결해서 프로그램이 가능한 방식으로 자기조립(self-assembly)하려는 연구는 지난 십여년간 활발히 이루어져 왔지만 이러한 디엔에이와 같은 생체 고분자가 연결된 복합물질이 여러가지 생물학적 정량법(bioassays)이나 약물전달시스템과 같은 나노 기술에 적용된 것과 비교하면 별다른 진전을 보이지 못하고 있었다고 할 수 있다. 이번 연구에서 디엔에이가 연결된 금속 나노입자 시스템의 통계물리적인 특성을 밝혀 이 시스템에서 이러한 자기조립을 방해하는 요인이 디엔에이의 선형구조나 나노입자를 연결하는 여러가닥의 디엔에이의 협동현상 등에 기인하는 느린 동역학 거동이나 복잡한 상그림 등이라는 것을 규명하였다. 이러한 이 시스템에 대한 물리적 이해는 디엔에이를 이용한 나노입자의 프로그램이 가능한 결정화에 성공적으로 적용될 수 있음을 보였다.

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FF-06 **Elasticity of a Cisplatin-DNA Adduct Studied by Magnetic Tweezer** LEE Nam-Kyung, JOHNER Albert[1], PARK Jin-Sung[2], HYUN Ju-Yong[2], LEE Kyung-J[2], HONG Seok-Cheol[2], OBUKHOV Sergei[3](*세종대학교 물리학과.* [1]*Institut Charles Sadron, Strasbourg.* [2]*고려대학교 물리학과.* [3]*University of Florida, Physics.*) Cisplatin is known as an anti-cancer drug for a longtime. It is therapeutically active upon binding to DNA. At large scales abound cisplatin merely bends DNA into a localized kink.We model the elastic properties of cisplatin-DNA adducts at moderatetension below the transition to S-DNA. It is shown thatfrom the mechanical point of view the action of cisplatin can bedescribed by a decrease of the persistence length. Two expressions of the persistence length are derived that apply in the linear responseand strong force regime respectively. Experimental data for DNA-adducts stretched by magnetic tweezers are consistently fitted by these expressions. This allows to estimate the degree of platination at various salt concentrations.

FF-07 **Design and analysis of hybrid microsystems using cardiomyocytes** 박 정열(*서강대학교, 기계공학과.*) Quantitatively analysis of the contractility of cardiomyocytes is important for understanding the mechanism of heart failure as well as the molecular alterations in diseased heart cells. To achieve it, various microfabricated methods have been introduced. However, these technical approaches involve cell manipulations with probes, gluing, and clamping, which may have unknown effects on the cells and their functions or the hard contact between the cell and a bed of needles or pillars may have some effects on cell membranes and myocyte functions. In this study, we developed a microfabricated hybrid biopolymer microcantilever, in which the contractile force of self-organized cardiomyocytes can be measured and studied. This developed cantilever can be used hybrid cell actuator by contriaction force of cardiomyocytes. Using our presented cantilever, the contractility of cardiomyocytes in a 3D environment was quantified and compared with that observed in a 2D environment. By measuring the deflections of the microcantilevers with different surfaces (2D and 3D grooved surfaces) and carrying out finite element modeling (FEM) of the focal pressures of the microcantilevers, it was found that the contractile force of high-density cardiomyocytes on 3D grooved surfaces was 55~70% higher than that of cardiomyocytes on flat surfaces. We also present a crab-like microrobot that can actuate for a long period under a physiological condition using these developed cantilevers.

■ SESSION: K [KG1]
4월 17일(목), 12:30 - 13:20
장 소: 104호

K-01 **LO-포논에 의한 양자점 반도체의 광학적인 특성** 제 구출, 박 승한[1](*배재대학교, 전산전자물리학과.* [1]*연세대학교, 물리학과.*) 양자점 반도체와 같은 구조에서 전하들이 양자적으로 감금되는 현상으로 인해 bulk 반도체와는 다른 광학적인 특성과 수송특성을 갖는다는 것이 널리 알려져 있다. 에너지 상태들의 불연속성은 보통의 bulk에서 일어나는 감쇠(dephasing) 과정을 막게 되는데, (이 현상을 "phonon bottleneck"이라 부른다.) 이 현상은 양자점에서 non-Markovian pure dephasing 과정과 선형적인 광학에서 non-Lorentzian 형태를 갖게 한다. 본 연구에서는 광학적으로 여기된 단일 양자점 반도체 내에서 LO-포논과 상호작용하는 감금된 전하들의 초고속의 동역학을 기술하여, 감쇠 과정이 비선형광학을 포함한 광학적인 특성에 미치는 영향력을 조사할 것이다.

K-02 **도파로를 이용한 양자점의 흡수 스펙트럼 측정** 송 인선, 김 남제, 이 은구, 이 동한, 정 원국[1], 편 수현[1], 장 종원[2](*충남대학교, 물리학과.* [1]*성균관대학교 재료공학과.* [2]*나노 에피*) 본 연구에서는 양자점을 이용하여 제작한semiconductor optical amplifier(SOA)를 이용하여 파장에 따른 흡수 스펙트럼을 측정하였다. 웨이퍼의 표면에 빛을 수직하게 입사시키면 흡수 두께가 작고 양자점의 fill factor가 작아 적은 수의 양자점에만 흡수된다. 이런 경우 주기수가 많은 시료를 가지고 실험한다고 해도 적은 수의 양자점만이 빛을 흡수하기 때문에 흡수 스펙트럼을 얻기 힘들다. 하지만 SOA와 같은 광소자를 이용하여 표면이 아닌 측면에 빛을 입사시키는 방법을 사용한다면 빛이 지나가는 양자점의 개수가 많아져 흡수 스펙트럼의 측정이 가능할 것이다. 실험에서 측정한 시료는 InP 기반의 양자점 SOA이며, 측정하는 동안에는 고유한 흡수 스펙트럼을 얻기 위하여 전류를 인가해주지 않았다. 시료의 길이는 2 mm이고, 3 μm ridge 폭을 가지고 있으며, cleaving 면을 기준으로 하여 7° 틀어진 도파로 구조이고, AR coating을 이용하여 도파로 양단에서의 반사율을 줄였다. 이 시료의 경우 InAs 양자점의 작은 aspect ratio로 인해 편광특성이 크게 나타나기 때문에 PL, EL 그리고 이득스펙트럼을 측정해보면 transverse electric mode(TE) 와 transverse magnetic mode(TM) 에 대해서 다른 결과가 나온다. 전류를 인가해주고 amplified spontaneous emission(ASE)를 측정해본 결과TE와 TM의 ratio가 100배 이상 크게 나왔으며 중심파장은 1560 nm 근처에 있었다. 이 시료를 이용하여 흡수 스펙트럼과 ASE를 비교 분석하여 InP 기판 위에 성장된 InAs 양자점의 광학적 특성을 살펴보고, 이를 바탕으로 SOA 소자의 특성을 분석하였다.

K-03 **Light Emission From Si Nanocrystals In Silicon Dioxide Prepared On Porous Substrate** CHO Hyun-Ji, YOON Jong-Hwan(*강원대학교, 물리학과.*) The discovery of strong light emission from porous silicon stimulated considerable interest in efficient light emission from Si-based materials. One of such materials is silicon nanocrystals embedded in silicon oxide, which also produce strong room-temperature luminescence. In this work we prepared Si nanocrystals embedded silicon dioxide by thermally annealing silicon-rich oxide films deposited on porous silicon layer, and report their light emission characteristics. It is shown that photoluminescence (PL) intensity from Si nanocrystals significantly enhances, increasing with increasing porosity of porous layer. In addition, it is also shown that PL peak shifts to higher energy with increasing porosity. These demonstrate that the formation of Si nanocrystals is affected by substrate structure.

K-04 **Growth of the Carbon Tip with Resist Assisted-Patterning Process** 유 제황, 이 창석, 송 나영, 임 한얼, 정 일옥, 임 준원, 손 병택, S. Manivannan, 장 진, 박 규창(*경희대학교, 정보디스플레이학과. 차세대디스플레이연구센터*) 본 연구에서는 기 연구된 레지스트를 이용한 패터닝(Resist-Assisted Patterning) 법을 이용하여 우수한 구조적 특징과 전자방출 특성을 갖는 탄소팁을 개발하였다. 이는 실리콘 기판 위에 단층막/니켈 형성 후, 플라즈마화학기상증착 (plasma enhanced chemical vapor deposition) 법을 이용한 성장 조건을 변화시켜 구조적으로 안정된 팁을 얻을 수 있었다. 결과적으로 전자주사현미경 (scanning electron emission microscope)을 이용하여 탄소팁의 하부 직경은 마이크로미터의 크기라는 것을 알 수 있었고, 팁의 상부는 나노크기의 매우 뾰족한 형상을 볼 수 있었다. 따라서 지금까지 탄소나노튜브와의 형상과는 전혀 다른 안정된 구조물을 얻을 수 있었다. 이러한 탄소팁의 구조물은 안정된 전자방출 특성과 구조적 안정성으로 장수명의 에미터 소자 적용에 큰 기대가 될 것이다.

■ SESSION: K [KG2]
4월 17일(목), 14:30 - 16:10
장 소: 104호

K-05 **The roughness effects of ZnO buffer layer on ZnO nanorods grown by MOCVD** 곽 창하, 박 순홍[1], 서 수영, 김 선효, 한 상욱[2](*포항공과대학교 신소재공학과.* [1]*포항산업과학연구원.* [2]*전북대학교 과학교육학부.*) Vertically well-aligned ZnO nanorods were fabricated on Al_2O_3 substrates with ZnO homo-buffer layers by using a catalyst-free metal-organic chemical vapor deposition. X-ray diffraction (XRD) measurements demonstrated that ZnO buffer layers slightly enhanced crystal qualities of ZnO nanorods, but there a substantial amount of structural disorders existed in the ZnO nanorods grown on the ZnO buffer layer, compared with the nanorods grown on the GaN interlayer. Field-emission transmission electron microscope (FE-TEM) measurements from the interfaces of the nanorods and substrates also exhibited the structural disorders in the bottom part of the ZnO nanorods grown on the sapphire and the ZnO homo-buffer layer.From Field-emission scanning electron microscope(FE-SEM) and atomic force microscope(AFM) meacurements, as the surface roughness of ZnO buffer layers smaller, The ZnO nanorods vertically better aligned along c-axis. Our observation strongly suggested that the structural strain due to the surface roughness of the ZnO homo-buffer layer contributed to an island growth in the beginning of the ZnO nanorod growth.

K

K-06 **Epitaxial Growth and Electroluminescence of ZnO Nanorod Array/p-GaN via Wet Solution Approach** LEE Sam-Dong, KIM Yoon-Seok[1], CHOI Jae-Young[2], KIM Sang-Woo (*금오공과대학교 신소재시스템공학부.* [1]*교토대학교 전자공학부.* [2]*삼성종합기술원*) Recently, realization of LEDs with heterojunction structures such as n-ZnO on p-type materials has been attempted due to difficulty in fabrication of ZnO-based p-n homojunction LEDs. In general, however, it is very difficult to obtain the stable p-type ZnO with low density of defects at present although considerable efforts have been devoted to produce it by introducing various dopants to high-quality undoped ZnO. Moreover, the ZnO-based p-n heterostructures ever reported have been synthesized by high temperature processes such as chemical vapor deposition, which indicates that they accompany many disadvantages such as processes of high temperature, expensiveness of equipments, energy consuming processes, and extremely limited growth condition. Here, we fabricated p-n heterostructures based on nanosized ZnO nanorods/p-GaN film by a simple aqueous solution method at low temperature (90 °C) and report their electroluminescence (EL) characteristics. In order to vertically well-aligned ZnO nanorods array, ZnO nanoparticles as a starting precursor were formed on the p-GaN thin film. ZnO seed layers on p-GaN substrates were formed by simple dipping process of the substrates into mixture solution of zinc acetate dissolved with de-ionized (DI) water. And then, the samples were pre-annealed for 20 min at 100 °C before main growth. Vertically well-aligned ZnO nanorods on nano-sized ZnO seeds dispersed onto the p-GaN epilayer were grown by the "dipping-and-holding" process that the substrates maintain into the mixture solution consisting of de-ionized water, 25 mM zinc nitrate, and 25 mM hexamethylenetetramine for 4 hour at 90 °C. The LED with this hybrid structure was fabricated by using a conventional photolithography technique. It was found that the ZnO nanorods grown by the solution method have a perfect epitaxy relationship with the GaN thin film used as a growth template in synchrotron x-ray scattering measurements. In addition, we could observe white light broad EL emission as well as near ultraviolet emission in the EL measurements of the ZnO nanorod/p-GaN samples.

K-07 **Probing exciton diffusion in semiconductor nanorods using nanorod quantum structures** 유 진경, 이 규철, DANG Le Si(*포항공과대학교 신소재공학과.*) Exciton transport properties, which are directly related to material qualities, are important areas because the characteristics are related to performances of photonic devices. Because excitons are electrically neutral quasi-particles, optical methods have been usually employed to study excitons in thin films and bulk materials. Although cathodoluminescence (CL) spectroscopy has been employed as a method for studying exciton diffusion due to its high spatial resolution, the spatial resolution of CL can be influenced by the interaction volume within carriers generated through a cascading effect. Semiconductor nanorods can give a solution to cascading effect because the nanorod diameter is smaller than the penetration depth of the highly energetic electron beam. We will present a scheme to study the exciton transport in semiconductors and demonstrate that diffusion length can be directly determined by CL of single nanorods embedding a single quantum well (SQW) on their tips.The exciton diffusion behavior of ZnO/MgZnO nanorod SQW was investigated using low temperature CL measurements at 5 K. After the MgZnO nanorods were grown on Si substrates using catalyst-free metal-organic chemical-vapor deposition (MOCVD), the nanorod SQWs were *in-situ* fabricated on the MgZnO nanorods in the same MOCVD chamber. The nanorod SQWs detached from the substrates were dispersed on a Si substrate. The sample was loaded in the scanning electron microscope chamber equipped with CL setup. Through a series of CL analyses, we estimated exciton diffusion length in MgZnO nanorods.

K-08 **Thermoelectric Power Measurements of One-dimensional Wide Bandgap Semiconducting Nanostructures** LEE Chul-Ho, ZUEV Yuri M.[1], YOO Jinkyoung, HONG Young Joon, KIM Philip[2], YI Gyu-Chul(*National CRI Center for Semiconductor Nanorods and Department of Materials Science and Engineering, Pohang University of Science and Technology (POSTECH).* [1]*Department of Applied Physics and Applied Mathematics, Columbia University.* [2]*Department of Physics, Columbia University.*) Limitations of complementary metal-oxide-semiconductor (CMOS) scaling as well as rapid progress on various fabrication methods of nanomaterials provoked tremendous interest in 1-D semiconducting nanostructures as building blocks for nanoscale electronics, optoelectronics, and electrical sensors. In particular, 1-D wide bandgap semiconductors such as ZnO and GaN have been intensely studied for short wavelength optoelectronics, transparent electronics, and high-temperature electronics. In spite of recent remarkable progress on fabrications of various nanodevices, it has still been the lack of the understanding on electrical and thermal properties of 1-D nanomaterials. Since thermoelectric power (TEP) is a very sensitive quantity to small changes of Fermi energy states, the electrical properties of 1-D nanostructures can be understood by TEP measurements. Nevertheless, *in-situ* TEP measurements of individual wide bandgap semiconducting nanostructures have never been studied presumably because of difficulties in forming good ohmic contacts on wide bandgap semiconductor nanomaterials while those of carbon nanotubes (CNTs), Si nanowires, and semimetallic Bi nanowires have been reported. Here, we report on electrical and *in-situ* TEP measurements of individual 1-D wide bandgap semiconducting nanostructures such as ZnO nanorods and GaN nanowires at various temperatures between 10–300 K. Furthermore, the reasonable extraction of carrier concentrations for both ZnO and GaN nanostructures using the temperature dependence of the TEP will be presented.

K-09 **Novel Synthesis and Chemical Sensor Applications of Tin-Oxide Nanoplates and Nanodisks** LEE Deuk-Hee, KIM Sang-Hyeob[1], MAENG Sunglyul[1], MOON Seung Eon[1], PARK Hyun-Kyu, KIM Sang-Woo(*금오공과대학교 신소재시스템공학부.*

[1]*한국전자통신연구원*) In the past decade, low-dimensional semiconducting oxides nanostructures with well-controlled size and morphology have attracted great attentions owing to their peculiar applications in electronic/optoelectronic devices. Recently, one-dimensional and two-dimensional semiconducting oxides nanomaterials such as ZnO, SnO_2 and In_2O_3 based nanowires, nanorods, nanosheets, and nanowalls have been extensively investigated. Among these nanomaterials, SnO_2 has been regarded as a promising functional material for realization of gas sensors with high sensitivity, solar cells, and n-type transparent conducting electrodes. However, material properties and device applications of SnO have been rare investigated.In this work, SnO nanoplates and nanodisks were synthesized on SiO_2/Si (001) and ITO-coated glass substrates in a thermal evaporation process. SnO nanoplates and nanodisks were synthesized using a pure tin oxide (99.99% SnO) powders via a vapor-solid mechanism at 400-500 °C. FESEM measurements showed that the synthesized nanoplates have rectangular shape with diameters of 1.0 ~ 1.5 μm and thickness of 80 ~ 150 nm. We could confirm that the SnO nanoplates with no planar defects and structural uniformity are of ±(110) and ±(10) preferred growth direction as well as a single-crystalline tetragonal structure via HRTEM and FFT studies. In addition, we were confirmed that the gas sensing properties of SnO nanoplates have much higher sensitivity comparing to other nanostructures such as nanowires and nananorods.

K-10 **CdSe/ZnS 나노결정 양자점의 TiO_2 박막으로의 임베딩과 Light-Emitting Diode 응용** 강 승희, 김 경현[1], 허 철[1], 김 의태(*충남대학교 공과대학 나노공학부*; [1]*한국전자통신연구원 미래기술연구본부*) 최근 용액 상에서 콜로이드 합성법에 의한 CdSe 같은 화합물반도체 나노결정 양자점 제조와 이를 이용한 소자응용연구가 큰 주목을 받으며 활발히 연구되고 있다. 콜로이드 나노결정 양자점은 용액 상에서 제조되어 존재하기 때문에 대부분의 응용연구가 용액 상의 분위기와 적합한 바이오분야나 고분자와 결합한 형태의 소자에 국한되어 왔으며 기존 반도체 공정 및 소자에 적용하기에는 큰 장벽이 있다. 그러나 콜로이드 나노결정을 산화물과 같은 안정한 고체상태 안으로 임베딩시킬 수 있다면 이를 이용하여 light-emitting diode (LED)나 laser, 메모리 소자와 같은 전자 및 광전자소자를 대면적의 실리콘 웨이퍼에서 구현할 수 있는 장점이 있다. 본 연구에서는 콜로이드법으로 제조된 CdSe/ZnS core-shell 구조의 나노결정 양자점을 p-type Si (100) 웨이퍼 위에 분산시킨 후 plasma-enhanced MOCVD를 이용하여 TiO_2 박막 내로 임베딩 시켰다. 증착온도 약 300 °C 이상에서 양자점의 photoluminescence (PL) 효율이 크게 감소되는 것을 볼 수 있었다. 이는 TiO_2 내에서의 상호확산과 CdSe/ZnS 양자점의 크기가 ~5 nm 정도이기 때문에 bulk 상태보다 더 큰 증기압을 가질 수 있기 때문으로 생각된다. 본 발표에서는 임베딩 공정 중의 CdSe/ZnS 양자점 열적 안정성과 임베딩된 양자점을 활용한 ITO/TiO_2/양자점/Si(100) 구조의 LED 소자 특성에 대해 논의하고자 한다.

K-11 **Growth and Characteristics of CdS Thin Films by Chemical Bath Deposition** CHALA Kiran Kumar, NGUYEN Thi Quynh Hoa, 김 의태(*충남대학교 공과대학 나노공학부*) Cadmium sulphide (CdS) has been extensively studied for photoconductor applications such as solar cells because it is one of the most sensitive photoconductors in the visible light regime. Although high-quality CdS can be produced by metalorganic chemical vapor deposition or molecular beam epitaxy, the fabrication cost increases significantly. Chemical bath deposition (CBD) is alternative approach to synthesize high-quality polycrystalline CdS thin films on large-scale wafers including flexible substrates at a low cost. In this study, polycrystalline CdS thin films were successfully deposited on various substrates such as glass and Si by CBD method. CdS thin films were prepared at various concentration ratios of Cd and S (1:5, 1:2 , 1:1 , 1:0.125 , and 2:1) at various temperatures (40 °C, 60 °C, 80 °C, and 100 °C). The thin films prepared by low concentrations of sulfur (S) source and at temperature of 80 °C have shown low sheet resistance values due to the presence of more S vacancies. It was observed that not only the concentration ratio of Cd and S, but also the concentrations of NH_3 and TEA placed an important role to determine the photoconductive characteristics of CdS films. We noticed that the dark sheet resistance and the photo sensitivity (dark/photo sheet resistance) of CdS films were increased with decreasing the ammonia volume. We will further discuss the growth mechanism and characteristics of CdS films by CBD.

K-12 **Vapor-Liquid-Solid 법에 의한 GeSbTe 나노선 성장 및 제어** 박 영수, 강 승희, 정 순원[1], 윤 성민[1], 김 의태(*충남대학교 공과대학 나노공학부*; [1]*한국전자통신연구원 IT 융합 부품연구소*) 최근 GeSbTe (GST) 같은 칼코지나이드(chalcogenide) 화합물의 결정상태와 비결정상태의 큰 저항차이를 이용한 상변화메모리(Phase-Change Random Access Memory: PRAM) 소자가 차세대 메모리소자로 각광을 받으며 많은 연구가 진행되고 있다. 기존 메모리소자를 대체하기 위한 차세대 PRAM은 고집적화를 위한 작은 셀 크기, 작은 소비전력 및 빠른 속도가 필수적이다. 이를 위해 수 십 nm 크기로 GST를 제작하기 위한 연구가 활발히 진행되고 있고, bottom-up 접근방법에 의한 GST 나노선 제조가 가능성 있는 대안으로 관심을 끌고 있다. 극히 최근 vapor-liqui-soild (VLS)법을 이용한 GST 나노선 제조결과 및 상변화특성이 발표되고 있으나 아직도 GST 나노선의 크기, 모양 및 방향성 성장 제어에 관한 연구결과는 미흡하다. 본 발표에서는 먼저 GeTe와 SbTe의 VLS 성장특성이 다름을 논의하고자 한다. 또한 이러한 다른 성장특성의 이해를 통해 GST 나노선의 성장을 제어할 수 있는 방법을 모색하고자 하였다. GeTe와 SbTe는 튜브 노에서 각각 500-650 °C, 450-600 °C 범위에서 기화를 시켜 Ar과 H_2 혼합가스를 사용하여 ~3, 7, 10, 20 nm의 Au가 증착된 Si(100) 웨이퍼 위로 전달되어졌다. 나노선 성장온도는 400-500 °C 사이에서 변화되어졌다. 일반적인 VLS법에 의한 나노선 성장과는 달리 GeTe 나노선의 경우 성장된 나노선의 직경이 초기 형성된 Au ball 크기에 따라 크게 변하지 않는 것을 볼 수 있었다. GeTe 뿐만 아니라 SbTe와 GST 나노선 성장결과에 관해 보다 자세한 논의가 이루어질 것이다.

■ SESSION: K [KG3]
4월 17일(목), 14:30 - 16:10
장 소: 209호

K-13 **GW Calculations For The Defect Levels Of Oxygen-vacancy In HfO_2** CHOI Eun-Ae, CHANG Kee Joo(*KAIST.*) High-k dielectric oxides have attracted much attention due to alternatives for SiO_2 gate oxide in Si-based nanoscale devices. Among high-k materials, HfO_2 has a large band gap and good interfaces with Si, resulting in relatively low leakage currents. However, there are several problems in HfO_2-based devices, such as Fermi level pinning and threshold voltage instability. In HfO_2, oxygen vacancy (Vo) is the most likely intrinsic defect and regarded as a major cause of the flat band voltage shift. Despite many studies, the energy levels of Vo in HfO_2 are not clearly understood because calculations mostly rely on the local-density-functional approximation (LDA), where the band gaps are usually underestimated. Here we perform GW calculations to investigate more accurately the defect properties of Vo in monoclinic HfO_2. Based on our calculations, we discuss the role of the Vo defect on Fermi level pinning and threshold voltage instability.

K-14 **방사광 NEXAFS와 XPS를 이용한 N 도핑된 GeTe 박막의 화학적 상태 분석** 정 민철, 신 현준, 김 기홍[1], 송 세안[1], 정 홍식[2](*포항가속기연구소.* [1]*삼성종기원.* [2]*삼성전자.*) 차세대 비휘발성 메모리 소자로 각광을 받고 있는PRAM(Phase-change Random Access Memory)의 핵심 물질인 구조적 상변화 물질(Chalcogenide materials)은 저온 상에서 비정질에서 준안정화된 결정질로 변화하면서 그 저항값이 10~100 배 정도의 차이를 보이는 흥미로운 물질이다. 최근 이러한 상변화 물질에 도핑을 통하여 상변화 특성 변화를 유도하는 연구가 다양하게 진행되고 있다. 이에 본 연구에서는 가장 기본적인GeTe 상변화 물질에 N을 도핑하여 N 도핑에 따른 상변화 물질상에서N 도핑의 역할에 대하여 방사광을 이용한 NEXAFS와 XPS 실험으로 규명하고자 한다. N 도핑된 GeTe는 표면의 자연산화막을 제거하기 위하여Ne^+ 이온 스퍼터링을 거쳐 NEXAFS와 XPS 실험을 포항방사광가속기연구소 8A1 빔라인에서 수행하였다. NEXAFS에서 우리는 N_2 molecular vibration peak을 관찰하였고, XPS 실험상에서 N은 Te과는 chemical bonding이 형성되지 않고, 오직 Ge하고만 chemical bonding을 하게 됨을 Te 4d와 Ge 3d shallow core-level peak 상에서 확인할 수 있었다. 결국 N 도핑은 GeTe 상에서 불완전하게 박막내에 N_2 분자의 존재와 Ge nitride를 형성함을 확인할 수 있었다. 이를 통하여 N 도핑에 따른 상변화 온도의 증가 및 상변화시의 불완전성에 대하여 논의하고자 한다.

K-15 **Room-Temperature Ferromagnetism of Co-doped $TiO_{2-\delta}$ Nanobelts Synthesized by Metalorganic Chemical Vapor Deposition** NGUYEN Thi Quynh Hoa, 강 승희, 정 명화[1], 김 의태(*충남대학교 공과대학 나노공학부.* [1]*한국기초과학지원연구원 미래융합연구실*) One-dimensional (1-D) diluted magnetic semiconductor (DMS) nanostructures are of intense interest for fundamental research and promising spintronic device applications. Among potential DMS materials, transition metal-doped TiO_2 has been extensively studied as one of the most promising candidates since cobalt (Co)-doped TiO_2 ($Ti_{1-x}Co_xO_2$) was shown to be ferromagnetic with T_C up to 400 K. However, little information is available on the synthesis and characteristics of $Ti_{1-x}Co_xO_2$ 1-D nanostructures. Synthesis methods of $Ti_{1-x}Co_xO_2$ 1-D nanostructures have been limited to template-assistant fabrication and solution-based techniques such as hydrothermal treatment so far. Synthesis of $Ti_{1-x}Co_xO_2$ 1-D nanostructures by chemical vapor deposition (CVD) represents a challenging issue which has not been reported thus far. Another key issue is the origin of the room-temperature ferromagnetism (RTFM) of $Ti_{1-x}Co_xO_2$, whether it is due to an intrinsic or an extrinsic effect (Co clusters). In this study, Co-doped $TiO_{2-\delta}$ nanobelts were self-catalytically grown at 510°C on Si (100) substrates without the use of any metal catalysts by metalorganic CVD. The nanobelts consisted of ~10-20 nm nanocrystallites, which were dominantly rutile structure. The Co-doped $TiO_{2-\delta}$ nanobelts showed ferromagnetic behavior at room temperature. In this presentation, we will further discuss the growth mechanism and the origin of the room-temperature ferromagnetism.

K-16 **양극 산화를 이용한 Ni-Ti-O 박막의 가역적 저항 변화 현상에 대한 XPS 분석** CHOI Joonhyuk, JUNG Kyooho, KIM Yongmin, JUNG Woong, KIM Hyunjeong, IM Hyunsik, KANG Soohyun, KIM Hyungsang[1](*동국대학교 반도체과학과.* [1]*동국대학교 물리학과.*) We present bias-polarity dependent resistive switching characteristics in Ni–Ti Oxide thin films grown by anodizing Ni film on a Ti/SiO2/Si substrate. Very clear resistance switching *I-V* characteristics are observed as shown in Fig. 1. SEM is used to study the structural properties as a function of anodizing time. To understand the mechanism responsible for the bias-polarity dependent resistance switching, depth profiles of X-ray photoelectron spectroscopy (XPS) are measured for different resistance-states, high-resistance *off* and low-resistance *on* states. In the initial state before forming, there are main three bonding state peaks, NiTi, TiO_2, and NiO_x. However, after forming whilst the intensity of bonding state peaks for NiTi and TiO_2 decreases that for NiO_x increases. In the high-resistance *off* (like the initial state) and low resistance *on* (like the state after forming) states show a similar behavior. Thus, broken bonding states of Ni-Ti &Ni-O structures are created producing metallic Ni defects and titanium oxide structures. As a result, metallic Ni defects in the oxide film are believed to play a crucial role in creating the low resistance conduction path. We present a simple model to explain the resistance switching mechanism.

K-17 **Electrical property improvements of high k gate oxide by F plasma treatment** 김 형준, 맹 완주, 손 종역(*포항공과대학교, 신소재공학과.*) Recently, the fluorine treatment has emerged as an effective way to improve the performance of high k gate oxides. So far, the F treatments have been carried out by F implantation and UV exposure. However, the F treatment by plasma has rarely been studied in spite of its simplicity and compatibility

with device fabrication processes. In this study, we have improved the electrical properties of gate oxides by F plasma treatments pre- and post- HfO_2 plasma enhanced atomic layer deposition (PE-ALD). The F depth profile (pre- or post deposition treatment) and treatment time (from 0 to 120 s) were controlled and the effects on the electrical properties were comparatively studied. The best electrical properties in terms of hysteresis, dielectric constant, and interface state density were obtained when the F treatment was performed before oxide deposition for 60s. The dielectric constant increased to 12.7 (untreated HfO_2 : 11.8) and the interface state density of this film decreased to $0.7 \times 10^{11} cm^{-2} eV^{-1}$ (untreated HfO_2 : $1.20 \times 10^{11} cm^{-2} eV^{-1}$). Also, the changes of electronic structures in the film by F treatment were studied by x-ray photoemission, ultraviolet photoemission spectroscopy, and X ray absorption spectroscopy using synchrotron X-ray. The results show that the Si-F bonding generation by F treatment is a main reason for enhanced film properties. Also, the results of synchrotron x-ray analysis show that too much F incorporation induces large gap state and shift of valence band maximum, indicating the incorporation of proper amount of F atoms is required.

K-18 **Studies of Anisotropic Mobility of TMTSF Single Crystal Organic Semiconductor Utilizing Stamp-type Organic Field Effect Transistor** JA-YEON Kim, SANG-MIN Lee, MIRA YUn, INJAE Lee(*Chonbuk National Univeristy, Department of Physics.*) We report the studies of anisotropic mobility of TMTSF single crystal semiconductor utilizing Stamp-type organic FET. The millimeter size of TMTSF single crystal has been synthesized from purified powder source by PVD method. For the fabrication of Organic FET device, a low K dielectric polymer Parylene-C was used as a gate insulator on an elastomeric substrate Polydimethylsiloxane (PDMS). The parylene-C which has exceptional chemical inertness and high dielectric strength was coated with chemical vapor deposition method. A natural press contact was made between a pair of source-drain contact pads made of usual Ti/Au and a semiconducting organic single crystal TMTSF. The top gate stamp-type device helps to minimize stress exerted on the organic single crystal while warranting reversible use of the device. Anisotropic mobility of the thin plate TMTSF single crystal semiconductor has been measured in different angular orientation of the crystal relative to the source-drain electrode. The maximum field effect mobility was obtained as 3.96 cm^2/Vs (Saturation region) and the on-off ratio of the field effect device was 10^{-3}.

K-19 **상온제작한 금속-2중금속산화물-금속 구조의 다이오드 특성에 관한 연구** 최 광남, 박 준우[1], 이 호선[1], 정 관수 (*경희대학교 전자공학과.* [1]*경희대학교 물리학과.*) Oxide diode had been studied as ultra violet photo detectors, ultra violet light emitting diodes, and transparent field effect transistors due to their transparency. These transparent oxide semiconductors (TOS) are suitable for the fabrication of an optoelectronic devices. Recently oxide diode has been developed as a switch element for electronic devices. Silicon based transistor have been the most popularly used switch element. However, silicon based transistor do not conform to high density, three dimensional(3D) stack structures due to their high processing temperatures and the difficulty of growing high quality epitaxial silicon over metals. We have fabricated double oxide layer diode from NiO and ZnO films deposited at room temperature. This diode structure provides a high rectifying ratio of 10^3 at ±3 V. This oxide diode as a switch element was fabricated using a pn-heterojunction diode composed of oxide semiconductors. The electrical properties of this nickel oxide and zinc oxide layer were investigated by Hall Effect measurement and those of the nickel oxide/zinc oxide junction by current-voltage (I-V) measurement. The diode exhibited a clear rectifying I-V characteristic and forward threshold voltage of ~2 V.

K-20 **Double Patterning Mask synthesis with Inverse Lithography: Double Patterning is a realistic technology for 20 nm half pitch formation in Semiconductor Manufacture.** 김 상곤(*한양대학교 응용물리학과*) Dobule pattern technolgy (DPT) is analytically shown more dense patterns then single or double exposures. For the reduction of the DPT complexity, a mask design method, which is the inverse lithography technology (ILT) based on pixels and the lithography model, is described as an integrated computational lithography platform to handle the DPT. The ILT can use the decomposition of design and optical proximity correction for 20 nm half pitch pattern generation. A simple example is performed for its verification.

K

■ SESSION: K [KG4]
4월 17일(목), 16:30 - 17:55
장 소: 104호

K-21 **Analysis of energy levels in InAs/GaAs self-assembled quantum dot system by using C-V and deep level transient spectroscopy** KIM Jin Soak, KIM Eun Kyu, KIM Jun Oh[1], LEE Sang Jun[1], NOH Sam Kyu[1](*Department of Physics and Quantum-Function Spinics Laboratory, Hanyang University, Seoul 133-791, Korea.* [1]*Korea Research Institute of Standards and Science, Deajeon 305-600, Korea.*) Self-assembled quantum dot (QD) systems have been widely investigated their properties and applied to many kinds of optical devices because of their atom-like discrete energy levels. It was known that properties of the energy levels in the QD system are similar to the hydrogen atom by theoretical calculations. However, results of most measurements such as photoluminescence and deep level transient spectroscopy (DLTS) show only few levels. Especially, results of the DLTS show only one signal at many kinds of measurements. In order to find the reason, we measured and analyzed the energy levels in the QD system by using DLTS methods with minutely changing conditions. The InAs/GaAs QD system grown by molecular beam epitaxy method was used in this study. The InAs/GaAs QD system was well developed and their properties were stabilized. To find the exact information for the energy

levels of QDs, DLTS measurements were done with varying the bias voltage and filling pulse width.

K-22 **Polarization Dependence of Edge Micro-Photoluminescence in InAs/InGaAsP Quantum Dots Emitting at 1.5 μm**
박 재규, 이 동한, 장 유동[1], 편 수현[2], 정 원국[2](*충남대학교 물리학과.* [1]*University of Sheffield, Department of Physics and Astronomy.* [2]*성균관대학교 재료공학과.*) InAs/InGaAsP quantum dot(QD)의 carrier lifetime과 degree of polarization(DOP)의 관계를 연구하였다. InAs/InGaAsP QD의 carrier lifetime 측정을 위해 time resolved photoluminescence(PL)를 측정하였고, transverse electric(TE) mode와 transverse magnetic(TM) mode를 연구하기 위해 edge micro PL을 측정하였다. QD의 aspect ratio가 커지면 DOP는 증가하며, 이때 carrier lifetime이 긴 것은 aspect ratio와 wavefunction overlap의 관계에 의해 해석할 수 있었다. 실험에 사용된 시료는 InGaAsP barrier 두께가 40 nm인 7주기 InAs QD(QD1)와 한 주기 InAs QD(QD2)이다. 두 시료의 저온 PL 파장은 약 1400 nm이고, full width at half maximum(FWHM)은 각각 60 meV(QD1), 28 meV(QD2)였다. 각각의 시료의 PL band에서 carrier lifetime은 같았고, 그것은 QD들이 서로 잘 독립되어 있음을 의미한다. 시료의 구조가 거의 같음에도 불구하고carrier lifetime은 1.8 ns(QD1), 3.8 ns(QD2)로 크게 달랐고, DOP는 65% (QD1), 74% (QD2)였다. InAs/InGaAsP system의 경우 conduction band offset이 스트레인이 고려되지 않은 경우 40%로, valence band offset에 비해 작기 때문에 전자의 파동함수가 상당부분barrier로 투과 되어있어서 전자와 홀의 wavefunction overlap이 작은 상태이다. 또한 wavefunction의 overlap은 aspect ratio가 큰 경우 더욱 작아지게 된다. QD1의 경우 DOP가 QD2에 비해 10%정도 작은 값이므로, QD1의 aspect ratio는 QD2에 비해 작아고, wavefunction overlap은 증가하게 된다. 그 결과로 carrier lifetime은 QD1이 QD2에 비해 2배 정도 빨랐다. 이것으로부터 DOP를 통해 aspect ratio에 대한 정보를 얻을 수 있었고, aspect ratio 따른 carrier lifetime의 관계로부터 aspect ratio가 감소함에 따라 wavefunction overlap이 증가함을 알 수 있었다.

K-23 **Cavity Length Dependent Lasing Wavelength of the In(Ga)As/InGaAsP/InP Semiconductor Quantum Dot Laser Diode.** 이 종민, 김 남제, 이 은구, 이 동한, 편 수현[1], 정 원국[1], 장 종원[2](*충남대학교, 물리학과.* [1]*성균관대학교, 재료공학과.* [2]*나노에피.*) InP 기판위에 성장한InAs/InGaAsP 양자점을 이용해 Laser diode(LD)를 만들고 공진기 길이에 따른 발진파장 특성을 측정하였다. 이상적인 양자점의 경우 상태밀도가 델타 함수처럼 불연속적으로 분포되어 있어 공진기 길이를 바꿔주어도 동작파장이 어느 정도까지는 변하지 않고 있다가 기저상태의 이득이 부족할 경우 여기상태의 파장으로 불연속적으로 변한다고 알려져 있다 본 실험에서는 InP 기판위에 성장한 양자점을 이용해LD를 제작하고 공진기 길이가 다른 여러 개의 시료를 준비하였다. Ridge 폭을 고정하였기 때문에 공진기 길이가 짧을수록 mirror 손실계수가 증가하여 LD 동작을 위한 전류밀도가 증가하는 것을 알 수 있었다. 이 때 시료들의 발진 스펙트럼을 공진기 길이에 따라 측정하였고 공진기 길이가 짧아짐에 따라 동작파장이 높은 에너지 상태로 이동하는 것을 알 수 있었다. 또 Hakki-paoli 방법을 이용하여 전류밀도에 따른LD의 이득특성을 분석하였다. 이를 통하여 InP 기판위에 성장된 양자점이 GaAs 기판위에 성장된 양자점과 매우 다른 에너지 레벨 구조를 가지고 있는 것을 확인할 수 있었다. 이를 InAs/InGaAsP 양자점의 물리적인 특성을 이용하여 설명하고, 제작된 양자점 LD의 상온 연속 동작 특성을 설명하였다.

K-24 **Characterization of Quaternary AlGaInN Layers and AlGaInN/(Al)GaInN MQWs Grown by MOCVD** 전 성란, 이 승재, 정 성훈, 이 상헌, 백 종협(*한국광기술원/광반도체팀.*) Nitride-based ultraviolet emitters have been developed by the intense effort due to a number of applications, including white lighting, sterilization and decomposition, biological sensing devices, and high-density optical storage. In order to obtain high-intensity UV emission at shorter wavelength than can be realized by using InGaN/GaN as an active medium, the development of AlGaN or quaternary AlGaInN-based UV emitters is necessary. The use of quaternary AlGaInN layers is considered to be quite effective for the realization of the high-efficiency UV emitters due to In segregation effects, which effects were already obtained In InGaN QW.In this study, to realize high-efficiency UV LED at wavelength of near 380 nm emission, we have been investigated the effect of Indium atoms in the AlGaN thick layers and multiple quantum wells. Also, we have been demonstrated the UVLEDs with AlGaInN/InGaN MQWs. The structural and optical properties of the layers were measured by AFM, XRD, TEM, CL and PL. The adding In atoms are made the surface smoother and disappearing of larger pits on the AlGaInN layer. From the room temperature PL, multiple peaks were showed for the AlGaN/InGaN MQWs, while a single peak was observed in the AlGaInN/InGaN MQWs.

K-25 **Spatially Resolved Photoluminescence of Periodic Deflector Embedded Light Emitting Diode by using Ultraviolet Near-field Scanning Optical Microscopy** 정 현, 차 옥환[1], 김 형구[2], 김 잔디[2], 서 태훈[2], 홍 창희[2], 서 은경[2], 김 종수[3], 변 지수[3], 정 문석[3] (*전북대학교 반도체과학기술학과/광주과학기술원 고등광기술연구소.* [1]*에피밸리(주).* [2]*전북대학교 반도체과학기술학과.* [3]*광주과학기술원 고등광기술연구소*) InGaN LED의 활성층에서 생성된 광자는 GaN와 air사이의 큰 굴절률 차와 전반사 조건에 의해 내부 반사를 반복함으로써 외부로 탈출하는 광자의 수가 현저하게 줄어들어 광 추출 효율을 떨어뜨리게 된다. 이러한 문제점들을 보완하기 위하여 최근까지 많은 연구가 진행되어 왔으며 보다 높은 광 추출 효율을 구현 하기 위하여 시료들에 대한 발광 매커니즘의 분석이 요구되고 있다. 본 연구에서는 활성층에서 생성된 광자가 외부로 탈출하기 용이한 임의의 각을 주기적으로 삽입하여 통상적인 LED보다 높은 광 추출 효율을 나타내는 periodic deflector embedded light emitting diode (PDE-LED)의 공간분포 광 발광(photoluminescence) 특성을 분석하기 위하여 100nm 이하의 공간분해능으로 topographical information 과 optical information을 동시에 얻을 수 있 near-field scanning optical microscope(NSOM)을 사용하였다. 주기적으로 존재하는 패턴의 내부와 패턴 내부의 경사진 면, 그리고 c-plane의 flat한 부분에서 각각 다른 peak의 spectrum을 관찰 할 수 있었으며 구조적 특성과 관련 지어 발광 매커니즘을 설명하였다.

K-26 **UV and Blue Emission from n-GaN NW/p-GaN**

Light-Emitting Diodes based on Dielectrophoresis Assembly method KIM Tae-Hong, LEE Seung-Yong, JANG Chan-Oh, LEE Sang-Kwon(*Department of Semiconductor Science and Technology, SPRC, Chonbuk National University.*) We report on the current-voltage characteristics and electroluminescence (EL) of UV-blue nanowire light emitting diodes (LEDs) composed of gallium nitride nanowires (GaN NWs) on p-GaN substrate. The parasitic series resistance was 120-180 kΩ with a sharp turn-on forward voltage of 3.4-4.0 V and had as low as ~ 7×10^{-7} A of leakage current for a reverse bias of -10 V. From EL spectra, dominant emission peaks were observed at 388-422 nm for an applied forward bias. The EL of GaN nanowire LED could be observed with the naked eye. We concluded that the high-brightness EL spectra resulted from the enhancement of the carrier injection due to the size effect of the n-GaN nanowires on the p-GaN substrate.

K-27 **Electrical Characteristics of GaN Nano-Schottky Diodes** LEE Sang-Kwon, LEE Seung-Yong, JANG Chan-Oh, HYUNG Jung-Hwan, KIM Tae-Hong, SEONG Han-Kyu[1], CHOI Heon-Jin[1](*Chonbuk National University.* [1]*Yonsei University.*) We investigated nano-Schottky diodes of several Schottky contact metals (Cr, Ti, Al and Au) having different metal work functions to unintentionally doped GaN nanowires using current-voltage characteristics. The current-voltage characteristics of metal/GaN nano-Schottky diodes exhibited a clear rectifying behavior. In addition, we found the abnormal behaviors of Schottky barrier heights (SBHs) and ideality factors in the metal/GaN nano-Schottky diodes. Our results indicated that the metal/GaN nano-Schottky diodes had a large departure of their ideality factors from unity as well as had a much lower SBH than that for thin-film based metal/GaN Schottky diodes. These abnormal behaviors can be explained by an enhancement of the tunneling current effects owing to both high concentration of the GaN nanowires and the size-effect of the metal/GaN nano-Schottky diodes.

■ SESSION: K [KT1]
4월 17일(목), 18:30 - 20:10
장 소: 104호

KT-01 **광반도체 LED 공정 및 소자** 곽 준섭(*국립순천대학교 신소재응용공학부*) 광 반도체 LED(light emitting diode)는 무수은 친환경 광원, 저전압 구동, 에너지 절감, 색순도 및 선명한 영상, Slim화, 장수명, 신뢰성, 소재 단순화 등 인간친화형 조명의 광원으로서, 2010년에는 13조원의 시장이 형성되고2020년에는 일반조명의 50%를 광반도체 조명이 대체하여100조원의 시장이 창출될 것으로 예측된다. 광반도체 LED 공정은 1990년대 말까지 n형 전극과 p형 전극이 모두 LED 소자 표면에 형성되는'top emitting LED' 공정이 양산에 주로 사용되었으나, 2000년대에 들어와서 고출력 LED에 대한 연구가 진행되면서'flip chip LED' 공정이 개발되었고 최근에는 flip 공정의 단점을 극복하기 위하여 'vertical LED' 공정이 개발 진행 중이다. 본 세미나에서는 위 세가지 광반도체 LED 공정에 대하여 소개하고 최근 공정 개발 동향과 이슈에 대하여 설명하며, 향후 광반도체 LED 공정의 발전방향에 대하여 논의한다.

KT-02 **GaN계 화합물 반도체의 최근 기술 동향과 GaN 기반의 고속 고주파 소자** 이 정희(*School of Electrical Engineering &Computer Science, Kyungpook National University, Republic of Korea.*) 광대역 유/무선 통신시스템의 수요증가와 고성능화의 요구에 힘입어 고속/고주파/고출력 소자 개발에 대한 연구는 기존Si 기반에서 GaAs/InP를 거쳐 GaN계 화합물 반도체로 이어지고 있다. 지난 10여 년 동안 비약적인 발전을 거듭하고 있는 GaN 전자소자의 경우 특히 사파이어 기판상에 AlGaN/GaN 이종접합을 기본으로 한 HFET 는 최근 40GHz 대역에서 Pout=10W/mm의 결과를 보여 차세대 rf 전력 증폭기로써 가능성을 한층 높이고 있고 기술개발의 속도가 빨라서 이미 WiMAX/WiBro 등 무선통신용 소자로써의 위치를 확고히 하고 있는 실정이다. 본 세미나에서는 AlGaN/GaN 이종접합을 기본으로 한 GaN 계 전자소자의 이론 및 mmWave 용 소자로써 가능성 그리고power switch 응용을 위한 E-mode HEMT 등 최근 기술동향과 제작기술 및 응용분야에 대해서 알아보고 국내외 GaN 전자소자 기술의 개발수준을 가늠해 본다.

■ SESSION: K [KF1]
4월 18일(금), 09:00 - 10:40
장 소: 104호

KF-01 **Effect of thermal annealing on the carrier transport and efficiency of organic solar cells** LEE Chang Hee, NOH Seung Uk, KIM Ji Young(*School of Electrical Engineering and Computer Science, Seoul National University, Seoul 151-744, Korea.*) Organic solar cells have many benefits due to ease of fabrication, low-cost production of large-area devices, compatibility with flexible substrates, and semi-transparency compared to inorganic solar cells. However, there are many technical issues such as low efficiency and poor stability for practical applications. Especially, low carrier mobility of amorphous organic thin films is responsible for small short-circuit current (Isc). In addition, the space-charge effect in such materials reduces the open-circuit voltage (Voc). In order to overcome such problems large efforts are focused on increasing the carrier mobility. Thermal annealing after the device fabricationhas been widely used to improve device performances of organic solar cells. In order to understand the effect of thermal annealing on the carrier mobility and the cell performances, we studied the temperature dependence of the photovoltaic properties and carrier mobility in organic solar cells based on P3HT:PCBM (1:1, weight %) blends and copper phthalocyanine (CuPc)/fullerene (C60) heterojunctions. We also measured the effect of thermal annealing on optical absorption spectra and X-ray diffraction patterns. These results indicate that the thermal annealing improves the morphological order and thereby increases the carrier mobility and Jsc.
Acknowledgement: We acknowledge the funding from the

Ministry of Commerce, Industry and Energy (MOCIE), Korea (M1-0213-27-0002-03-B15-27-002-12).

KF-02 **III-V 고효율 화합물 반도체 태양전지 기술개발 동향** 김 성일(*나노과학연구부, KIST.*) 현재 급격한 유가 상승 및 온실효과에 의한 지구 온난화 문제를 해결하기 위해 재생에너지, 그 중에서도 특히 태양에너지 분야에 관심이 집중되고 있다. 태양에너지 사업 분야의 시장은 2006년 150억 달러, 2010년 433억 달러로 추정된다. 최근 태양에너지 발전 시장 규모의 급속한 확장으로 실리콘 원자재 가격이 급등하고 있다. III-V 화합물 태양전지는 직접 천이형 밴드갭을 가지고 있으므로 간접 천이형 밴드갭을 갖는 Si 태양전지에 비해 광 흡수율이 높다. 따라서 태양전지의 두께가 얇아도 입사되는 대부분의 광을 흡수하는 장점을 가지고 있다. 또한 에피층 성장기술의 발달로 다중접합(Multi-junction) 구조의 성장이 가능하며, 이 경우 태양스펙트럼의 이용 효율이 증대 되고, 그 결과 초고효율 태양전지 제작이 가능하다. 또한 III-V 화합물 반도체는 고온 특성이 우수하여 온도 안정성 및 신뢰성이 우수하고 또한 집광 시 효율이 상승하는 특성이 있어 고배율 집광형 태양광 발전 시스템에 가장 적합하다. 따라서 최근들어서 III-V 화합물 반도체 태양전지에 대한 관심이 고조되고 있다. III-V 화합물 반도체 태양전지는 높은 광전 변환 효율에도 불구하고, 원재료비가 비싸고, 고진공 고가 장비인 MBE, MOCVD 를 사용하므로 제조단가가 높아서 인공 위성용 태양전지 이외에는 그 사용이 제한되어 왔다. 그러나 최근 40% 이상의 높은 광전 변환 효율을 갖는 고효율 III-V 화합물 반도체 태양전지가 개발되고, 500 배 이상의 고배율 집광장치를 사용하여 태양전지 모듈의 가격 비중이 많이 낮아져서 시장에서 Si 시스템과 경쟁할 수 있는 수준이 되었다. III-V 화합물 반도체 다중접합 태양전지의 경우 적당한 재료 및 밴드갭을 잘 선택하여 다중접합 구조를 잘 설계하면 태양에너지 스펙트럼의 넓은 영역을 다 이용할 수 있으므로 효율이 50% 이상의 고효율 태양전지도 제작이 가능할 것으로 예상된다. 전세계적으로 연구동향을 살펴보자면, 미국 보잉사 소속의 Spectrolab, Emcore, NREL, 독일의 Fraunhofer ISE, 일본의 Sharp, Toyota 공대 등에서 좋은 연구결과들을 많이 발표하고 있다. 주요 연구 프로젝트로는, 미국의 DARPA에서는 530 억원의 연구비를 투입하여 2005년 11월 부터 초고효율 태양전지 모듈 개발 중이고, 유럽에서는 Fullspectrum 프로젝트를 통하여 유럽의 여러 연구소, 대학 및 회사 등이 서로 연합하여 활발하게 연구 중이고, 일본에서는 NEDO 등의 프로젝트를 통하여 고효율 태양전지를 개발하려는 노력들이 그 동안 지속적으로 진행되어 왔다. 국내에서는 KIST와 ETRI 등에서 주로 많은 연구가 진행되어 왔고, KANC와 광기술원에서도 고효율 태양전지를 개발하기 위한 많은 연구가 현재 진행 중이다. 본 발표에서는 III-V 화합물 반도체 태양전지의 전반적인 연구 발전 동향 및 이와 관련된 여러가지 기술적인 문제들에 대하여 논의하고자 한다.

KF-03 **Current Status of Cu(In,Ga)Se2-Based Thin Film Solar Cells** YOON Kyung Hoon(*나노과학연구부, KIST.*) CuInGaSe2(CIGS)-based compound semiconductors have emerged as very promising materials for high efficiency and low cost thin film solar cells, due to its high optical absorption, optimum band gaps and tolerance to deviations from stoichiometry. World record cell efficiency of 19.9% has been obtained and large area module efficiencies over 13% have been achieved with excellent stability in the field. Furthermore, CIGS solar cells have proven to have high-energy radiation resistance that is very important property for lightweight space solar cells. Several companies and research groups in the world have been developing low cost fabrication processes for mass production and high efficiency techniques using tandem structure. This presentation will review the status of CIGS-based thin film solar cells in the world as well as in Korea. The KIER (Korea Institute of Energy Research) has been studying CIGS absorber layer using physical and chemical deposition processes. From glass/Mo/CuInGaSe2/CdS/i-ZnO/n-ZnO/Al device structure using typical three-stage elements co-evaporation process we can now obtain a reproducible conversion efficiency of about 17 % (active area) from a device size less than 1 cm2. With the objective of developing cheap and simple fabrication process, we have been tly studying the synthesis of CIGS nanoparticles and the formation of thin layers using spray or doctor-blade technique.

KF-04 **III-V 집광형 솔라셀의 경제성 검토** 김 택(*삼성종합기술원.*) III-V 화합물 반도체로 제작되는 Multiple junction solar cell은 thermalization loss 를 최소화 하여 높은 광전 변환효율을 확보할 수 있으나 셀가격이 비싸 지금까지는 주로 인공위성등 한정된 용도로 사용되어 왔다. 그러나 최근 셀 효율이 40%를 상회함에 따라 가격이 저렴한 집광렌즈로 모듈가격을 레버리지 하는 개념이 점차 설득력을 얻고 있다. 본 발표에서는 집광형 솔라셀 모듈 및 시스템 가격을 분석하고 응용별, 지역별 시장 경쟁력을 예측한다.

포스터발표논문 초록

■ SESSION: P1
4월 17일(목), 14:30 - 16:15
장 소: 109호

Dp-001 **Investigation of Structural Units in K2O-B2O3-V2O5 Glass System.** 차 유정, 김 영훈, 강 재필, 홍 성덕, 서 용문, 송 승기, 김 선하[1], 한 옥희[1](*명지대학교. [1]한국기초과학지원연구원.*) In the previous work [1], we observed vanadyl ion using EPR technique in K2O-B2O3-V2O5 glasses, which showed that V4+ions exsist as VO2+ions in octahedral coordination with tetragonal symmetry. Following the EPR analysis, we have been investigated the structure of boron- oxide and vanadium environment using 11BNMR as a function of composition. Equations which predict the behavior of N4 as a function of K (K= K2Omole%/B203mole%) and R (R = V2O5mole%/B2O3mole%). It is found that V2O5 as well as B2O3 participate in glass network and boron atoms fit into the vanadate chains in substitution positions forming V-O-B bridges, K+ion is situated between the vanadate chains.
[1] Bulletin of the KPS, October (2005).

Dp-002 **Influence of the Ligand Deficient Octahedra on the lattice dynamics near the structural phase transition temperature in the nonisomorphic crystal systems, K2SnCl6:Fe3+/Cu2+** 김 영훈, 염 태호[1], 서 용문, 최 덕, 송 승기(*명지대학교. [1]청주대학교.*) In the nonisomorphic impurity doped crystal systems K2SnCl6:Fe3+/Cu2+,unusual behaviour of the critical dynamics has been observed in theCl-NQR studies. Their overall features are strongly nonlinear, i.e. point to two time scale fluctuation of the local field[1,2]. They have been attuributed to the formation of Ligand Deficient Otahedra (LDO), octahedral defect complexes, each of which possesses a hole via the charge compensation. In this study we discuss the role of LDO in the critical lattice dynamics in conjunction with the thermally activated hindered rotation of SnCl6 octahedra that triggers the phase transition in this family of crystals. Recent results of the electron paramagnetic resonance measurements of the paramagnetic impurity ions Fe3+ and Cu2+ in these crystals showed clearly the existence of LDO from the rotation angle independence of their spectra. This substantiates our present point of view.

Dp-003 **Current-Induced Magnetic Domain Wall Motion in a Nanowire with Perpendicular Magnetic Anisotropy** 정 순욱, 김 우진[1], 이 택동[1], 이 경진[2], 이 현우(*POSTECH. [1]KAIST. [2]고려대.*) Spin-polarized electric currents in ferromagnets can transfer their spin angular momentum to local magnetizations. The resultant spin transfer torque promises control of magnetization configurations in nanoscales and allows new types of magnetoelectric devices. In a ferromagnetic nanowire, a representative candidate system for spin transfer torque applications, its effect yet remains negligibly weak unless an excessively large current is applied. Here we show theoretically that the perpendicular magnetic anisotropy in a nanowire can enhance its effect drastically. We found that the anisotropy removes an energy barrier that the spin transfer torque has to overcome and fast magnetic domain wall motion can be achieved at orders of magnitude smaller current densities, provided the width and thickness of a nanowire are properly tuned. This scheme works at room temperatures and can be implemented with existing nanofabrication technologies. Our result makes nanoscale magnetoelectronic devices based on current-induced domain-wall motion promising candidates of post-silicon electronics.

Dp-004 **Investigation of proton irradiation effect on O – O bond distance in KH_2PO_4 using ^1H chemical shift and neutron diffraction** LEE Cheol Eui, KWEON Jin Jung, OH In Hwan[1], LEE Kyu Won[1](*Korea University, Department of Physcis. [1]Korea University, Department of Physics.*) Proton irradiation effect on O – O bond distance in KH_2PO_4 is studied using ^1H isotropic chemical shift and neutron diffraction methods. We have compared experimental results of Magic Angle Spinning (MAS) ^1H NMR on KH_2PO_4 powder sample before and after proton irradiation with the neutron diffraction experiment on unirradiated KH_2PO_4 single crystal. Before irradiation, the increase in chemical shift is observed with decreasing temperature corresponding to the neutron experimental results. After proton irradiation, ^1H isotropic chemical shift is changed from 14.538ppm to 14.605ppm at 300K. The increase in the chemical shift indicates the decrease of the distance between the two oxygen atoms. Futher invesitgation by conductivity, TEM and neutron diffraction is planned.

Dp-005 **GaAs/Fe/Au 구조에서의 Brillouin light scattering을 이용한 Fe층의 자기 이방성 측정** 하 승석, 유 천열, 이 석목, OHTA Kenta[1], NOZAKI Takayuk[1], SUZUKI Yoshishige[1], VAN ROY W.[2](*인하대학교 물리학과. [1]Graduate School of Engineering Science, Osaka University, Japan. [2]IMEC, Kapeldreef 75, B-3001 Leuven, Belgium.*) 반도체-강자성체 접합 구조는 자기박막 구조에 대한 자성 특성에 대한 흥미로운 연구 대상이며,스핀주입을 이용한 산업적 응용 면으로 가치가 매우 큰 이종 접합 구조이다. 그 중 GaAs/Fe 구조는 두 물질의 lattice mismatch가 1.4% 정도로 작기 때문에 결정 상태가 매우 좋은Fe 층을 성장 시킬 수 있으므로 이종접합 구조로써 많은 연구가 진행되어 왔다. 본 연구에서는 (4×6) GaAs(001) 표면에 Fe 층을 쐐기 모양(0~3.4 nm)으로 성장시키고 Au 층을 5 nm 두께로 성장시킨 시료를 Brillouin light scattering(BLS) 측정 방법을 이용하여 자기 이방성에 대해 조사하였다. BLS 측정방법은 열적으로 들뜬 스핀 파의 수GHz영역대인 주파수를 측정함으로써 많은 종류의 자기적 성질을 비 접촉방식으로 측정할 수 있는 광학적 측정방법이다. Fe 층의 각각의 두께에 대해서 easy axis와 hard axis 방향으로 외부자기장 의존도를 측정했으며, laser의 입사각 의존도, in-plane각도 의존도를 조사함으로써 Fe 층의 자기 이방성은 기판인 GaAs와 Au 층에 영향을 받아 Fe 층의 두께에 따라 다른 자기 이방성을 보인다는 것을 알아내었다.

Dp-006 **Magnetization and Magnetic Engropy Change in Superparamagnetic Nanoparticles with Spinel Structure** CHOI Eun Jung, SONG Chang Been[1], CHO Jun Hee, AHN Ynagkyu, KO Sang Gil(*Konyang University. [1]Kongju University.*) The synthesis

of spinel zinc-ferrite nanoparticles was carried out with the aid of ultrasound radiation. The sample was found to be have a cubic spinel structure with a lattice constant a_0= 8.450 Å. The average size of particles was 13.4 nm. The Curie temperature was about 140 K. The magnetization measured at 10 and 300 K in the field of 20 kOe is 31.3 and 6.6 emu/g, respectively. The maximum value of in the field of 20 kOe is found to be about 0.20 J/kg·K. The maximum value of increases as the applied field increases.

Dp-007 **저온플라스마 ZrO_2 박막** 백 경철, 최 준, 이 봉주 (*조선대학교, 물리학과.*) 반도체 공정에서 유전물질(dielectric material)로 이용되고 있는 SiO_2는 유전 상수(k)가 작기 때문에 메모리 용량이 기가(giga)급인 소자에서 그 두께가 5nm 이하로 얇아지게 되었으나, 전자 터널링(electron tunneling) 현상에 기인한 누설전류(leakage current)에 의해 적용상에서 한계에 도달하여, 기존의 SiO_2(k=3.9~5.0)를 대체할 재료로 Al_2O_3(k=8~10), ZrO_2(k=25) 및 HfO_2(k=30)등이 연구되고 있다. 이 들은 유전상수가 SiO_2 보다 크기 때문에 보다 두꺼운 상태에서 적정 유전 특성을 가질 수 있다. 그렇지만 Si 기판과 전극(electrode)과의 열적 안정성이 확보되어야 할 뿐만 아니라, 적정 에너지 밴드 갭(energy band gap) 및 결함이 없는 미세구조를 가지고 있어야 우수한 누설 전류 특성이 유지되어야 하며 또한 공정상의 적합성, 오염 등의 많은 문제가 해결되어야 SiO_2를 대처할 수 있으므로 증착 공정 개발에서부터 물질 평가에 이르기 까지 많은 연구가 이루어지고 있다. 또한 ZrO_2는 높은 용융점, 굴절율, 경도값을 가지고 있으며 낮은 열용량과 우수한 내식성을 갖고 있어 과학기술 분야에서 많은 주목을 받고 있으며, 광학 코팅제를 비롯하여 큰 크기의 집적회로에서의 유전체층,높은 큐리온도(curie temperature)에서 산화물 초전도체의 버퍼층, 평판 디스플레이에서 활성층의 용도로 각광받고 있으며, 티타늄보다 강도가 2~3배 강하고 탄성 및 내식성 등이 뛰어나 향후 플라스틱을 대체할 것으로 기대되는 첨단 신소재이기도 한다. 이미 골프클럽의 소재로 상용화 된 바 있으며, 이동전화, 개인 휴대 단말기의 케이스 등 전자기기뿐만 아니라 의료용 기기, 자동차, 방위 산업 등에 폭넓게 응용되며 건물 벽면, 유리, 거울, 타일 등에 쉽게 코팅할 수 있는 광촉매로의 역할도 하고 있다. Al_2O_3, HfO_2, 더불어 ZrO_2는 높은 온도에서도 실리콘과 열 안정성이 우수하며 이중 ZrO_2는 비교적 높은 유전상수를 비롯하여 넓은 에너지 밴드 갭(energy band gap), 실리콘과의 접촉시에 높은 열적 안정성과 더불어 Si 기판에 증착 되었을 때 상당히 높은 장벽 높이를 가지고 있기 때문에 장래성이 있는 금속-산화물 박막을 형성할 수 있다. 본 연구에서는 저온플라스마에 의한 ZrO_2 박막을 형성하는데, 여러 조건에 의한 변화를 연구하기 위하여 X-ray diffraction(XRD), ellipsometry등을 이용하여 증착율을 비교 분석하였고, SEM과 AFM을 통한 표면의 모포러지 변화를 관찰하였다.

Dp-008 **Ni 나노 자성점의 자화 연구** KIM YongSeok, SEO Youngsoo, SEO Yongho(*Sejong University, nanotechnology and advanced material engineering.*) 유기물 박막의 자기조립 (self-assembly) 특성을 이용한 패턴 제작 방법을 이용하여 수 십 나노미터 크기의 니켈 나노 자성점을 제작하였고, magnetic force microscopy(MFM)를 이용하여 나노 자성점의 자성을 연구하였다. 여기서 우리는 자성체의 자화 이미지를 측정하면서 동시에 외부자기장을 가하면서 자성체의 자기 모멘트 변화를 관찰하였다 결론적으로 이 연구에서는 외부자기장을 가하지 않은 상태에서는 스핀 방향이 수직형상이 나타났으면, 외부자기장을 각각 25, 50, 75 Gauss 씩 가했을때 자기 모멘트 스핀방향이 수평으로 회전하는 변화를 알게 되었다. 한편 자기장에 따른 MFM 이미지의 변화로 부터 니켈 자성점의 크기에 따른 보자력의 변화를 측정할 수 있었다. 본 연구를 통해, 수 십 나노미터 크기의 자성체 소자의 자기모멘트를 연구함으로써 하드디스크, 비휘발성 메모리 소자 개발에 기초 연구로 활용될 것으로 기대된다.

Dp-009 **3-D magnetic free energy mapping in (Ga,Mn)As ferromagnetic semiconductors** SON Hyunji, CHUNG Sun-jae, YEA Sun-young, LEE Hakjoon, LEE Sanghoon, LIU X.[1], FURDYNA J.K.[1](*Physics Department, Korea University, Seoul Korea.* [1]*Department of Physics, University of Notre Dame, Notre Dame In, USA.*) The magnetic anisotropy of (Ga,Mn)As ferromagnetic films with different hole concentration has been investigated by Hall measurements. The various hole concentration of GaMnAs films were obtained by chemical etching, which thinned the film thickness. The systematic change of magnetic easy axes from in-plane to out-of-plane was observed as the hole concentration in the film is decreased. Since the magnetic easy axis is determined by the minimum position of magnetic free energy density of (Ga,Mn)As, it is important to know the magnetic anisotropies constructing the free energy of the system. We have obtained both in-plane and out-of-plane magnetic anisotropy constants by measuring the angular dependence of planar Hall resistance and anomalous Hall resistance [1]. The three-dimensional (3-D) magnetic free energy diagram was constructed by substituting anisotropy constants into free energy equation given by Liu *et al.* [2]. The 3-D magnetic free energy diagram of given system clearly demonstrates that the transition of easy axis from in-plane to out-of-plane can occur with application of external magnetic field along vertical direction to the film. [1] Hyunji Son, Sun-jae Chung, Sun-young Yea, Sanghoon Lee, X. Liu, and J. K. Furdyna, J. Appl. Phys. 103, 07F313 (2008). [2] X. Liu, W. L. Lim, L. V. Titova, M. Dobrowolska, J. K. Furdyna, M. Kutrowski, and T. Wojtowicz, J. Appl. Phys. 98, 063904 (2005).

Dp-010 **Magnetic domain pinning energy distribution in GaMnAs ferromagnetic films** KIM Jungtaek, SHIN D. Y., YOO Taehee, LEE Sanghoon, LIU X.[1], FURDYNA J. K.[1](*Physics Department, Korea University, Seoul 136-701, Korea.* [1]*Physics Department, University of Notre Dame, Notre Dame, Indiana 46556, USA.*) The domain pinning energy distribution of ferromagnetic GaMnAs films have been investigated by PHE measurements as a function of applied field orientation. While a narrow pinning energy distribution was obtained for as-grown GaMnAs, annealed GaMnAs film exhibited a broad range of pinning energies. Such pinning energy distribution was interpreted in terms of fluctuations of magnetic anisotropy over the area of the film. All domains comprising as-grown GaMnAs have similar magnetic anisotropy (predominantly cubic), so that the sample as a whole behaves like a uniform magnetic

phase as suggested in Ref. [1] However, domains in GaMnAs have a broad range of pinning fields (including a non-zero probability of *negative* pinning field), thus indicating areas with various degrees of uniaxial anisotropy. The broad pinning field distribution observed in the annealed GaMnAs sample thus agrees with the mixed magnetic phase model proposed in Ref. [2]. The present study therefore demonstrates that the magnetic nature of GaMnAs films can be represented both by a single phase and by a mixed phase model, depending on the degree of magnetic anisotropy variation associated with the degree of spatial magnetic fluctuations within the GaMnAs film. [1] K. Hamaya, T. Taiyama, Y. Kitamoto, T. Fujii, and Y. Yamazaki, Phys. Rev. Lett., 94, 147203 (2005) [2] K. Y. Wang, M. Sawicki, K. W. Edmonds, R. P. Campion, S. Maat, C. T. Foxon, B. L. Gallagher, and T. Dietl, Phys. Rev. Lett., 95, 217204 (2005)

Dp-011 **$Ca_3(Co,X)_2O_6$ (X=Mn, Rh, Ir) 의 방사광 분광 연구** 이 현진, 김 그라시아, 김 대현, 강 정수, 박 혜림[1], 정 윤희[1], CHEONG S.-W.[2], 이 한길[3], 김 재영[3](*가톨릭대학교 물리학과.* [1]*포항공과대학교 물리학과.* [2]*Rutgers University.* [3]*포항가속기연구소*) 최근 많은 물리학자들의 관심의 대상인 $Ca_3Co_2O_6$ 산화물은 상온에서 큰 열기전력 (thermopower) 을 보이며, Co 이온 대신 Mn, Rh, Ir 등이 치환된 Ca_3CoXO_6 (X=Mn, Rh, Ir) 에서 재미있는 자기적 물성이 관측된 바 있다[1,2]. 마름모계 구조 (rhombohedral structure)의 Ca_3CoXO_6 산화물은 2차원적인 CoO_2면과 1차원적인 Co-Co 체인을 가지고 있으며, CoO_6 삼각형 프리즘(trigonal prism)과 CoO_6 팔면체 (octahedron)가 c축 방향으로 체인을 이루면서 서로 번갈아 자리한다[1]. 체인들은 Ca 이온들에 의하여 떨어져 있는데, 사슬구조를 이루는Co 이온 간의 거리는 같은 체인 내에서는 약 2.6 Å이며 이웃한 사슬을 이루는Co 이온까지의 거리는 약5.2 Å으로 1차원적인 자기적 성질을 예상할 수 있다[2]. 그러나 프리즘 위치와 팔면체 위치에 있는 Co 이온들의 원자가 상태와 스핀 배열 상태, Co를 다른 원소로 치환시킬 때 치환된 원소들이 어떤 위치(site)로 치환되는지, 그리고 원소치환에 따른Co 이온의 원자가 및 스핀 상태의 변화 등에 대해서는 아직 잘 이해가 되지 않은 현황이다. 이 연구에서는Ca_3CoXO_6 (X=Mn, Rh, Ir) 의 전자 구조를 연구하기 위하여 방사광을 이용한 연x 선 광흡수 분광법 (soft x-ray absorption spectroscopy: XAS) 과 연 x선 자기원형이색성 분광법 (soft x-ray magnetic circular dichroism : XMCD) 등의 실험을 수행하였다. 이 연구로부터 Co 이온의 원자가 상태와 스핀 상태, Co 이온 대신 Mn, Rh, Ir 등으로 치환되었을 때의 전자구조의 변화 등을 연구하였다. [1] A. Maignan, et al., Mater. Sci. Eng. B104, 121, (2003).[2] S. Rayaprol, et al., Solid State Commun. 128, 79 (2003).

Dp-012 **입방체 페로브스카이트 산화물 $Sr(Mn_{1-x}Fe_x)O_3$ 의 방사광 분광 연구** 김 대현, 이 현진, 김 그라시아, 강 정수, DABROWSKI B.[1], 정 민철[2], 신 현준[2], 이 한길[2], 김 재영[2](*가톨릭대학교.* [1]*Northern Illinois University.* [2]*포항가속기연구소*) ABO_3 (A : 2가 이온, B : 전이금속 이온) 형의 페로브스카이트 산화물들은 전하/오비털 정렬(charge/orbital ordering), 금속-절연 상전이 (metal-insulator transition) 등의 재미있는 전자기적 성질을 보이는데, 이는 스핀, 전하, 포논 간의 상호작용에 의한 것으로 생각되고 있다. 이러한 여러 종류의 경쟁적인 상호작용의 관점에서 볼 때 $Sr(Mn_{1-x}Fe_x)O_3$ 형의 입방체 페로브스카이트(cubic perovskite) 산화물은 $Mn^{4+}(t_{2g}^3)$ 이온과 $Fe^{4+}(t_{2g}^3e_g^1)$ 이온을 포함하고 있을 것으로 예상되는 흥미있는 물질계이다. $SrMnO_3$는 T_N ~ 233 K인 반강자성 절연체이며(T_N : Neel Temperature), $SrFeO_3$는 T_N ~ 134 K인 나선형의 반강자성체이다. 그리고 $SrFeO_3$의 온도에 따른 저항은 금속성 경향을 보인다. 한편 $SrMn_{1-x}Fe_xO_3$의 치환 중간 영역에서는 스핀유리 (spin-glass) 거동이 관찰된 바 있다[1]. 이 연구에서는 $Sr(Mn_{1-x}Fe_x)O_3$ ($0 \le x \le 1$) 입방체 페로브스카이트 산화물들의 전자구조를 연구하기 위하여 방사광을 이용하여 x-선 광흡수 분광 (soft x-ray absorption spectroscopy : XAS), x-선 자기원형이색선 분광 (soft x-ray magnetic circular dichroism : XMCD), 광전자 분광 (photoemission spectroscopy : PES)등의 실험을 수행하였다. 이러한 분광 실험 결과로 부터 $Sr(Mn_{1-x}Fe_x)O_3$ 의 Mn 이온과 Fe 이온의 원자가 상태, 전자 스핀 배열 상태, Mn과 Fe 3d 전자들의 에너지 준위 등을 결정하고, 이들의 전자 구조가 전자기적 물성에 미치는 영향을 이해하고자 하였다. [1] S. Kolesnik, et al., Phys. Rev. B 67, 144402 (2003)

Dp-013 **Effect of Eu^{+3} on anisotropies of magnetic properties for grain-aligned $Sm_{1-x}Eu_xBa_2Cu_3O_{7-\delta}$ superconductor** AHMAD Dawood, KIM G C, LEE J H, KO Rock-Kil[1], PARK In Suk, KIM Y C(*Department of Physics, Pusan National University.* [1]*Korea Electrotechnology Research Institute.*) Anisotropies in magnetically aligned $Sm_{1-x}Eu_xBa_2Cu_3O_{7-\delta}$ series samples were investigated by both x-ray diffraction and magnetization measurement. Magnetization hystereses of aligned samples were measured with an applied magnetic field both parallel and perpendicular to their principal axes. The anisotropy was calculated by the ratio of $\Delta M_{\parallel}$-principal axis to $\Delta M_{\perp}$-principal axis. The x-ray diffraction patterns manifested that grains of x= 0.0 and 0.3 align with their c axes parallel to the magnetic field while the grains of x= 0.7, 0.9 and 1.0 were originated to lie their c axes perpendicular to the field direction, which, therefore, shows that Eu is the main cause for normal alignment in highly Eu doped samples. With the increment of temperature, a crossover was observed at certain applied field, i.e., $\Delta M_{\parallel}$ to $\Delta M_{\perp}$. This crossover was observed in whole series of samples. We attribute this crossover with different vortex structure, which is independent of crystalline axes of aligned samples.

Dp-014 **Magnetic properties in EuTiO3 thin films under misfit strain** CHANG Young J., CHAE S. C., JO Y.[1], JUNG M.-H.[1], LEE B. W.[2], CHOI I.[2], JUNG C. U.[2](*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [1]*Quantum Materials Research Team, Korea Basic Science Institute, Daejeon 305-333, Korea.* [2]*Dept. of Physics, Hankuk University of Foreign Studies, San 89, Wangsan-ri, Mohyeon-myun, Yongin, Gyounggi-Do 449-791, Korea.*) Perovskite oxide systems have attracted a great deal of attention on account of their outstanding physical properties, such as high-temperature superconductivity and colossal magnetoresistance. Furthermore, multiferroic materials that show both ferromagnetic and ferroelectric behavior have recently become an active area of research. As a new multiferroic candidate, EuTiO3 (ETO), a Mott insulator with excess d-electrons,

was proposed from a recent first principle calculation [1]. However, the experimental investigation is rarely reported.We fabricated ETO thin films on SrTiO3, (La,Sr)(Al,Ta)O3 (LSAT), and LaSrGaO4 single crystal substrates with a thickness of 150 nm by pulsed laser deposition. We carefully controlled oxygen atmosphere to obtain single phase ETO thin film, affirmed by high-resolution x-ray diffraction measurements. Although bulk ETO has a cubic perovskite structure with a lattice constant of 3.905 Å, the films are fabricated under the misfit strain of 0%, 0.7%, 1.6%, respectively. The out-of-plane lattice constants of the films grown on the three kinds of substrates were larger than those of bulk ETO.Magnetic properties of the ETO films were analyzed by comparison with detailed strain states of the films. All the ETO films present the saturating at around 2 K. However, the magnetization is anisotropic and changes depending on detailed strain states of the ETO films. The strain states were determined by reciprocal space mappings of the (103) pseudocubic substrate lattice. The change of anisotropic magnetizations of the ETO films will be discussed in terms of strain relaxation.1. C. J. Fennie and K. M. Rabe, Phys. Rev. Lett. 97, 267602 (2006).

Dp-015 **Optimization of ferromagnetic metallic properties of $SrRuO_3$ thin films** CHANG Young J., PHARK Soo-hyon, NOH Tae W., JUNG C. U.[1](*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [1]*Dept. of Physics, Hankuk University of Foreign Studies, San 89, Wangsan-ri, Mohyeon-myun, Yongin, Gyounggi-Do 449-791, Korea.*) Perovskite oxide systems have attracted a great deal of attention on account of their outstanding physical properties for future oxide electronics. Among lots of perovskite materials, SrRuO3 (SRO) thin films have played an important role of metallic electrode in various perovskite hetero-epitaxial structures such as capacitors or ferroelectric devices on account of the high conductivity and chemical stability. The metallic property of SRO film is considered its major aspect, but also its ferromagnetic property should be emphasized in the magnetic tunnel junction and a novel multiferroic structure, suggested recently [1, 2].We fabricated SRO thin films on TiO2–terminated SrTiO3(001) single crystal substrates with a thickness of about 30 nm by laser-molecular beam epitaxy(MBE). We carefully controlled deposition condition such as oxygen partial pressure, substrate temperature, laser fluence, and target-to-substrate distance. We also controlled precisely the thickness of the SRO films via monitoring reflection high energy electron diffraction equipped in laser-MBE system. The real-time monitoring suggests that the SRO films of flat surface morphology grow through 2-dimensional (layer-by-layer or step-flow) growth modes. Metallic properties of the SRO films were analyzed by measuring temperature dependent resistivity using standard four-probe method. By increasing oxygen pressure and the target-to-substrate distance, we successfully obtain high-quality epitaxial SRO films. Comparable to bulk SRO values reported earlier, the SRO films have very low resistivity with ferromagnetic transition signature of about 145 K. When we analyzed the ferromagnetic transition temperature with crystal structure, we find out the systematic increase of ferromagnetic transition temperature with the shrink of crystal volume of SRO films. This phenomenological tendency will be discussed in terms of chemical defects, such as oxygen and cation vacancy.1. M. Stengel and N. A. Spaldin, Nature 443, 679 (2006).

Dp-016 **Characterization of Surface and Pore Morphologies on Nanoporous Organosilicate Films** 김 제은, 이 희주, 송 상훈, 차 원석, 김 현정, 박 건우[1], 민 성규[1], 이 태훈[1], 이 희우[1], 김 광우[2] (*서강대학교 물리학과&바이오융합과정.* [1]*서강대학교 화공생명공학과.* [2]*포항 가속기 연구소*) 전자장비의 소형화에 따른 차세대 반도체의 연구에서 반도체 소자의 층간 절연 물질로서 기계적 물성이 강하면서 저유전율을 갖는 절연물질의 개발은 필수적이다 본 연구의 대상인 반응성 포라젠을 이용한 나노기공 유기실리케이트 박막은 비반응성 포라젠보다 같은 함량에서 더 낮은 유전율을 가지면서도 높은 기계적 강도를 갖는 특성 때문에 주목받고 있다본 연구는 반응성 포라젠을 이용한 나노기공 유기실리케이트 박막을 제조하여 포라젠 함량에 따라 형성되는 기공의 크기와 비율 및 박막의 표면을 Ellipsometry, X-ray Reflectivity(XRR)와 Grazing Incidence Small Angle X-ray Scattering(GISAXS)를 이용하여 측정하였다. 제조된 나노 기공 박막의 기공의 크기와 비율을 후열처리 조건과 시간에 따라서 측정하였다 포라젠의 함량이 늘어남에 따라서 전자밀도가 감소함을XRR 실험을 통해 확인했다. 포라젠 함량이 10% ~40%에서는 기공의 크기가 매우 작게 균일하게 분포되어 있고 50% 이상에서는 기공의 뭉침 현상이 일어나 기공의 크기가 증가함을 알았다. This study was supported by Korea Science &Engineering Foundation and Seoul Research &Business Development program (10816) and by Korea research Foundation.

Dp-017 **Magnetic properties of hexagonal lattice Co/Pd multilayer nanodot arrays with a wide range of dot sizes fabricated by self-assembled colloidal lithography** 정 종율, LE VAN Phong, 김 사라[1], 김 상현[2], 양 승만[3], 신 성철[2](*충남대학교 나노공학부.* [1]*Department of Chemistry, University of Cambridge.* [2]*KAIST 물리학과.* [3]*KAIST 생명화학공학과*) We have investigated fabrication of Co/Pd multilayer nanodot arrays with tunable spacing using self-assembled colloidal lithography technique in combination with reactive ion etching (RIE) and Ar^+ ion milling. The Co/Pd multilayer nanodot arrays in the wide range of 20 to 600 nm were successfully fabricated by using the different size of colloidal particle and adjusting the RIE time in this method. Focused magneto-optical Kerr effect (FMOKE) measurements for the nanodot arrays revealed that such arrays exhibit similar evolution patterns with the same maximum location at relative interdot distance(δ)~1. The appearance of maxima in the coercivities is attributed to inter-dot magnetostatic interaction in the single domain region from the magnetic force microcopic measurements.

Dp-018 **Investigation on Electronic Properties of NiAs-and B20-type MnAs** JEONG T, SHIN H, KWON Y(*Konkuk University.*) The electronic and magnetic properties of MnAs with both NiAs-and B20-type crystal structures have been studied with density functional calculations under the local density

approximation. The hexagonal NiAs-type MnAs is found to have a ferromagnetic instability and its magnetic properties are understood to be due to spin splitting of flat Mn 3d bands near the Fermi level. A hypothetical B20-type MnAs with a theoretically-determined equilibrium lattice constant shows a small-gap behavior with sharp density of states near the Fermi level. With these features electronic and magnetic properties of the B20-type MnAs are expected to change drastically with doping or pressure as in isoelectronic compound of FeSi or FeGe. The ferromagnetic spin splitting in the B20-type MnAs is observed only when the lattice constant expands by 5% beyond the equilibrium value.

Dp-019 **Contrasting Variation of Exchange Bias with Anealing Temperature in NiFe/FeMn/CoFe Trilayers** KI-YEON Kim, HYEOK-CHEOL Choi[1], CHUN-YEOL You[1], JEONG-SOO Lee(*Neutron Science Division, Korea Atomic Energy Research Institute.* [1]*Department of Physics, Inha University.*) Exchange bias is developed by field-cooling a magnetic heterostructure containing a ferromagnet(F)/antiferromagnet(AF) interface across AF blocking temperature or depositing it in the applied magnetic field. We investigate the exchange bias at NiFe/FeMn and FeMn/CoFe interfaces as a function of annealing temperature in 20-nm NiFe/15-nm FeMn/20-nm CoFe trilayers. NiFe(bottom)/FeMn/CoFe(top) trilayers are deposited on Si(100) substrate at ambient temperature using dc magnetron sputtering. A 5-nm Ta underlayer to promote FeMn(111) texture and a 5-nm Ta capping layer to prevent oxidation are also incorporated. After film growth, they are annealed in vacuum for 1 hour in an applied field of 300 Oe with varying temperature from 100℃ to 250℃. Crystallographic structure is characterized by x-ray reflectivity and high-angle x-ray diffraction, magnetic property by vibrating sample magnetometer and chemical depth profile by Auger electron spectroscopy. *Part of this work was supported by the HANARO Nuclear R&D Program of Ministry of Science and Technology.

Dp-020 **Structure properties and growth mechanism of ZnO nanorods studied by In-situ EXAFS** EUN-SUK JEONG, LIONEL VAYSSIERES[1], SANG-WOOK HAN(*Institute of Fusion Science, Institute of Science Education and Division of Science Education, Chonbuk National University, Jeonju 561-756, Korea.* [1]*International Center for Young Scientists, National Institute for Materials Science, Ibaraki 305-0044, Japan.*) The growth mechanism of ZnO nanorods synthesized with an aqueous solution method was investigated by using in-situ extended x-ray absorption fine structure (EXAFS) at Zn K-edge. From an aqueous $Zn(NO_3)_2$ solution, Zn complexes were obtained by adding hexamethylenetetramine (HMT) at 80℃. The Zn complexes were precipitated on Si substrates at 95℃. In-situ EXAFS measurements were performed at each step. The EXAFS revealed that the environments of Zn atoms in $Zn(NO_3)_2$ powder and $Zn(NO_3)_2.6(H_2O)$ solution was amorphous and that the coordination numbers of oxygen around the zinc atoms were close to 2 or 4 in the powder and the solution, respectively. Zn atoms as the second nearest neighbors first appeared at the ZnO complex state. However, there were a substantial amount of disorders and vacancy in the Zn-Zn pairs. ZnO was crystallized and became nanoparticles, as the complexes were precipitated. We will present the changes of coordination, bonding lengths and disorders around the zinc atoms at the steps in detail and discuss the growth mechanism of ZnO nanorods.

Dp-021 **무반사 코팅 기판에 형성된 나노구조에서 MOKE 신호의 증가** 김 덕호, 유 천열(*인하대학교 물리학과.*) 자성 물질로 된 나노선과 나노점은 그것이 가진 물리학적기술적인 중요성 때문에 흥미로운 연구 주제이다. 연구 대상이 되는 자성 나노구조의크기는 주로 수 100 nm 이거나 100 nm 이하의 크기인데, 이 경우 MOKE를 이용한 측정은 빛의 회절한계 때문에 신호의 감소로 적용이 곤란하다. 이런 문제점을 극복하기 위해 우리는 무반사 코팅이 된 기판을 사용한 측정 방법을 제안하였다. MOKE 신호는 반사율과 두 개의 자성 상태에서의 반사율의 차이의 비로 정의가 된다. 본 연구를 통해 기판의 반사율을 줄이는 조건을 이용한 간단한 MOKE 계산으로 MOKE 신호가 증가함을 확인하였다. 우리는 선폭과 레이저 빔의 반지름 각각에 대한MOKE 신호의 의존성을 계산하였다. 선폭이 100-nm이고 가우시안 빔의 반지름이 1500-nm 인 조건에서 무반사 코팅 된 기판의 반사율이0.007일 때 MOKE 신호는 덩치값의 79% 정도가 됨을 알아내었다. 또한 우리는 본 연구를통해 기판의 반사율이 작을수록 더 큰 MOKE 신호를 얻을 수 있었다. 위에서 제안된 방법은 나노구조에서MOKE 신호의 크기를 증가시켜 나노구조에 대한MOKE 측정의 활용도를 크게 증진 시킬 것이다.

Dp-022 **Strain induced changes in electrical conductance from single wall carbon nanotube devices** JEON Eun-Kyoung, KIM Byoung-kye[1], PARK Chan-Hyun[1], PARK Dong-won[1], HWANG Jae Ho[1], KONG Ki-Jeong[1], BUH Gyoung-Ho[1], SO Hye-Mi[1], CHANG Hyunju[1], LEE Jeong-O[1], KIM Ju-Jin, PARK So Hee[1](*Chonbuk National University.* [1]*KRICT.*) In our previous work, we fabricated hybrid cantilever devices by incorporating single wall carbon nanotube (SWNT) devices on them. Increased conductance from SWNT devices observed upon bending cantilevers, which could be interpreted by using electronic structure simulations. To have a better understanding for such a behavior, it is necessary to correlate the chirality of individual nanotubes with the change of strain-induced electrical conductance. Therefore, we have fabricated ultra-long carbon nanotube (~㎜) devices on micro-cantilevers to interpret the deflection of cantilever by measuring the electrical conductance from SWNT device. Metallicity of individual nanotubes could be measured from I-Vg characteristics, and change of conductance from different locations upon stress was measured by bending the cantilever using micro balance.

Dp-023 **Synthesis and characterization of (x) $Ni_{0.5}Zn_{0.25}$-$Cu_{0.25}Fe_2O_4$ + (1-x) $Ba_{0.5}Sr_{0.5}TiO_3$ magnetoelectric nanocomposites by pulsed laser deposition** KANAMADI C. M, YANG Hyun Kyoung, JEONG Jung Hyun(*부경대학교, 물리학과.*) Composite materials play a critical role in the modern technologies for unusual properties that they can achieve. Due to the exhaustive research that

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has gone into the development of these materials, it is likely that totally new composites will emerge. Many of our modern technologies require materials with a combination of properties that can not be met by the conventional metal alloys, ceramics and polymeric materials. Composites are desirable for the synthesis of materials with unique or improved properties. Samples containing piezomagnetic (ferrite) and piezoelectric (ferroelectric) phases, known as magnetoelectric (ME) composites, show magnetoelectric property capable of conversion of energies stored in electric and magnetic fields. ME composites made by combining several ferroelectric and ferromagnetic substances have been developed for their excellent magnetoelectric (ME) effect, which promises potential applications in multifunctional devices, transducer, actuators and sensors. The magnetoelectric effect is characterized by the appearance of an electric polarization on applying a magnetic field or a magnetic polarization on applying an electric field. ME effect is the coupling between the piezoelectric effect in the ferroelectric phase and the magnetostrictive effect in the ferromagnetic phase. Under the application of a magnetic field, the ferromagnetic phase changes its shape due to magnetostriction and the resulting strain is induced in the piezoelectric phase, causes a change of electric polarization.In this study, we synthesize magnetoelectric nanocomposite thin films of (x) $Ni_{0.5}Cu_{0.25}Zn_{0.25}Fe_2O_4$ + (1-x) $Ba_{0.5}Sr_{0.5}TiO_3$ (x = 0.15, 0.30 and 0.45) by pulsed laser deposition at different substrate temperature. The presence of constituent phases in the nanocomposite was confirmed by x – ray diffraction studies. The average grain size was calculated by using FE – SEM. The ferromagnetic and ferroelectric hysteresis of as-deposited films was carried out by SQUID magnetometer and ferroelectric hysteresis loop tracer at room temperature. The dielectric constant and dielectric loss were measured as a function of frequency in the range 20 Hz to 1 MHz.

Dp-024 **자성 나노선 소자에서의 joule heating에 관한 연구** 김 갑진, 이 재철[1], 신 경호[2], 최 석봉(*서울대학교, 물리 천문학부. [1]서울대학교, 물리 천문학부, 한국과학기술연구원 [2]한국과학기술연구원*) 기존 메모리 기술의 한계를 극복할 수 있는 대안으로 자구벽 나노선 소자가 각광받고 있다. 이러한 나노선 소자는 전류에 의해 구동됨으로써 기존의 메모리 소자가 갖지 못한 여러 장점을 가지게 되었다. 하지만 전류에 의해 자구벽을 구동시키기 위해서는 높은 전류밀도가 필요하고, 이는 필연적으로 joule 열을 발생시키게 된다. 열적 안정성 측면에서 이러한 joule 열에 의한 영향을 분석하는 것이 중요하다. 이에 본 연구에서는 자성 나노선 소자에서 전류에 의해 발생하는 joule열을 이론적으로 분석하고 실험을 통해 확인하였다.

Dp-025 **DLC 박막을 이용한 탄소 나노결정의 성장에 대한 연구** 김 지영, 윤 지혜, 전 혜영, 송 문호, 박 홍준, 이 재열, 김 용(*동아대학교 물리학과*) P-type Si(100) 웨이퍼에 촉매금속(Ni, Fe, Co)을 증착 시킨 후 RF-PECVD장치에서 메탄(CH_4)을 분해하여 DLC(Diamond Like Corbon)박막을 증착하였다. 이때 증착시간을 달리 하여 DLC 박막의 두께에 변화를 주었다. 이 샘플들을 열반응로에서 열처리하여 탄소의 결정상인 나노 다이아몬드와 탄소나노튜브가 각각 성장됨을 FE-SEM을 이용해서 확인하였다. 열반응로에 흘리는 수소(H_2) 기체의 양 그리고 열처리 시간과 온도를 변수로 두 종류의 나노결정이 형성되는 조건을 찾았다. 결정성장시 촉매의 종류에 따른 차이도 확인하였다.

Dp-026 **Direct Observation of Bakrhausen Avalanche in Fe Thin Films** LEE Hun-Sung, RYU Kwang-Su, SHIN Sung-Chul(*KAIST.*) We report direct observation of Barkhausen avalanches in Fe thin films by means of a magneto-optical microscope magnetometer (MOMM), capable of time-resolved domain observation. In this work, the Fe samples were prepared on glass substrate using magnetron sputtering. From the direct visualization of magnetization reversal, we found that the occurrence of Barkhausen jumps is random with respect to interval, size, and location. Through a statistical analysis of the Barkhausen jump sizes from repetitive experiments, the distribution of the jump sizes was found to exhibit power-law scaling behavior, fitted as $P(s) \sim s^{-\tau}$ with the critical exponent $\tau \sim 1.1$.

Dp-027 **Magnetic property of epitaxial Fe films grown on Cu(100)/Si(100)** 김 재영, 박 재훈, 박 성훈, 이 준식, 장 호영(*포항공과대학교 물리학과*) Magnetic and structural properties of epitaxially grown Fe film on Cu/Si(100) have been studied using Low Energy Electron Diffraction(LEED), Surface Magneto-Optical Kerr Effect (SMOKE), and X-ray Diffraction(XRD). A well-defined Si(100) surface was prepared by a sequential direct heating and it was confirmed by measuring LEED pattern, which showed (2X1) reconstruction. A thick Cu layer was evaporated on this surface and the crystallinity of it was also checked by LEED and XRD. With this Cu layer as a substrate, a thin Fe layer is grown also with e-beam evaporation. The magnetic hysteresis of Fe film has been measured by SMOKE. In this study, we will show the magnetic property of this film and it will be compared with that on Cu(100) single crystal. We expect that this work will contribute to understand the role of magneto-elastic energy on the total anisotropy energy.

Dp-028 **HFCVD 장치를 이용해 인가하는 전압에 따른 탄소 whisker 성장의 변화** 김 미경, 유 정호, 전 혜영, 김 지영, 박 홍준, 이 재열, 김 용(*동아대학교 물리학과*) HF(hot filament) CVD 장치에서 CH_4기체를 분해하여 탄소 whisker를 실리콘 기판에 증착하였다. 이 때 필라멘트와 기판 홀더 사이에 인가하는 전압을 변수로 하여 탄소 whisker를 성장시켰다. 전압에 따른 탄소 whisker 성장의 변화를 FE-SEM을 이용하여 조사하였고 성장 메카니즘에 대한 논의를 하였다.

Dp-029 **온도에 따른 스핀 동역학 측정을 위한 MOKE 측정 장비 개발** 김 준연, 최 석봉(*서울대학교 물리천문학부.*) 새로운 기억 매체로 각광을 받고 있는 나노선 소자 개발을 위하여 나노선에서의 스핀 동역학에 대한 연구가 요구되고 있다. 나노선 소자의 동역학 측정에는 높은 공간, 시간 분해능의 장비가 필요하다. 광원이 펨토초 펄스 레이저인 MOKE (Magneto-optic Kerr effect) 측정 장비는 나노선 연구에서 요구되는 700 nm의 공간 분해능과 수백 펨토초의 시간 분해능을 가진다. 한편 나노선 내에서의 자구

벽 동역학에서 온도가 미치는 영향은 많은 관심을 받고 있다 4 K에서 500 K의 온도를 제어할 수 있는 cryostat을 펨토초 레이저를 광원으로 하는 MOKE 측정 장비와 결합하여 온도에 따른 스핀 동역학 측정 장비 개발을 수행하였다.

Dp-030 **NiFe 나노선의 회전하는 필드에 대한 자화역전 현상** 문 경웅, 이 재철, 최 석봉(*서울대학교 물리천문학부.*) 자구벽 메모리 소자의 기본적인 자기적 특성을 조사하였다.자구벽 메모리 소자의 기본적인 형태로두께 20nm, 폭 600nm, 길이 17um의 NiFe 나노선을 제작하였다. 나노선 소자의 평면방향으로 일정한 세기의 자기장을 걸어주고 자기장이 인가되는 방향을 연속적으로 바꿔주었다. 동시에 AMR현상을 이용한 전기적 저항측정을 통해 나노선의 자화상태가 변화하는 것을 알아 내었다.자기장과 나노선이 이루는 각도에 따른전기저항 그래프의 형태가 외부 자기장의 세기에 따라 크게4가지 형태로 나누어짐을 확인 할 수 있었다. 또한 자기장의 세기에 따른 자화 역전이 일어나는 각도는single domain model로 설명되지 않는데 이 현상을 설명하기 위해 시뮬레이션을 하였다. 그 결과 나노선의core부분과 edge부분의 자화역전 현상이 다르게 나타남을 확인하였다.

Dp-031 **Magneto-transport properties of Si counter doped GaMnAs ferromagnetic semiconductors** KIM Hyungchan, SHIN D. Y., KIM Yungjun, LEE Sanghoon, LIU X.[1], FURDYNA J. K.[1] (*Physics Department, Korea University, Seoul 136-701, Korea. [1]Physics Department, University of Notre Dame, Notre Dame, Indiana 46556, USA.*) The magnetic properties of a series of GaMnAs:Si ferromagnetic semiconductor films, in which Si (n-type dopant for GaAs) act as counter dopant against Mn (p-type dopant for GaAs), were investigated by magneto-transport measurements. The GaMnAs:Si samples were grown by low temperature molecular beam epitaxy (MBE) on (001) GaAs substrate. The Mn concentration was varied from 7 % to 10 % and Si doping level was changed correspondingly with increasing Mn concentration in the series. The temperature scan of resistivity revealed the systematic increase of Curie temperature (T_C) with increasing Mn concentration in the series. Since the T_C of un-doped GaMnAs ferromagnetic semiconductor decreases with increasing Mn concentration above 6 %, the observation of systematic increase of T_C in our GaMnAs:Si series indicates effectiveness of our counter doping in controlling hole concentration in the system. The magnetization reversal and magnetic anisotropy of the GaMnAs:Si were also investigated by measuring planar Hall effect (PHE). Though the overall magnetization reversal process was similar in all samples, the magnetic anisotropy property changed systematically in the series. Specifically, uniaxial anisotropy becomes increasingly important with increasing Si counter doping level in the series. This study clearly demonstrates that the counter doping Si significantly affect the magnetic properties of GaMnAs ferromagnetic semiconductors.

Dp-032 **HFCVD법을 이용한 CNF 합성 연구** 전 혜영, 유 정호, 김 미경, 김 지영, 윤 지혜, 이 재열, 김 용, 박 홍준(*동아대학교, 물리학과.*) 실리콘 웨이퍼에Ni, Co, Fe의 촉매금속을 각각 증착시킨 후 RF-PECVD법을 이용하여 DLC (Diamond-Like Carbon) 박막을 그 위에 합성하였다. 이렇게 얻은 DLC 시료를 HFCVD 장비에 장착하고, H2 반응기체를 흘리면서 열처리하여 CNF(carbon nano fiber)의 성장 조건을 찾았다. DLC 박막의 두께, 촉매의 종류, CH4의 유량, 열처리 시간과 기판 온도에 따른CNF의 성장 속도와 밀도의 변화를 조사하고 이 시료의 전계방출 특성도 분석하였다.

Dp-033 **유도결합 플라즈마를 이용하여 Ar 플라즈마 처리된 PEN 기판위에 증착한 AZO 박막의 특성에 관한 연구** 방 태복, 권 오정, 하 재영, 왕 태현, 지 승훈, 이 병로, 양 정민, 홍 우표, 김 종재, 박 승환, 김 화민(*대구가톨릭대학교, 전자디스플레이공학과.*) 본 연구에서는 ICP-CVD(Inductively Coupled Plasma - Chemical Vapor Deposition) 장비를 이용하여 플라즈마 전 처리를 실시 한 후AZO박막을 증착시켰다. ICP-CVD를 이용한 플라즈마 전 처리 시 초기진공과 공정 진공은 Torr와 Torr로 Ar량은 20 sccm 기판사이의 거리는200 mm로 고정하였다. 플라즈마 처리 공정에서 인가전력은 RF POWER 300 W 로 고정 하였으며 시간은 1,3,5 분으로 변화를 시키며 플라즈마 처리를 실시한 후 동일한 조건(2000 Å)의 AZO박막을 증착하였다. 실험에 사용된AZO 박막은 순도 99.99%의 Al_2O_3와 ZnO 분말을 성분 조성비를2 : 98 wt%로 하여 타겟을 제작한 후 Ar량은 25 sccm, 기판사이의 거리는 45 mm, 인가전력은 RF 20 W 로 1시간동안 증착하였다. 플라즈마 전처리 후의 PEN 기판의 표면 특성은AFM을 이용하여 5×5 ㎛ 영역의 표면 거칠기를 측정하였으며 접촉각 분석기를 사용하여 젖음성 정도를 알아보았다. AZO박막의 광학적 특성으로는UV-Vis Spectrophotometer를 이용한 광투과도를 측정 하였으며 전기적 특성은4-Pin-probe를 사용하여 면저항을측정하였다. 플라즈마 처리 전후의 박막의 부착력을 분석하기 위하여Bending Test를 실시하였다. *본 연구는 교육인적자원부가 지원하는 제2단계 BK21사업의 재정 지원을 받은 것임.

Dp-034 **유기첨가제에 의한 전기도금 니켈-철 퍼말로이 박막의 GMI 효과 향상** 이 호준, 방 원배, 김 누리, 홍 기민, 이 희복[1](*충남대학교 물리학과. [1]공주대학교 물리교육학과*) 니켈-철 합금 연자성 박막은 낮은 보자력과 높은 투자율을 지니고 있어 MEMS (Microelectromechanical system) 소자와 GMI (Giant Magnetoimpedance) 소자로 활용이 가능하다. 이 박막은 일반적으로 진공 방법으로 제작이 되어 왔으나, 최근에는 전기도금 방법을 이용하는 연구가 활발히 진행되고 있다. 전기 도금 방법은 진공 방법에 비해 제작비용이 저렴하고 상대적으로 고순도의 박막을 얻을 수 있다는 장점이 있으며, 특히 최근에는 전기도금 용액에 유기첨가제를 가하여 도금 박막의 결정구조와 결정립의 크기를 조절하고, 그에 따라 물질의 자기적 특성을 조절하고자 하는 시도가 활발히 진행되고 있다. 본 연구에서는 연자성체인 니켈철 퍼말로이 합금 박막의 물성 최적화를 위해 정전압 방법과 정전류 방법으로 제작한 후 물성을 비교하였다. 유기첨가제인 SNPS (Saccharine N-propane sulfonate)를 도금용 전해액에 미량(<1 μmol/L) 첨가하여 도금한 박막들의 경우SNPS의 농도에 따라 보자력 값과 표면거칠기가 감소하며 투자율이 증가하는 경향을 보였다. 표면거칠기의 변화는 보자력의 변화와 비례관계가 있으며, 이는 유기첨가제 SNPS에 의해 Ni-Fe(200) 결정립의 감소에 의한 것으로 판명되었다. 이에 따라 실제GMI 변화를 측정한 결과 주파수 영역에 따라 최대 20%까지 증가하는 경향을 보였다. 즉 유기첨가제 SNPS는

전기도금 시 확산거리를 줄여주는 가속제의 기능이 있고, 도금 박막의 결정성을 변화시키며 표면 거칠기를 감소시키는효과가 있어, 그 결과로 보자력 값의 감소와 GMI의 증가에 기여하는 것으로 판명되었다

Dp-035 **Magnetodielectric Effect in Dysprosium Iron Garnets** 송 기명, 이 재일, 허 남정(*인하대학교*) We will report the magnetodielectric effect, magnetization and magnetostriction of Dy3Fe5O12 single crystal in this presentation. We have investigated the relationship between the magnetodielectric effect and magnetostriction in RE3Fe5O12 single crystals. It has been reported that the magnetodielectric effect is mainly related to magnetostriction in the case of Tb3Fe5O12. However the magnetodielectric effect in other iron garnets with different rare earth has not been investigated. Possible origins of the magnetodielectric effect will be discussed in connection with the magnetic structure as well as magnetostriction in Dy iron garnets.

Dp-036 **Structural analysis of phase separation &competition in electron doped manganite ($Sm_{1-x}Ca_xMnO_3$, $0.8 \le x \le 0.92$)** 김 봉주, 권 대영, TONG peng, 이 성익[1], 정 상욱[2], 김 복기(*부산대학교 물리학과. [1]포항공과대학교, 물리학과. [2]Department of Physics and Astronomy Materials, Rutgers University, USA.*) 망간 산화물은 colossal magneto resistance (CMR) 효과를 비롯하여 온도와 조성에 따른 다양한 물리적 특성을 가지고 있다 이러한 특징으로 인하여 대단히 큰 학문적 관심을 받고 있으며, 실제 소재의 이용에 있어서 큰 기대를 받고 있다. 하지만 대부분의 연구는hall doping 된 망간 산화물에서 이루어 져 왔으며, electron doping된 망간 산화물은 아직도 밝혀야 할 많은 연구 과제가 남겨져있다. 본 연구는 electron doping 된 $Sm_{1-x}Ca_xMnO_3$ 시료에서 나타나는 상분리 및 상경쟁 현상을 상전이 온도영역을 중심으로 X-ray powder diffraction 실험을 수행하여, 그 결과를 rietveld refinement를 통하여 온도에 따른 상분리와 상경쟁 그리고 결정구조의 변화를 연구하였다본 시료는 저온에서 C-type AFM, G-type AFM, FM cluster 상호간의 상경쟁 현상이 자화 측정에서 나타나며 cluster-like phase를 나타내는 Griffiths phase 와 percolating 현상이 자화측정과 비저항 측정에서 각각 보인다. 이러한 특징을 설명하기 위해 수행한 구조분석 연구에서는 자성 상전이 온도영역에서는orthorhombic phase 와 monoclinic phase로 나뉘는 것을 알 수 있으며, monoclinic phase volume fraction이 온도와 electron doping level에 의존하는 것을 알 수 있다. 또한 Jahn-teller spliting effect를 발생시키는 lattice distortion의 온도에 따른 차이가electron doping level에 따른 의존성을 가지고 있다. 따라서, electron doped $Sm_{1-x}Ca_xMnO_3$ 의 물성은 이러한 특징의 종합적인 현상으로서 정의할 수 있다.

Dp-037 **Magnetostricton of BeFe binary alloy from first-principles calculations** YUN Won Seok, HONG Soon Cheol(*Dept. of Physics, Univ. of Ulsan.*) The magnetostriction, i.e., the change of dimensions of the magnetic materials caused by a modification of the magnetization, is widely used in various applications such as actuators, sensors, and linear motors. Some rare earth-transition metal alloys such as $Tb_{0.3}Dy_{0.7}Fe_{1.9}$ (so called Terfenol-D), $TbFe_2$, and $DyFe_2$ exhibit large magnetostriction at room temperature. However, these alloys not only require high magnetic field to achieve saturation, but also are brittle and expensive. In this work, we investigated magnetostriction of ordered B2- and B32-BeFe alloys by using first-principles calculations. In order to determine equilibrium atomic structures, we performed calculations the Vienna *ab initio* simulation package (VASP) with the projector augmented wave (PAW) pseudopotentials. The equilibrium lattice constants of B2- and B32-BeFe alloys were determined from the total energies calculation to be 2.642 and 5.280 Å in ferromagnetic state, respectively. For investigation on detailed magnetism of the alloys we will present results obtained from the full potential linerized augmented plane wave (FLAPW) method within generalized gradient approximation (GGA).

Dp-038 **마이크로 도선을 이용한 자성체 유량 제어** 금 동연, 김 정대, 이 팽로, 홍 기민(*충남대학교 물리학과*) 바이오센서는 바이오 물질을 센서 소자로 이동하여 암과 같은 질병을 감지하는데 이용되고 있다. 바이오 물질을 센서까지 운반하기 위해서 운반자 역할을 하는 물질이 필요하며, 이러한 운반자 역할을 하는 대표적인 물질로 마이크로미터 크기의 자성체가 주로 이용되고 있다. 이러한 마이크로 자성체는 외부 자기장을 이용하여 센서까지 이동할 수 있으며 고감도 센서에 의한 감지가 용이하여 최근 많은 연구가 진행되고 있다. 본 연구에서는 마이크로미터 선폭의 도선에 전류를 가하여 자기장을 발생하고, 이 자기장을 이용하여 마이크로 자성체의 위치를 제어하는 방법을 연구하였다 실리콘 웨이퍼에 노광공정과 진공 증착 방법을 이용하여 두께300 nm, 선폭 5～10 , 길이 8～12 mm인 금속 도선을 1～2 도선에 전류를가하여 자기장을 발생하고, 이 자기장을 이용하여 마이크로 자성체의 위치를 제어하는 방법을 연구하였다. 실리콘 웨이퍼에 노광공정과 진공 증착 방법을 이용하여 두께 300 nm, 선폭 5～10 , 길이 8～12 mm인 금속 도선을 1～2 도선에 전류였으 마이크로 자성체의 거동 제어에 대하여 연구 하였다.

Dp-039 **Selectively Removal of Semiconducting Single-walled Carbon Nanotubes by CO_2 Gas Treatment** GÜNEŞ Fethullah, KIM Ki Kang[1], KIM Su Min, LEE Young Hee[2](*SKKU Advanced Institute of Nanotechnology (SAINT). [1]Department of Physics. [2]SKKU Advanced Institute of Nanotechnology (SAINT), Department of Physics.*) A selectively removal of semiconducting SWCNTs (Single-walled carbon nanotubes) by a simple gas phase reaction at high temperatures by CO_2 gas was introduced. In order to open the cap of individual or small bundled SWCNTs dispersed onto Si substrate, a strong oxidation in O_2 environment was performed for a short time prior to the soft oxidation process of CO_2 gas etching. The tip opening of SWCNTs was confirmed by TEM (transmission electron microscope). The metallic property of etched samples was characterized by the resonant Raman spectra with two wavelengths of 514 and 633 nm. Peaks of semiconducting-SWCNTs in RBM (radial breathing mode) of Raman spectra were strongly suppressed compared to the metallic-SWCNT peaks. This was attributed to the fact that the zigzag-metallic tubes were etched more effectively than armchair-tubes due to the selective adsorption energy of CO_2 molecules on the zigzag-tube edges. Moreover, development of long tail

at lower energy side of G band in Raman spectra was a good indication of increasing metallicity.

Dp-040 **Magnetic Properties of $Ti_{50+x}Zr_{33-x}Ni_{17}$ Quasicrystals**
LEE yun man, JEON Jae-kyun, LEE Sanghwa, SHIN Hyemin, KIM Jae-yong(*한양대학교 물리학과*) Since the first discovery of quasicrystals (QCs) by Shechtmann *et al*. in 1984 from rapidly quenched Al-Mn alloys, QCs have drawn much scientific and engineering attention due to their peculiar structural feature which is different from amorphous and crystal. The most striking characteristic of the QCs is that they exhibit a 5-fold rotational symmetry which is forbidden in ordinary crystalline materials. Although many investigations about the structural properties of Ti-based QCs are reported, the electronic and magnetic properties are rarely studied including diamagnetism, paramagnetism, spin glass, ferromagnetism and ferrimagnetism. We prepared small grain sizes of Ti-Zr-Ni quasicrystalline-phase ribbons by using a rapid quenching and as-cast method. We have studied magnetic properties of $Ti_{50+x}Zr_{33-x}Ni_{17}$ QCs by measuring the magnetization (M) as a function of applied magnetic field (H) at different temperatures by using a vibrating sample magnetometer (VSM), and the results of will be demonstrated.

Dp-041 **Supersolid Helium-4 Confined in Porous Gold**
KIM Duk Young, KWON Sang-Il, KIM Hyoung Chan[1], KIM Eunseong(*Center for Supersolid &Quantum Matter Research and Department of Physics, KAIST.* [1]*National Fusion Research Institute.*) The supersolid phase of ^{4}He was reported by a series of torsional oscillator experiments [1]. Recently, Day and Beamish reported the shear modulus change of solid helium in the similar temperature range [2]. We have investigated the dynamic response of the torsional oscillator containing solid helium confined in porous gold. The porous gold has a multiply connected worm-like structure with a characteristic pore diameter of about 700nm and 70% porosity. The effect of the shear modulus change in these narrow channels is expected to be negligible. The measured non-classical response in our measurements corresponds to 1~7% of the total solid helium which is similar to the previous results of torsional oscillators.Clark *et al* reported that the resonant period of the torsional oscillator containing solid helium is thermal history dependent [3]. This hysteretic behavior is accompanied with the extended equilibration time of the torsional oscillator below 60mK. We have investigated the period and amplitude response of the system to the driving force change. Only the period with increasing driving force showed the prolonged equilibration time. Since the equilibration time is order of hours, the period dependence on the driving force looks hysteretic according to the increasing and decreasing drive force. The origin of the long equilibration time is not clear yet. We try to understand the experimental result with various explanations including vortex liquid, dislocation network and glass transition. [1] E. Kim and M. H. W. Chan, *Science* 305, 1941 (2004); *Nature* 425, 227 (2004); *J. Low Temp. Phys.* 138, 859 (2005); *Phys. Rev. Lett.* 97, 115302 (2006). [2] J. Day, and J. Beamish, *Nature* 450, 853 (2007). [3] A. C. Clark, X. Lin, and M. H. W. Chan, *Phys. Rev. Lett.* 97, 245301 (2006).

Dp-042 **Sonication dependent nanodispersion of single wall carbon nanotubes in water** BISWAS Chandan, GENG Hong-Zhang, PARK Hyeon Ki, LEE Young Hee(*Department of Physics, and Center for Nanotubes and Nanostructured Composites (CNNC), Sungkyunkwan University, Suwon 440-746, Korea.*) Sodiumdodecyl benzenesulfonate (NaDDBS) has been used as a surfactant forthe dispersion of single wall carbon nanotubes (SWCNTs) in water.Chemically purified and unpurified SWCNTs has been added into theNaDDBS dispersed water and followed by different sonication time andcentrifugation to optimize the nanodispersion conditions. Absorptionspectroscopy and Raman spectroscopy has been used to characterize andcompare the CNTs in to the different nanodispersed solution.Nanodispersed CNTs deposited on PET and Silicon wafer afterwardsseveral heat and acid treatment has been done to remove thesurfactant from CNT sidewalls. Atomic force microscopy and scanningelectron microscopy has been used to conform the nanodispersed CNTnetwork on the deferent substrate. Nanodispersion conditions withouthaving defects on CNT surface has been compared and discussed by theabove indicated characterization methods.

Dp-043 **Anomalous ferroelectric properties under high fields in multiferroic $Ba_2CoGe_2O_7$** 김 재욱, 천 세환, JO Y.J.[1], BALICAS L.[1], CHOI Y.J.[2], LEE S.S.[2], CHEONG S.-W.[2], BALAKIREV F.[3], HARRISON N.[3], 김 기훈(*서울대학교 물리천문학부.* [1]*National High Magnetic Field Laboratory.* [2]*Rutgers University.* [3]*Los Alamos National Laboratory.*) We investigate the electric and magnetic properties of the multiferroic $Ba_2CoGe_2O_7$ single crystal by dielectric constant (ε), electric polarization (P), and magnetization (M) measurements at temperature (T) down to 0.6 K and under high magnetic field (H) up to 45 T at NHMFL. $Ba_2CoGe_2O_7$ is isostructural to the known spiral antiferromagnet $Ba_2CuGe_2O_7$ (S=1/2 spins on Cu^{2+}) and shows an antiferromagnetic (AF) order below T_N=6.7 K. It is reported that spin moments at zero H are confined in the *ab* plane due to the strong anisotropy of the Co^{2+} spins (S=3/2) [1]. While no P is observed at zero magnetic field (H), P develops along the *a*-axis with a small applied H ~1 T along the *c*-axis below T_N, which is also evidenced by a peak in the ε vs. T curve. On further applying higher H, the ε-peak becomes sharper and shifts to lower temperatures. By using a pulse magnet to achieve higher fields above 33 T, we find that the ε-peak is further suppressed to the proximate zero temperature at H~35 T. Interestingly, P shows a sign reversal from a low field positive to a high field negative value at H close to the ε-peak field. Furthermore, the $M(H)$ curve at each temperature below T_N shows a saturation near the ε-peak field, indicating that the negative P state is linked to the fully ordered spin configuration. The phenomenology in the electrical measurment is similar to the case of $BiMn_2O_5$, in which ε develops a peak at the polarization reversal point driven by high H and extends down to the proximate zero temperature [2]. However, the polarization re-

versal in $BiMn_2O_5$ coincides with the AF spin-flop crossover, while in $Ba_2CoGe_2O_7$, it appears to occur in a region where the $M(H)$ curve linearly increases before reaching the saturation field. We suggest possible mechanisms on this unique multiferroic behavior and future plans to further understand the phenomena. [1] A. Zheludev *et al.*, Phys. Rev. B 68, 024428 (2003).[2] J. W. Kim *et al.* Submitted.

Dp-044 **Phase Transition of Magnetic Domain Configuration in $[CoFe/Pt]_{10}$ Nano-wires with Perpendicular Anisotropy** LEE Jae-Chul, KIM Kab-Jin, SHIN Kyung-Ho[1], CHOE Sug-Bong(*Seoul National University, Department of Physics.* [1]*Korea Institute of Science and Technology, Center for Spintronics Research.*) Magnetic domain configuration and the reversal process in $[CoFe/Pt]_{10}$ multilayers are invesitgated by using a magneto-optical Kerr-effect microscope capable of thermo-magnetic domain formation and real-time domain imaging. The domain reversal behavior shows a transition between dendritic-growth and wall-motion processes with respect to the wire width, resulting either stripe domains or single domain respectively. The transition width is found to be about 1 mm, which corresponds to the natural stripe width appreared in a contiouous films. A simple analytic theory is proposed to explain the transition, by consideration of the shape anisotrpy varaition with changing the wire width.

Dp-045 **Oxygen and Ar Ion Irradiations and In-siut I-V Characterizations of Carbon Nanotubes.** JANG Jin Ho, KIM Soo Min[1], SO Gang Pyo[1], CHAE Seung Jin[1], LIM Seong Chu[2], LEE Young Hee[3](*department of physics Sungkyunkwan University.* [1]*SKKU Advanced Institute of Nanotechnology Sungkyunkwan University.* [2]*department of physics, Center of Nanotubes and Nanostructured Composites Sungkyunkwan University.* [3]*department of physics, Center of Nanotubes and Nanostructured Composites, SKKU Advanced Institute of Nanotechnology Sungkyunkwan University.*) Carbon nanotubes (CNTs) have been exposed to energetic ions and their I-V characteristics are measured in-situ. Ar ion irradiation did not show doping effect, but increase the resistance of semiconducting CNTs in proportional to exposure times. As a result, CNTs were amorphorized with an infinite resistance. However, oxygen ion irradiation on semiconducting CNTs exhibited the shift of threshold voltage at low dosage and then, showed metallic behaviors at higher dosage. According to Raman spectra, oxygen ion bombardment increased the D-band, whereas the substructures in G-band did not show any indications of doping. Our result indicates that defects generated by energetic ions may contribute to the enhancement of conductivity.

Dp-046 **Micromagnetic Study of Transitional Behavior of Spin Ground States for Diamond Shaped Ferromagnets with Aspect Ratio Variation** KIM Dong-Hyun, DJUHANA Dede, PIAO Hongguang(*충북대학교 물리학과*) Recently, various spintronic applications using magnetic field or magnetoelectric effects are proposed, where ferromagnetic nanoelements with square, circle, and diamond shapes are used as logic unit. Here, we investigate a transitional behavior of spin ground state for diamond shaped ferromagnets with a systematic variation of aspect ratio by means of micromagnetic simulation [1]. With changing aspect ratio from 1:6 to 1:1, we observed spin ground state exhibits transition from a single domain to flux-closure domain state, as illustrated in Fig. 1. With aspect ratio between 1:3 to 2:3, repeated simulations end up with two states stochastically, when the simulation starts from a random spin initial condition. We analyze further magnetic energies of the two possible states working as two potential wells in magnetic energy landscape. We propose a novel idea for ferromagnetic elements device based on our micromagnetic simulation for spintronic application. This work was supported by the research grant of the Chungbuk National University in 2007.
[1] M. J. Donahue and D. G. Porter, *OOMMF User's Guide*, http://math.nist.gov/oommf.

Dp-047 **Ferromagnetism in Mn_2GeSb thin film grown on GaAs(001) by molecular beam epitaxy** HWANG Younghun, KIM Jaehwi, CHOI Jeongyong, CHO Sunglae(*University of Ulsan, department of physics.*) Epitaxial ferromagnetic (FM) or ferrimagnetic (FIM) thin films on semiconductor have recently attracted many interests for hybrid spintronic devices. From this point of view, we investigated the magnetic and transport properties of ferromagnetic Mn_2GeSb thin film grown on GaAs (001) substrate by molecular beam epitaxy. The reflection high-energy electron diffraction (RHEED) and X-ray diffraction (XRD) studies indicate the rough film surface and c-axis orientation in tetragonal crystal structure. Mn_2GeSb thin film exhibited a ferrimagnetic ordering at room temperature, which is supported by the magnetization, magnetoresistances and anomalous Hall effect measurements.

Dp-048 **Electrical Spin Injection and Detection in InAs Channels by Using Vanadium** HAN Dong Seok, KIM Eun Kyu, EOM Jonghwa[1], KOO Hyun Cheol[2](*Quantum-Function Spinics Lab. &Department of Physics, Hanyang University.* [1]*Department of Physics, Sejong University.* [2]*Center for Spintronics Research, Korea Institute of Science and Technology.*) We have investigated spin injection and detection in a two-dimensional electron gas (2-DEG) based on InAs heterostructure by measuring a chemical potential which originates from spin accumulation. The device consists of two ferromagnetic electrodes and a transport channel made of InAs/InGaAs heterostructure. In the first fabrication process, a 15-μm-wide InAs channel of 2-DEG was defined by photolithography and Ar-milling. In the subsequent step, ferromagnetic film (NiFe) was deposited to make spin injector and detector on the surface of InAs channel, which was cleaned by oxygen plasma and Ar-milling, and then deposited Au and vanadium (V) on the ferromagnetic film. The sizes of injector and detector are 0.2x15 μm^2 and 0.4x15 μm^2. We reduced channels without any affect to V layer by using Ar-milling, and then V layer was removed by H_2O_2 dipping. The effect of V as a hard mask on the spin transport has been studied at low temperature (10K).

Dp-049 **Magnetism and Catalytic behavior of Pd (001) surface: First-principles calculation** 홍 순철, 권 오룡(*울산대학교*) 촉매로 널리 사용되고 있는 전이금속(Ni, Pt, Pd, Rh 등)은 자성을 띠고 있거나 거의 자성을 가지려하는 성향이 있다. 본 연구에서는 특별한 환경에서 자성을 띠는 것으로 알려진Pd 의 자성과 촉매작용의 상관관계를 규명하기 위해 제일원리계산을 수행하였다. Pd 의 격자상수를 변화시켜 자성을 변하게 하여 CO 나 NO 해리에 미치는 자성의 영향을 연구하였다.

Dp-050 **Electronic Structures and Magnetic Exchange Interactions of Monoclinic $FeCr_2Se_4$ and Cubic Spinel $FeCr_2S_4$** BAIK Seung Su, KIM B. H., MIN Byung Il(*POSTECH, Dept. of Physics.*) $FeCr_2Se_4$ and $FeCr_2S_4$ manifest the complex interplay of the charge, spin, and orbital degrees of freedom. In both compounds, $FeCr_2Se_4$ and $FeCr_2S_4$, Fe ions are nearly divalent and Jahn-Teller active ions. Also, Fe 3d electrons are strongly hybridized with the Se 4p and the S 3p electrons respectively in each compound. However, they have the distinct mechanisms in their magnetic exchange interactions. The octahedrally coordinated Fe 2+ ions in the monoclinic $FeCr_2Se_4$ structure are antiferromagnetically coupled along the a and b axes forming the (2x2x1) supercell whereas the tetrahedrally coordinated Fe 2+ ions in the cubic spinel $FeCr_2S_4$ structure are ferromagnetically coupled with one anther. To describe these differences and similarities, the superexchange mechanism in conjunction with the inter-site charge transfer and the intra-site Coulomb repulsion energies is explored. The energy band structures and the partial density of states are examined in this procedure.

Dp-051 **Electronic structure and magnetic properties of MnV_2O_4** 최 홍철, 권 세균, 민 병일(*포항공과대학교 물리학과*) Polycrystal MnV_2O_4 spinel shows the ferrimagnetic transition at T_N = 56.5 K and exhibits the structural transition from the face centered cubic to the body centered tetragonal at T_s = 53.5 K [1]. For a single crystal MnV_2O_4, the two transitions seem to occur at 57 K [2]. Interestingly, it was reported that the transition temperature and the structural symmetry of MnV_2O_4 could be controlled by the magnetic filed [1]. In this study, we have investigated the electronic structure and magnetic properties of MnV_2O_4 using the *ab-initio* total energy electronic band structure method. The generalized gradient approximation (GGA) was adopted for the exchange-correlation potential. In addition, the on-site Coulomb interaction (*U*) and the spin-orbit interaction were also considered. We have found that the ferrimagnetic $I4_1/a$ structure is the most stable out of the three structures of one face-centered cubic structure and two body-centered tetragonal structures. The effect of the spin-orbital interaction on the electronic structure of MnV_2O_4 will be discussed.[1] K. Adachi *et al*, Phys. Rev. Lett. 95, 197202 (2005).[2] T. Suzuki *et al*, Phys. Rev. Lett. 98, 127203 (2007).

Dp-052 **Electronic structures and magnetic properties of La_2MnNiO_6: a ferromagnetic insulator** KIM Bongjae, CHOI Hongchul, MIN Byung Il(*POSTECH.*) Ferromagnetic semiconductors and insulators are good candidates for the next generation electronics materials. For the commercial use of the ferromagnetic semiconductors and insulators, magnetic orderings of the materials should be seen at high temperatures. La_2MnNiO_6 is known to be a rare example of a ferromagnetic insulator. In this study, electronic structures and magnetic properties of La_2MnNiO_6 is investigated by using the first principles band structure method. The valence states of Mn^{4+} and Ni^{2+} are confirmed.[1] Also, from the electron density plot, the orbital ordering is examined. We have discussed the origin of the ferromagnetic insulator in La_2MnNiO_6. [1] S. F. Matar et al., J. Magn. Magn. Mater, 308, 116 (2007)

Dp-053 **The Monte-Carlo study of the temperature-driven spin reorientation transition in an antiferromagnetic system** KIM Beom Hyun, MIN B. I.(*Department of Physics, POSTECH.*) A number of antiferromagnets exhibit intriguing order-order phase transition in which the easy axis of the magnetization changes from one direction to another as a function of temperature. There is no lattice distortion during the transition. This phenomenon is called the spin reorientation transition (SRT). Typical examples are the Morin transition in hematite, and the change of the direction of the magnetization from *a*- to *c*-axis in rare-earth orthoferrites ($RFeO_3$). In this study, we have employed the Monte-Carlo method to study the SRT in the three-dimensional (3D) antiferromagnetic system. We have investigated the thermal behavior of the easy axis of the magnetization which is influenced by the single-ion anisotropy and the anisotropic dipolar interaction. We have emonstrated the temperature-driven rotation of the easy axis. Further, we have discussed transition types of the spin reorientation.

Dp-054 **The condition for the ferromagnetism in ZnCoO powder fabricated by sol-gel method** LEE Seunghun, KIM Su-Jae[1], KIM Sung-Jin, CHO Yong Chan[2], JEONG Se-Young (*Departartment of Nano Fusion Technology, Pusan National University, Miryang 627-706, Korea.* [1]*BK21 Team of Nano Fusion Technology, College of Nanoscience and Nanotechnology,.* [2]*Center for Dielectric and Advanced Matter Physics, Pusan National University, Busan 609-735, Korea.*) Diluted magnetic semiconductors (DMSs) are attracting large interest for potential new device application in spin-based information-processing technology[1]. Recently, many studies have tried to confirm the ferromagnetism of ZnCoO. In case of powder state, the effect of secondary phase which is related with cobalt cluster cannot be excluded[2]. Some researcher suggested defect of ZnO system, like oxygen vacancy and Zn interstitial, can induce ferromagnetism of ZnCoO[3]. In a previous report, we studied that the ferromagnetism was enhanced in ZnCoO by spin-spin interaction in the Co-H-Co complex[4,5]. In this study, we report that change of magnetic property of ZnCoO powders according to post treatment. ZnCoO powder was fabricated by sol-gel method. Firstly, to confirm oxygen vacancy effect on ZnCoO powder, we performed annealing process in oxygen and vacuum. Secondary, to confirm hydrogen effect, ZnCoO powder was treated by hydrogen plasma. The structural properties of each powder were investigated by XRD and

the magnetic properties were measured by SQUID. Through this result, we expect to suggest hydrogen effect on ZnCoO system and confirm the theoretical model. [1] Shinji Kuroda et al., Nature Mater. 6, 440-446 (2007)[2] Hyeon-Jun Lee and Se-Young Jeong et al., Appl. Phys. Lett. 81, 4020 (2002).[3] D. Rubi and J. Fontcuberta et al., Phys. Rev. B. 75, 155322 (2007)[4] C. H. Park and D. J. Chadi, Phys. Rev. Lett. 94, 127204 (2005).[5] H. -J. Lee and S. –Y Jeong et. al., Appl. Phys. Lett . 88, 062504 (2006).

Dp-055 **열처리 조건에 따른 $Tb_2Bi_1Ga_1Fe_4O_{12}$의 Ga 이온의 부격자 점유도에 관한 연구** 김 철성, 박 일진(*국민대학교*) Garnet $Tb_2Bi_1Ga_1Fe_4O_{12}$를 sol-gel법으로 제조하여 공기 중에서, 그리고 진공 중에서 열처리 하여 열처리 조건에 따른 시료의 결정학적 및 자기적 특성의 변화를 연구하였다Sol-gel 법으로 얻어진 전구체를 각각의 조건에서1000 °C에서 열처리 하여 단일상의 시료들을 합성하였으며, x-선 회절기(XRD), 진동자화율측정기(VSM), 뫼스바우어 분광실험을 이용하여 결정학적 및 자기적 특성을 측정하였다. 결정구조의 분석을 위하여 Fullprof 분석프로그램을 이용하여 Rietveld 방법에 의한 분석을 하였으며, 분석 시 사용한 피크의 모양은 Pseudo-Voigt 함수에 맞추어 분석하였다. $Tb_2Bi_1Ga_1Fe_4O_{12}$의 결정구조는*Ia3d*의 공간그룹을 갖는 cubic구조임을 알 수 있었고, 두 조건에서 얻어진 시료의 격자상수는12.465 Å으로 분석되었다. 시료의 상온에서의 포화자화 값과 보자력은 진공 중에서 열처리한 시료는7.64 emu/g, 229.4 emu 로 측정되었고, 공기중에서 열처리한 시료는1.91 emu/g, 407.5 emu 로 각각 측정되었다. 또한 시료의 온도에 따른 자화곡선이 진공중에서 열처리한 시료는 보상효과를 보이지 않은 반면 공기중에서 열처리한 시료는 350 K 에서 보상점을 가지는 보상효과를 나타내었다. 이와 같은 결과로부터 $Tb_2Bi_1Ga_1Fe_4O_{12}$ 계에서 열처리 조건은Ga 이온의 분포에 영향을 미치며, 비자성이온인Ga의 부격자 점유도에 따라 시료의 자성특성은급격히 달라짐을 확인할 수 있었다.

Dp-056 **Stray Field Effect of Py Nanomagnets** SHIM Seong Hoon, CHANG Joonyeon, HAN Suk-Hee, LEE Yun-Hi[1](*Center for Spintronics Research, Korea Institute of Science and Technology. [1]National Research Laboratory for Nano Device Physics, Department of Physics, Korea University.*) Datta-Das spin transistor geometry is essential to fabricate spin-FETs. Unlike the spin-valve geometry, the two ferromagnets (FMs) are parallel to the transport channel, and the edges of FMs are located on top of the channel in the spin transistor geometry. Consequently, the magnetic fringe fields at the edges cause a local Hall effect on the carriers of the channel. Therefore, it is necessary to examine a possible role of the fringe field carefully in order to minimize side effects. We simulated stray fields from the Py FMs and magnetization chnage of the FMs. Varing the sizes of FMs and the gap between the FMs, we compared the amplitude of the stray fields.

Dp-057 **Effect of surfactants on surface for ink jet printing.** LEE YoungHee, LEE DaeSik, LIM SeongChu(*Department of Physics1, Center of Nanotubes and Nanostructured Composites2, SKKU Advanced Institute of Nanotechnology3 Sungkyunkwan University.*) Single walled-carbon nanotubes (SWCNTs) were dispersed in a water using SDS (sodium dodecyl sulfonate) and NADDBS (sodium dodecylbenzene sulfonate). Regardless of low viscosity, 1-2 cps, our inks were well jetted. It is observed that the surface tension (h) in general decreased at higher surfactant concentration. Also, the low h leaded to a low the contact angle (q) on In layer. However, in CNT/NaDDBS, h and q saturated above critical micelle concentration (CMC). Even at comparable h for those inks, q is much lower in CNT/NaDDBS than CNT/SDS because of hydrophobic chains in NaDDBS, improving the interfacial energy. The line widths of each ink were 50-60 and 110-120 mm for SDS and NaDDBS, respectively.

Dp-058 **Scanning Tunneling Microscopy Study on the Formation of Graphene Layers on the Vicinal 6H-SiC(0001) Surface** 김 일유, 조 은진, 황 찬용[1], 김 원동[1](*전남대학교 물리학과. [1]한국표준과학연구원*) We investigated the possibility of the growth of graphene nano ribbons on the 6H-SiC(0001) surface using Scanning Tunneling Microscopy(STM), Low energy electron diffraction (LEED) and Auger electron spectroscopy(AES). The substrates used in our experiment were sliced from a 6 degree off axis 6H-SiC(0001) wafer. The substrates were then introduced into the ultra high vaccum chamber with 1x10-10 Torr base pressure and treated according to the well-known recipy for the growth of graphene layers on the flat 6H-SiC(0001) surface. At each step of the growth process, the LEED pattern and AES spetra were measured. At several critical stage of the growth, STM experiment were performed to obtain the information of atomic structure of formed graphene layers. At the early stage of the growth, we identified that the short ribbon-like stripes of graphene layers and confirmed that with a suitable condition, the graphene ribbon arrays with better ordering and alignment could be possible.

Dp-059 **$CuFeO_2$ 박막 증착에 대한 연구** 김 철성, 최 동혁, 심 인보(*국민대학교 물리학과*) 일반적으로 여러 증착장비를 사용하여 우선배향성을 가지는 박막이나 에피탁시 박막을 증착할 경우, 증착하는 물질의격자상수와 가장 lattice mismatch가 적은 기판을 사용한다. 본 연구에서는 비정질glass 기판 위에 우선배향성을 가지는 $CuFeO_2$ 박막을 PLD(Pulsed Laser Deposition)로 성공적으로 증착하였다. 또한 XRD, AFM, 및 SEM을 이용하여 결정학적 및 미세구조에 대하여 연구하였다. 박막의 증착에 사용된 target은 고상반응법으로 제조하였고 결정구조hexagonal 구조를 가지며 그 격자 상수는 a_0= 3,033, c_0=17.159 Å으로 분석되었다. $CuFeO_2$ 제조시 second phase로 $CuFe_2O_4$가 잘 생성되는데 이를 없애기 위하여 N_2 분위기에서 증착하였으며, glass 기판온도는 500 ~ 700 ℃ 에서 증착하였다. XRD 측정 결과N_2 분위기 gas의 양에 따라 결정의 성장방향에 많은 영향을 주며, N_2 가 20 mTorr일 때 c-축면을 나타내는 (002), (004), (006), 및 (008)면만 나타남을 확인할 수 있었다. 또한 AFM 및 SEM 측정 결과 hexagonal 결정구조를가지는 육각 판상 모양으로 잘 형성됨을 확인할 수 있었다.

Dp-060 **Study of Cast Iron (CI) based soft magnetic BMG $Ci_{88.3}Al_2Ga_1P_{4.35}B_{4.36}$** KANE Shashank, 이 효진, 김 성백, 정 윤희, HYUN S.W.[1], KIM C.S.[1], VARGA L.K.[2](*포항공과대학교. [1]국민*

대학교. [2]*RISSPO.*) Bulk amorphous cast iron based alloys will be presented as cheap soft magnetic materials which can be cast in sheet form up to several mm. We report the structural and magnetic investigation of $Ci_{88.3}Al_2Ga_1P_{4.35}B_{4.36}$ alloy, by adding minimal amount of glass forming elements (B, P, Al and Ga) to the cast iron to turn it into a bulk glass and to preserve the high saturation induction. Ribbon of nominal composition $Ci_{88.3}Al_2Ga_1P_{4.35}B_{4.36}$, where Ci = $Fe_{72}Si_{3.35}C_{12.3}Mn_{0.6}$ (about 0.035 mm thick and 4 mm wide) was prepared using planar flow casting on copper wheel with 33 m/s tangential velocity. Thermal stability was examined by DTA measurements performed at a heating rate of 20 K/min. The crystallization peak temperature (T_{x1}) was 513 °C. Specimens were annealed in the inert atmosphere of flowing Ar at 460, 515 and 600 °C for 10 min., which are respectively below, at and above T_{x1} values. XRD, transmission Mössbauer spectra and hysteresis loops were measured at room temperature. Temperature dependent magnetization was also measured up to 900 K Annealing at higher temperatures deteriorates the magnetic properties, ascribed to the precipitation of hard magnetic components. It was demonstrated that a cheap soft magnetic material can be obtained from cast iron with B_s about 1.5 Tesla having a possible application as transformer sheet replacing the Fe Si electric steel.

Dp-061 **^{27}Al and ^{55}Mn Nuclear Magnetic Resonance studies of YMn_4Al_8** 강 기혁, 민 병진, 한 기성, 최 헌화, 곽 철영, 이 무희, 조 병기[1](*건국대학교 물리학과.* [1]*광주과기원, 신소재공학과.*) We have performed ^{27}Al and ^{55}Mn pulsed nuclear magnetic resonance (NMR) measurements on a single crystal YMn_4Al_8 at 8 T down to 4 K. NMR spectrum, Knight shift, linewidth, spin-lattice relaxation rate $1/T_1$ and spin-spin relaxation rate $1/T_2$ are measured as a function of temperature for the c-axis parallel and perpendicular to the magnetic field. ^{27}Al NMR spectrum shows two different sites with five satellites for each site from the nuclear quadrupole interaction of nuclear spin I=5/2. ^{55}Mn NMR spectrum shows five broad satellites due to the nuclear quadrupole interaction for the nuclear spin I=5/2. Temperature dependence of Knight shifts and Korringa product T_1T as well as the magnetic susceptibility show a large decrease at low temperature indicating the opening of a pseudo gap in YMn_4Al_8.

Dp-062 **Influence of B and P content on structural and magnetic properties of cast iron based amorphous alloys** KANE Shashank, 이 효진, 김 성백, 정 윤희, KIM C.S.[1], VARGA L.K.[2](*포항공과대학교.* [1]*국민대학교.* [2]*RISSPO.*) Soon after the synthesis of bulk amorphous alloys, Fe-based alloy systems have attracted attention particularly because of their commercial importance as cheap soft magnetic materials. Cast iron (Ci) alloys with a small amount of B allows one to be able to cast cylinders with transversal dimensions of up to 0.5 mm; P helps in obtaining homogenous amorphous phase in the ribbons produced by melt spinning and also helps in improving thermal stability and bulk glass forming ability. In this work we report the influence of B and P content on thermal stability, structural and magnetic properties of cast iron based amorphous alloys using DSC, Mössbauer spectroscopy and magnetic measurements. Ribbons (about 35 μm thick and 4 mm wide) prepared using a planar flow casting technique of nominal composition $Ci_{95.65}B_{4.32}$, $Ci_{91.48}B_{8.42}$, $Ci_{87.82}B_{12.17}$, $Ci_{87}P_{8.65}B_{4.35}$, $Ci_{91.3}P_{4.35}B_{5.35}$ were studied. Results suggest that addition of B and P affects the stability, glass forming ability, spin texture, disorder and the soft magnetic properties of the studied specimens. Detailed results will be presented.

Dp-063 **First-principles Study of Half-metallicity in Fe/MnAs/Fe Structures** KIM Kyung Yeon, CHOI Hyoung Joon(*Department of Physics and IPAP, Yonsei University.*) We study Fe/MnAs/Fe structures by first-principles electronic-structure calculations. MnAs in the zinc-blende structure is a half-metallic ferromagnet in which only majority-spin electrons are present at the Fermi level. To find any modification of the half-metallicity in ferromagnet/half-metal junctions, we obtain Fe/MnAs/Fe structures by minimizing the total energy, and analyze the electronic structures by projected density of states and local density of states for each spin. We use the local spin density approximation and generalized gradient approximation to the density functional theory, norm-conserving semicore pseudopotentials, and pseudo-atomic orbital basis set. Both parallel and anti-parallel alignments of the magnetization in Fe and MnAs are considered. This work was supported by the KRF (KRF-2007-314-C00075), the KOSEF Grant No. R01-2007-000-20922-0, and KISTI Supercomputing Center (KSC-2007-S00-1011).

Dp-064 **고온 열분해법에 의한 나노크기 Ba-Ferrite 제조** 김 철성, 이 인규, 최 동혁, 심 인보(*국민대학교, 물리학과.*) *M*-type Hexagonal $BaFe_{12}O_{19}$ 분말을 제조하는 기존의 합성 방법들에는 고상반응법, 공침소성법, 수열 합성법, 졸-겔법 등이 있다. 이러한 합성 방법들은 대부분 잔여유기물의 분해를 위해 하소과정을 거친 후에 긴 시간의 분쇄 및 혼합과정을 거치게 된다 본 연구에서는 고온 열분해법(High Temperature Thermal Decomposition)을 이용하여 나노 입자들로 구성된Ba-Ferrite 전구체를 제조한 후, 하소과정을 거치지 않고 짧은 시간의 분쇄 및 혼합과정을 거친 후, 열처리 온도 변화에 따른$BaFe_{12}O_{19}$의 결정구조, 미세구조 및 자기적 특성 변화를 관찰 하였다. x-선 회절기(XRD)와 투과전자현미경(TEM) 측정 결과 고온 열분해법에 의한 Ba-Ferrite 전구체는 10nm 크기의 구형 나노 입자들로 이루어졌으며, 950°C 온도에서 열처리 후 70~200nm 크기의 육각판상의 단일상 Ba-Ferrite가 생성 됨을 확인 할 수 있었다. 진동시료형 자화율측정기(VSM)를 이용한 자기적 특성 측정 결과950°C에서의 보자력은 3.15kOe, 포화자화는 60.2emu/g인 단일상의 자기적 성질을 띄는 Ba-Ferrite 분말이 생성됨을 알 수 있었다. 결론적으로 고온 열분해법을 이용한 화학적 제조법에 의한 Ba-Ferrite 제조의 경우 하소과정을 거치지 않고 짧은 분쇄 및 혼합과정을 거친 후950°C 이상의 온도에서 열처리를 할 때 이차상이 존재하지 않는 Nano크기의 단일상 Ba-Ferrite 분말이 제조 됨을 알 수 있었다.

Dp-065 **Al이 치환된 유화물 스피넬물질의 결정학적 및 자기적 성질에 관한 연구** 김 철성, 김 진모, 김 삼진(*국민대학교*

P1 포스터세션

물리학과.) Al이 미량 첨가된 $FeCr_{1.5}Al_{0.5}S_4$을 직접합성법으로 제조하였다. 제조된 시료를 X-선 회절기 (XRD), 진동 시료 자화율 측정기(VSM), 뫼스바우어 분광기(mössbauer spectroscopy)를 이용하여 결정학적인 성질과 자기적인 성질을 연구하였다. Rietveld 방법으로 X-선 회절도 분석 결과 결정구조는 공간 그룹 Fd3m을 가지는 Cubic Spinel 구조로 결정하였고 격자상수는 a=10.010 Å로 결정되었다. 진동 시료 자화율 측정기를 이용하여 온도구간 50 K부터 300 K까지 외부자기장 5 kOe 하에서 시료의 자화곡선 (zero-field-cooled curve:ZFC) 측정하였고 Neel온도는 128 K로 결정되었으며 포화자화 값은 0.65μ_b로 준강자성 자기적 질서를 이루고 있음을 밝혀냈다. 초미세 자기 상호작용의 변화를 알아보기 위해 뫼스바우어 스펙트럼을 측정하였고 4.2 K에서의 뫼스바우어 스펙트럼은 8개의 흡수선이 임의의 위치에서 중첩된 매우 비대칭적인 형태를 나타내었다. 상온에서의 뫼스바우어 데이터는 커다란 전기 사중극자에 의하여 갈라진 두 개의 흡수선이 대칭적인 모습을 나타내었다.

Dp-066 **다결정 $MnCr_2O_4$ 기저상태의 자기적 특성 연구**
윤 동영, 이 순칠, 오 윤석[1], 김 기훈[1](*한국과학기술원 물리학과.* [1]*서울대학교 물리학과.*) 최근 산업적 응용 가능성이 클 것으로 예상하는 multiferroic에 대해 많은 사람들이 관심을 갖고 있다. 우리는 magnetoelectric 효과를 가지고 있는 스피넬 계열의 다결정 $MnCr_2O_4$에 대해 Zero Field NMR과 SQUID를 이용하여 연구하였다. $MnCr_2O_4$는 상온 이하에서 입방구조를 가지고 있다. SQUID로 측정한 자화-온도 곡선에서는 약 40 K와 20K에서 2개의 뚜렷한 상전이 온도를 보여주고 있으며, 전자는 상자성-상평행 준강자성, 그리고 후자는 상평행 준강자성-원뿔 정렬(conical ordering)의 상전이 온도로 알려져 있다. 그러나 20K 이하에서 스핀 유리 특성도 같이 나타나기 때문에 스핀 기저 상태에 대한 의문이 여전히 남아있다. 스핀들의 기저 상태를 알기 위하여 20K 이하에서 Mn-NMR과 Cr-NMR을 수행하였고, 외부 자기장의 크기와 그에 따른 스펙트럼 이동량을 통해 스핀들이 원뿔 정렬과 같이 기울어져 있다는 것을 관측하였다. 한편 5K에서 시간이 지남에 따라 자화 크기가 약 6.3%의 증가하는 것과 함께 20K 이하에서 ZFC과 FC에서의 자화 크기의 차이를 보여주는 등 스핀 유리 특성도 존재한다.

Dp-067 **L 모양 나노 선에서의 자기장 유도 자벽 이동 분석** 윤 정범, 이 재철[1], 유 천열[2], 최 석봉[3], 신 경호[4], 정 명화[5](*한국기초과학지원연구원, 양자물성연구팀, 인하대학교, 물리학과.* [1]*한국과학기술연구원, 스핀트로닉스연구단, 서울대학교, 물리학과.* [2]*인하대학교, 물리학과.* [3]*서울대학교, 물리학과.* [4]*한국과학기술연구원, 스핀트로닉스연구단.* [5]*한국기초과학지원연구원, 양자물성연구팀, 서강대학교, 물리학과.*) 최근 스핀전달토크 현상에 관한 연구가 활발히 진행되고 있다. 스핀 전달 토크 현상은 자성체에 전자가 주입될 때 전자의 스핀 각운동량이 자성체의 자기 모멘트에 전달되어 자성체의 자기적인 상태가 변하는 현상을 말한다. 이러한 스핀전달토크현상에 의해 자벽을 전류로 이동시킬 수 있다는 사실이 알려져 있다. 그러나 아직 스핀전달토크 현상의 이론은 실험적 결과들을 완전히 설명하고 있지 못하다. 그래서 본 연구는 전류 유도 자벽 이동에 관한 연구의 선행 연구로서 자기장 유도 자벽 이동에 관한 연구를 하였다. 우리는 두께가 20 nm 이고 선폭이 600 nm 인 L 모양의 퍼멀로이 나노 선을 제작하였으며 이 시료에서 자벽의 생성과 소멸을 MFM (magnetic force microscope) 와 OOMMF (Object Oriented MicroMagnetic Framework) 시뮬레이터를 비교하여 자구와 자벽의 구조를 확인하였다. L 모양의 나노선을 위 방향으로 포화시키고 자기장을 0으로 줄였을 때 자벽이 생기는 과정과 반대방향인 아래 방향으로 자기장의 세기를 증가하였을 때 자벽이 사라지는 과정을 MFM으로 관측하였으며 OOMMF 시뮬레이터에 의해 확인하였다. 자기 이미지와 시뮬레이터를 분석한 결과 매우 유사한 자기 구조를 확인할 수 있었다.

Dp-068 **Magnetic transition of perovskite $SrFe_xMo_{1-x}O_{3\pm\delta}$**
이 효진, 박 병규, 송 종현[1], 구 태영[2], 박 재훈, 정 유희(*포항공과대학교, 물리학과.* [1]*충남대학교, 물리학과.* [2]*포항가속기연구소, 포항공과대학교, 물리학과.*) We have investigated systematically the crystal structure, electrical transport, and magnetic properties for a series of polycrystalline $SrFe_xMo_{1-x}O_{3\pm\delta}$ ($0.0\le x\le 1.0$) samples and constructed the magnetic phase diagram based on physical properties and electronic structure results for a series of compounds. The structural phase transition is observed for a series of polycrystalline $SrFe_xMo_{1-x}O_{3\pm\delta}$ ($0.0\le x\le 1.0$) at room temperature. Electrical properties also change along the series. We have found Pauli paramagnetic, antiferromagnetic ordering, and spin-glass behavior for a series of compounds. The magnetic and transport properties of $SrFe_xMo_{1-x}O_{3\pm\delta}$ ($0.0\le x\le 1.0$) in detail will be presented.

Dp-069 **Thermoelectric properties of Ca doped $LaCoO_3$**
LAREF Amel, CHOI Hongchul, MIN Byung-Il(*POSTECH.*) The thermoelectric properties of Ca doped lanthanum cobaltite (LaCoO3) are studied based on the semiclassical Boltzmann theory. The band structure of Ca doped LaCoO3 is obtained by using the *ab-initio* full-potential linearized augmented plane-wave (FLAPW) band method. From this analytical representation we calculate the derivatives necessary for the transport distributions. Thermopower, resistivity, thermal conductivity, and Hall effect are calculated by employing the semiclassical transport. The results are discussed in terms of the mixed low and intermediate spin states for this system. The calculations of Ca doped Hall coefficients for La1-xCaxCoO3 ($0.25<x<0.5$)suggest that the band structure plays an important role in determining the thermoelectric properties only at low concentrations. Our study is expected to predict good thermoelectric properties of this system.

Dp-070 **The Magnetoresistance Change in the Thin Cobalt Films According to the Angle Between the Film and the Magnetic Field** KIM Chan, BAE Hong-Sub, YANG Kiwon, RHEE Ilsu(*Kyungpook National University.*) The magnetoresistance change in the thin cobalt films was investigated for various angles between the film and the magnetic field. The angle between the film and the magnetic field is rotated and inclined relative to the magnetic field direction. When the rotation angle increases at a fixed inclination angle, the magnetoresistance peaks are changed from the down to the upper shape at a certain rotation angle. On the other hand, if the inclination angle is increased at a fixed rotation angle, the magnetic field difference between two magnetoresistance peaks, which is proportional to the coercive force, is increased.

■ SESSION: P2
4월 18일(금), 09:00 - 10:45
장 소: 109호

Ep-001 **Development of an MeV Proton Beam Writing Technology** JUNG Sung-Woo, NOH Byung-Hoon, KIM Kwan-Do, YOUN Minyoung[1], JEONG Yoon-Ha[2](*National Center for Nanomaterials Technology (NCNT). [1]National Center for Inter-University Research Facility, Seoul National University(NCIRF-SNU). [2]National Center for Nanomaterials Technology (NCNT), Pohang University of Science and Technology(POSTECH).*) Proton beam writing is a new direct write lithography technique for fabricating high aspect ratio structures[1]. Proton beam writing employs a focused MeV proton beam scanned in a predetermined pattern over a resist, which is subsequently chemically developed[2]. In this paper, we report an MeV proton beam lithography as an advanced lithography technology. We use 5㎛ thickness PMMA film as a resist, and the fluence is 100nC/mm^2 and development is done with IPA-water(7:3) for 20 min and rinsed in D.I. water.[3] The exposed pattern is 200㎛ wide and 5 mm long. Through this experiment, we show the potential of the proton beam a lithography technology.
*Acknoledgement : This study is sponsored by the 21st century Frontier R&D Programm of Ministry of Science &Technology.
Ref.[1] J. A. van Kan et al, Appl. Phys. Lett., 53, 1629 (2003) [2] J. A. van Kan et al, Microsyst. Tehnol., 13, 431 (2007) [3] N. Uchiya et al, Meth. in Phys. Res., B 260 (2007)

Ep-002 **유기 발광 소자 ITO/Alq$_3$/LiAl의 내장 전압** 윤희명, 이 은혜, 한 원근, 김 태완, 장 경욱[1], 정 동희[2], 송 민종[3](*홍익대학교, 디스플레이공학과. [1]경원대학교, 전기공학과. [2]광운대학교, 전기공학과. [3]광주보건대학, 의료정보공학과.*) 변조 광전류 분광학을 사용하여 내장 전압을 측정하였다 소자에 인가 전압이 영일 때 양극과 음극의 일 함수 차이 때문에 내장 전압이 존재하며, 그로 인해 내장 전기장이 생긴다. 유기 발광 소자의 광전도도는 엑시톤이 자유전자와 정공으로 분리될 때 발생한다. 이 때 발생되는 광전류와 광전류의 위상 변화를 측정하여 내장 전압을 추정 한다. 실험 장치로는 500W Xenon 램프, Keithley 236 SMU, Stanford SR530 lock-in amplifier를 사용하였다. 소자에 빛을 인가하여 발생되는 미세 광전류를 lock-in amplifier를 통하여 측정하였다. 이 때 사용한 chopping 진동수는 20Hz로 하였다. lock-in amplifier에서는 미세 광전류의 크기와 위상을 측정하며, 이들의 변화를 통하여 내장 전압을 측정하게 된다. 소자의 구조는 두 전극 사이에 단층으로 하여 만들었으며 모든 소자의 Alq$_3$ 두께는 150nm로 하고, 양극은 ITO를 사용하였고 음극은 Al과 LiAl을 100nm, 150nm 두께로 하였다. 양전극을 100nm로 하였을 때 내장 전압의 측정 결과 ITO/Alq$_3$/Al의 내장 전압은 0.9eV로 측정된 데 반해 ITO/Alq$_3$/LiAl은 1.6eV로 측정되었다. 따라서, LiAl을 사용한 소자의 경우 Al을 사용한 소자에 비해 내장 전압이 0.7eV 증가되었다. 이는 LiAl의 일함수가 Al보다 낮은 값을 갖는 것과 일치하는 결과이다. 다음으로는 Al과 LiAl를 150nm 두께로 하였을 때의 내장 전압에 대한 결과도 발표하고자 한다.

Ep-003 **Silicide process를 이용한 Co2MnSi 형성** 이 성재, 이 영백, 이 용수, 현 영훈, 조 환웅(*한양대학교 물리학과*) Co2MnSi는 반금속(half-metal) 자성체로서 0.4 eV의 minority bandgap 및 985 K의 큐리온도 등의 여러 장점으로 인하여 실리콘 기반 스핀 트랜지스터의 전극 후보 물질로서 각광받고 있다. 기존의 CMOS 기술을 그대로 활용하여 sub-100 nm 크기의 스핀 트랜지스터를 제작하기 위해서는 silicide (self-aligned silicide) process에 의한 Co2MnSi 소스와 드레인 전극 형성이 필수적이다. 본 연구에서는 이를 위하여 SOI (Silicon-On-Insulator)의 실리콘 표면에 Co/Mn 다층박막을 증착하고 다양한 후열처리 방법을 통하여 Co-Mn-Si 박막을 형성한 뒤 미세구조 및 자성 특성을 측정 분석하였다. 그 결과, 600 ℃, 10분간의 RTA (Rapid Thermal Annealing)의 조건에서 Co2MnSi 화합물이 잘 형성되며 1.6 μB/Co-atom에 해당하는 높은 포화자성(saturated magnetization)을 갖는 강자성 특성이 관측되었다 또한 전기전도도 측정을 통해 미세구조-자성-전자수송 특성간의 상관 관계를 규명하였다.

Ep-004 **Magnetic properties of ferritin core in PVA nanofibers** 현 영훈, 박 상윤, 서 민수, 이 영백, 김 기원[1], 신 민균[2], 김 선정[2](*한양대학교, 물리학과. [1]선문대학교, 물리학과. [2]한양대학교, 의공학과.*) The morphological and the magnetic properties of ferritin-embedded poly(vinyl alcohol) (PVA) nanofibers were investigated. The morphological difference between the mono-distributed ferritin (MF) and the clustered feritin (CF) samples was studied by high-resolution transmission electron microscopy (HR-TEM) and scanning electron microscopy. A superconducting quantum interference device magnetometer was used to analyze the magnetic properties of samples. The HR-TEM image shows that the giant clusters in CF sample are composed of a large number of ferritin nanoparticles. Even though the size is significantly large, the CF sample exhibits superparamagnetic (SPM) behavior. The magnetic phase of ferritin core was partly changed, depending on the heat treatment temperature. To elucidate the electronic structures of the ferritin cores at different heat treatment temperatures, x-ray absorption spectroscopy (XAS) was carried out with an energy resolution of 0.8 eV in total electron yield mode. From the XAS result, it was observed that the ionic state of Fe core has been changed from Fe^{2+} to Fe^{3+} after the heat treatment.

Ep-005 **Enhanced magneto-optical Kerr effect in one-dimensional gyrotropic gratings** LU Yuehui, CHO Minhyung, KIM Jinbae, LEE Geonjoon, LEE Youngpak, RHEE Jooyull[1](*1q-Psi and BK21 Program Division of Advanced Research and Education in Physics, Hanyang University, Korea. [1]2BK21 Physics Research Division and Institute of Basic Science, Sungkyunkwan University, Korea.*) Polar magneto-optical (MO) Kerr effects of one-dimensional gyrotropic gratings are numerically investigated for the zeroth and the first order diffracted beams by utilizing the rigorous coupled-wave approach implemented as an Airy-like internal-reflection series. The simulated Kerr spectra are compared with the experimental ones, presented by Antos *et al.* [Appl. Phys. Lett. 86, 231101 (2005)], and they are coincident well. The mechanism of the enhanced MO Kerr effect in the first-order diffraction, compared with that in the zeroth

one, is elucidated, and the diffracted MO Faraday effect is theoretically investigated as well. Such an enhancement through the gyrotropic gratings is superior to the conventional MO devices and the spin-photonic crystals. The potential applications are also suggested.

Ep-006 **Synthesis and luminescence properties of ZnO nanorods produced by a simple hydrothermal reaction** LEE Cheol Eui, LEE EunMo, PARK Jun Kue, LEE Su Chul(*Department of physics, Korea University.*) Zinc oxide (ZnO) is a wide-band-gap semiconductor material that is now being developed for many applications, including ultraviolet (UV) light-emitting diodes, UV photodetectors, transparent thin-film transistors, and gas sensors. In the present works, ZnO nanorods were fabricated by a hydrothermal reaction in ammonia and zinc chloride solution without any surfactant at 95◦C in a hydrothermal vessel. The microstructure characterization of x-ray powder diffraction (XRD), Raman and Scanning electron microscopy (SEM) images demonstrated that all ZnO nanorods grew along the [0001] direction. The optical properties of the product were studied. Some factors affecting the morphologies and optical properties were also investigated.

Ep-007 **Influence of ZnO nanorod on the luminescent properties of fluorescent dye-doped polymer nanocomposite** LEE Cheol Eui, PARK Jun Kue, LEE Kyu Won, LEE EunMo (*Department of physics, Korea University.*) The luminescent properties of fluorescent dye-doped polymer dispersed with ZnO nanorods were investigated. Poly(vinylcarbazole) (PVK) doped with 4-(dicyanomethylene)-2-methyl-6-(4-dimethylaminosty-ryl)-*4H*-pyran (DCM) at 1 wt% and ZnO nanorods were prepared by sonicating in chloroform respectively. The photoluminescence (PL) spectra were measured by using the DongWoo DM500i monochromator, SR 830 DSP Lock-In Amplifier and PMT. The excitation source is Argon Ion laser radiation (λ=351 nm) of power 60 mW, operating in continuous conditions. All of the measurements were performed at room temperature under ambient pressure conditions.

Ep-008 **The structure of thin diblock copolymer films studied by x-ray scattering.** 송 상훈, 차 원석, 김 제은[1], 김 현정[2](*바이오 융합기술 협동과정, 서강대.* [1]*물리학과, 서강대.* [2]*물리학과 &바이오 융합기술 협동과정, 서강대.*) We have investigated the thin diblock copolymer films of poly(styrene)-b-poly(butadiene) using x-ray reflectivity, grazing incidence small angle scattering (GISAXS), X-ray photon correlation spectroscopy(XPCS) .The measurements were performed at temperatures 30C~210C with difference thicknesses. The x-ray reflectivity and GISAXS results show that the structural changes appear at different temperature depending on the film thicknesses. These results will be compared with the calculation of electric field distribution(EFI) as a function of depth and incident angle. The surface dynamics from the XPCS will also be discussed. This study was supported by Korea Science &Engineering Foundation and Seoul Research &Business Development program (10816) and by Korea research Foundation. Experiment performed at 8ID beamline of Advanced Photon Source and 4C2 beamline of Pohang Accelerator Laboratory

Ep-009 **3D Imaging of Zeolite Single Crystals by Using Coherent X-ray Diffraction** CHA Wonsuk, SONG Sanghoon, JEONG Nak Cheon[1], YOON Kyung Byung[1], HARDER Ross[2], ROBINSON Ian K.[2], KIM Hyunjung(*Sogang University, Interdisciplinary Program of Integrated Biotechnology and Department of Physics.* [1]*Sogang University, Interdisciplinary Program of Integrated Biotechnology and Department of Chemistry.* [2]*University College London, Department of Physics and Astronomy.*) Coherent x-ray diffraction imaging(CXDI) is a rapidly advancing technique in form of microscopy. Since x-ray has very high resolution and capability of penetration, we can see not only the outside of sample but also the inside. In this study we carried out CXDI to map internal strain distribution of zeolite single crystals as a function of temperature. The measurements were performed at the temperature 30~400℃. The reconstruction process will be also presented. This study was supported by Korea Science &Engineering Foundation and Seoul Research &Business Development program (10816) and performed at 34ID-C beamline of Advanced Photon Source.

Ep-010 **Physical Vapor Deposition(PVD)에 의해 성장된 Copper Phthalocyanine(Cu-Pc) 박막의 열처리 온도변화에 따른 표면 특성연구** 김 미정, 강 상백, 채 영안, 오 동훈, 차 덕준, 조 승곤[1], 정 양준[1], 이 기진[2](*군산대학교 물리학과.* [1]*목포대학교 물리학과.* [2]*서강대학교 물리학과.*) Cu-Pc유기물 반도체를 PVD방법으로 ITO와 Si 기판위에 적층하여 표면의 특성을 조사하였다. 기판온도를 상온 및 100℃, 200℃, 300℃로 서로 다르게 고정하여 박막을 성장한 후, 이를 100℃부터 350℃이내의 서로 다른 온도와 시간으로 후열 처리하여 온도 변화에 따른 결정 구조 및 특성 변화를 측정하였다. Cu-Pc 박막의 성장두께는 100nm 이내로 fluxmeter 및 thickness monitor를 이용하여 제어하였다. 제작된 Cu-Pc의 박막은 {alpha}-phase와 {beta}-phase로 구분할 수 있으며 X-ray diffraction(XRD) 및 atomic force microscopy(AFM) 그리고 field emission scanning electron microscopy(FE SEM)를 이용하여 Cu-Pc 박막의 phase변화 및 구조적 결정성과방향성 등, 표면의 특성을 측정하여 비교분석 하였다.

Ep-011 **Co_2Z-Type 육방정 페라이트의 열처리 온도에 따른 특성 연구** 금 준식, 안 원기, 성 원모(*EMW 안테나, 중앙연구소, 기반기술팀.*) 공침법을 이용하여 $Co_2Z(Ba_3Co_2Fe_{24}O_{41})$ 분말을 제조 하였다. Co_2Z 의 특성을 연구하기 위해서 X-선 회절기(XRD), 진동시료 자화율측정기(VSM), RF 임피던스 아날라이저, 네트워크 아날라이저 를 이용하여 연구하였다. 1000 °C ~ 1300 °C 온도에서 열처리한 Co_2Z 분말을 XRD 를 측정해 본 결과 M-type, Y-type, Z-type 육방정 페라이트로 상이 변화하는 것을 확인 할 수 있었다. 여러 온도에서 열처리한 결과, 1250 °C 열처리 온도에서 단일상에 가까운 Co_2Z 페라이트 구조가 형성됨을 XRD 결과 확인할 수 있었다. VSM 을 이용하여 열처리 온도에 따른 포화 자화값, 보자력 값을 측정 하였다. 1250 °C 에서 열처리 한 분말의 유전율을 측정하기 위해서 Disk 를 제작하였으며, 복소 투자율 측정을 위

해서 toroidal 모양의 Disk 를 제작하였다. RF 임피던스 아날라이저를 측정한 결과200 MHz 에서 복소투자율 값은5.15, 유전율 값은 11.07 임을 확인 하였다. 네트워크 아날라이저를이용하여 공명주파수를 확인하였다.

Ep-012 **Magneto resistance and Thermoelectric power of the iodine doped Poly(vinyl Alcohol)-Cu^{2+} Chelate** PARK JiHyun, KIM YuKyung, YOO HoNam, NAM YoungWoo, CHU Seungwan, CHO ChongSu[1], PARK YungWoo(*Department of Physics and Astronomy &Nano Systems Institute–National Core Research Center, Seoul National University. [1]Department of Agricultural Life Engineering, Seoul National University.*) Organic semiconducting polymers can be classified into three types, such as π-electron systems, charge-transfer complex systems, and metal chelates. Among various type of organic semiconducting polymers, poly(vinyl alcohol)–Cu^{2+} chelate doped with iodine (PVA/Cu^{2+}/I_2) is known to have good surface conductivity [1]. To investigate the intrinsic bulk conductivity, we have measured the temperature dependent conductivity of the (PVA/Cu^{2+}/I_2) down to T=4K under magnetic field up to H=7 tesla. Four-probe pressure contact using platinum electrodes is applied for the conductivity measurement. The room temperature conductivity is $\sigma_{RT}=10^{-2}$ ~10^{-3} S/cm and it shows a broad maximum peak at around T=60K {σ(60K)/ σ_{RT}=1.4}. The magneto resistance (MR, Δρ/ρ) is positive and increased linearly as magnetic field increases up to 7 tesla. The results indicate that the observed high conductivity of the (PVA/Cu^{2+}/I_2) is not simply from the surface conductivity. It can be a bulk property of the doped sample. Thermoelectric power (TEP) has been measured from room temperature down to 1.8K. At room temperature, the TEP is +110μV/K and it decreases linearly upon cooling to T=1.8K. The positive TEP and high room temperature value indicate that the (PVA/Cu^{2+}/I_2) is p-type semiconducting. And yet, the linear temperature dependence of TEP suggests metallic characteristics of the sample. In addition the magneto-TEP has been measured at H=7 tesla for T<28K. The magneto TEP shows a slight reduction compared to the zero-field results indicating little influence of the magnetic field on the TEP. Reference[1] F. Hihashi, C. S. Cho, H. Hinoki, O. Sumita, *J. Polym. Sci., Polym. Chem. Ed. 17, 313* (1979)

Ep-013 **양면 발광용 유기 발광 소자의 유기물층 두께 변화에 따른 발광 스펙트럼 분석** 안 희철, 나 수환, 주 현우, 신 은철, 김 태완, 한 원근, 이 원재[1], 홍 진웅[2](*홍익대학교. [1]경원대학교. [2]광운대학교*) 유기 발광 소자의 발광 특성을 향상시키기 위하여 음극 방향에는 전자 주입층(HIL)과 수송층(HTL), 양극 방향에는 정공 주입층(EIL)과 수송층(ETL) 그리고 발광층(EML)의 다층 구조로 소자를 제작한다. 이러한 다층 구조의 소자에서 각 유기물층의 재료와 두께는 유기 발광 소자의 발광 특성에 직접적 영향을 미친다. 본 연구에서는 ITO/TPD/Alq_3/LiF/Al/Ag 구조로 제작하고, 이때 양전극으로는 ITO 투명 전극을, 음전극으로는 Al/Ag의 반투명 전극을 사용하여 양면으로 발광하는 소자를 구현하였다. 유기물층의 총 두께를 80nm~120nm로 변화시켰으며, HTL층과 EML층의 비는 4:6으로 EIL층은 0.5nm로 고정시켰다. 유기물층의 두께 변화에 따른 발광 스펙트럼을 시야각에 따라 측정하였으며, 발광 물질 고유의 PL값과 발광 스펙트럼이 일치하는지를 살펴보았다. 또한 극 좌표로 변환하여 Lambertian 발광과 비교하였다. 본 연구는 앞의 실험을 통해 유기 발광 소자의 양쪽 전극 사이에서 간섭 효과에 의한 microcavity 현상이 유기물층의 두께에 따라 어떻게 변하는지를 분석하고자 한다.

Ep-014 **RuO_2 코팅을 통한 탄소나노튜브의 전계방출 특성연구** 박 종윤, 이 승엽, 김 유석, 최 원철[1](*나노튜브 및 나노복합구조센터&BK21 물리연구단 성균관대학교. [1]나노튜브 및 나노복합구조센터, 성균관대학교*) 탄소나노튜브(CNT)는 material로써의 특성이 우수[1]하여 energy storage and energy conversion devices, sensors, field emission displays and radiation sources, hydrogen storage media and nanometer-sized semiconductor devices, SPM probes등 여러 분야에서 활발한 연구가 이루어지고 있다. 특히 field emission 분야에서는 1995년 Walt A. de Heer에 의해서 처음으로 CNT의 우수한 field emission특성이 확인된 이후로 끊임없이 다양한 연구들이 이루어지고 있다. 일반적으로 CNT의 field emission특성의 향상을 위해서는 적절한emitter's density, large aspect ratio, short counter electrode distance등이 요구된다. 하지만 최근에는 다양한 특성의 material들을 코팅함으로써 CNT의 field emission특성을 향상시킨 연구들이 많이 보고되고 있다. 이러한 material들은 크게 두 가지로 종류로 나눌 수가 있는데 하나는 work function이 낮은 material로써 전계방출시 effective work function을 낮추어 줌으로써 electron들의 emission이 쉽게 이루어지게 한다. 이러한 방법은 낮은 인가전압 하에서의 emission을 얻을 수 있을 뿐만 아니라 전류밀도의 향상에도 도움을 준다. 다른 하나는 emission시에 발생하는 residual gas에 의한 ion bombardment로부터 emission site를 보호하는 protective layer로써의 coating으로 SiO2, MgO등의 metal oxide가 사용된다. 이러한 경우에는 metal oxide가 insulating layer로 작용하여 emission 특성에 나쁜 영향을 미치지만 emission stability 측면에서는 긍정적인 특성을 보인다. RuO_2는 transition metal oxide로 tetragonal rutile 구조를 갖으며, 일반적인 metal oxide와는 달리 metallic한 특성을 갖는다. 또한 높은 화학적 · 열역학적 안정성을 갖고 있어서 지금까지 여러 분야에서 많은 연구가 이루어져 왔다. 본 연구에서는 이러한 RuO2를 CNT에 코팅하여 발생하는 화학적 조성변화와물리적 특성변화를 ESCA로 분석하고 CNT에 field emission특성 변화와의 관계를 연구하였다. [참고문헌] 1. G. Dresselhaus M. S. Dresselhaus, and P. Avouris, Carbon Nanotubes : Synthesis, Structure, Properties, and Application. (Springer, Berlin, 2001).

Ep-015 **A study of electrical transport and forming effect in Nb_2O_5 film by means of FIB-SEM** JUNG kyooho, KIM yongmin, HWANG inrok[1], LEE jiyeong[2], PARK beaho[1], IM hyunsik, LEE Jeon-Kook[3], SONG jea-hoon(*Dongguk University, Department of Semiconductor Science. [1]Konkuk University, Department of Physics. [2]Korea Institute of Science and Technology, Nano-Materials Research Center. [3]Korea Institute of Science and Technology, Thin Film Materials Research Center.*) We have investigated current characteristics of Nb_2O_5, the resistance switching material , in terms of temperature. Fundamentally, Nb_2O_5 has structure of MIM (Metal(Pt)/Insulator (Nb_2O_5)/Metal(Pt))) and the characteristic of reversible resistance. Nb_2O_5 has three type different current levels-the Low Resistance

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State (LRS or ON state), the High Resistance State (HRS or OFF state) and initial state, respectively. We observed current property of Pt/ Nb_2O_5/ Pt from room temperature to 7K. As temperature is decreased, while the LRS current increase as metallic property, the HRS current decreases and then saturates at a certain value. Also, to analysis of filamentary conduction path in Nb_2O_5 film by forming effect, images of cross section in Nb_2O_5 were scanned after forming by using Focused Ion Beam Scanning Electron Microscope(FIB-SEM) with in-situ IV measurement system, and we discovered the metallic path by forming process, clearly.

Ep-016 **소동물 생체영상 양전자방출단층촬영술(PET)에서 양전자방출동위원소의 물리적 특성이 영상의 정량화에 미치는 영상에 대한 고찰** 김 경민, 김 진수, 우 상근, 김 종국, 천 기정(*한국원자력의학원 방사선의학연구소 분자영상연구부*) 양전자방출단층촬영술(positron emission tomography)은 양전자방출동위원소 표지 방사성의약품을 체내에 주사한 후 방출되는 감마선을 체외에서 검출하여 영상화 할 수 있어, 최근 환자영상은 물론, 쥐와 같은 소동물을 이용한 신약개발평가 연구에서 널리 사용되고 있다. 소동물 이용 연구에서 사용되는 방사성의약품은F-18이나 C-11와 같은 방사성동위원소외에도I-124와 같은 양전자방출동위원소가 유용하게 이용된다. 이 연구에서는 가장 널리 사용되는 F-18과 I-124의 물리적 방사선 방출특성이PET데이터의 획득과 영상특성에 미치는 영향에 대해 컴퓨터 시뮬레이션과 물리적 실험을 통해 분석하였다. 실험에 사용되는 방사성동위원소와 영상화 대상 사물의 크기에 대한 충분한 고려가 정확한PET영상 분석에 필요하다.

Ep-017 **계면거칠기가 자기터널접합의 자기저항 및 자화스위칭에 미치는 영향** 이 선영, 이 장로, 임 혜인, 전 병선[1], 황 재연[2], 김 태완[3], 김 유송[4], 김 영근[4], 이 상석[5], 황 도근[5](*숙명여대, 물리학과.* [1]*Trinity College, CRANN.* [2]*원자력 연구소, 하나로센터.* [3]*세종대학교, 나노신소재공학과.* [4]*고려대학교, 신소재공학과.* [5]*상지대학교, 동서의료공학과.*) A DMTJ (double-barrier magnetic tunnel junction) requires ultrasmooth and uniform tunnel barriers where, in particular, the top one is more critical but very difficult to fabricate . To resolve this problem, we introduced an amorphous magnetic CoFeSiB to retard the columnar growth resulting in a wavy interface. The basic DMTJ structure consisted of Ta 45/Ru 9.5/IrMn 10/CoFe 7/AlO_x/free layer 7/AlO_x/CoFe 7/IrMn 10/Ru 60 (nm). Various free layers such as CoFe 7, CoFeSiB 7, and CoFe 1.5/CoFeSiB 4/CoFe 1.5 were prepared and compared. The structural and magneto-transport properties of DMTJs depending on the free layer structure are summarized here. By using an amorphous CoFeSiB layer, the normalized TMR(tunneling magnetoresistance) ratio (at +, - 0.4 V) and V_h (the voltage where the TMR ratio becomes half of its nonbiased value) increased and H_i (the interlayer coupling field) decreased. This result can be attributed to the fact that the upper tunnel barrier of the DMTJ became more uniform with the CoFeSiB layer compared to that with the CoFe layer. For reducing the H_i and suppressing the bias voltage dependence of the TMR ratio, the smooth free layer/tunnel barrier is indispensable.

Ep-018 **A study on structural characterization of 1-D ZnO nanostructures synthesized by VLS method** CHOI seokcheol, LEE changmin, DHO joonghoe[1], SOHN sangho[1](*Dept. of nano science and Technology, Kyoungpook National University, Daegu 702 701, Korea.* [1]*School of Physics and energy science, Kyoungpook National University, Daegu 702 701, Korea.*) One-dimensional semiconducting nanostructures, such as nanowires, nanobelts, nanoribbons and nanoplates have attracted much attention due to their unique properties like quantum confinement effect, surface area effect. ZnO material generally has wide band gap larger than IV element and has an exciton binding energy (60meV) larger than thermal energy. In this study, 1-D ZnO nanostructure were successfully synthesized by VLS method. The structures of Zinc oxide were characterized by XRD, SEM, TEM(SAED). According to XRD data, the structure of zinc oxide usually composed of two structure – wurzite &zincblende – together. In case of zinc oxide, the energy between two structure is so small that transition occur easily without large energy consumption. According to SEM result, various morphology – nanowire, nanorod, nanoribbon, nanoplate – observed. The growth direction varies with time, structure and morphology. But there maybe exist energetically favorably growth directions. Anyway, the SEM result couldn't find the growth properties of nanostructures. Therefore, we find the TEM. According to TEM(SAED) result, we knew the growth mechanism of nanostructures and defect on grown nanostructures.

Ep-019 **Gamma-ray Irradiation Effect on Polymer Solar Cells** LEE Cheol Eui, KIM Min Seok, KIM Namkyoon, LEE Kyu Won, LEE Eunmo, OH In Hwan(*Korea University, Department of Physics.*) The polymer composite of regioregular poly(3-hexylthiophene) (P3HT) and phenyl-C61-butyric acid methyl ester (PCBM), used as organic solar cells, was prepared by spin-coating on the ITO (indium-tin-oxide) glass. Time of flight (ToF) was measured before and after the gamma-ray irradiation. After the irradiation, the charge carrier mobility increased as compared with before. X-ray diffraction (XRD) was used to investigate the crystallization property before and after the irradiation. The XRD data revealed that the gamma-ray irradiation enhances the crystallinity in the P3HT:PCBM thin films.

Ep-020 **Single Crystalline Bi Nanowires by In-situ Self Assembled Wiring for High-efficiency Thermoelectric Devices** HAM Jinhee, KANG Joohoon, JEON Kyejin, LEE Wooyoung (*Department of Materials Science and Engineering, Yonsei University, 134 Shinchon, Seoul 120-749, Korea.*) Semimetallic bismuth (Bi) has been extensively investigated over the last decade since it exhibits very intriguing transport properties due to their highly anisotropic Fermi surface, low carrier concentration, long carrier mean free path l, and small effective carrier mass m^*. In particular, the great interest in Bi nanowires lies in the development of nanowire fabrication methods and the opportunity for exploring novel low-dimensional phenomena as well as practical application such as thermoelectricity [1]. In this work, we present the in-situ formation of highly single-crystal-

line Bi nanowires as a high efficient thermoelectric material.We demonstrated *in-situ* Bi nanowire device fabrication by self-assembled wiring using On Film Formation of Nanowires (OFF-ON). A Bi thin film was first deposited on a thermally oxidized Si (100) substrate at the rate of 32.7 Å/s by an UHV radio frequency (rf) sputtering system. For the lateral growth of the Bi nanowires, we sputtered a thin Cr (or SiO_2) layer on the topside of the Bi film. After thermal annealing, the Bi nanowires cannot be pushed out from the topside of the Bi films due to the Cr (or SiO_2) layer. Instead, Bi nanowires grow laterally as a means of releasing the compressive stress. In particular, the growth spot and the growth direction of nanowires can be controlled the pattern shape and applied electric field during the growth of the nanowires. We observed scanning electron microscope (SEM) images of *in-situ* self-assembled Bi nanowire (d = 192 nm) device using OFF-ON after annealing at 250 ˚C for 5 hours. From I-V curve taken for the Bi nanowire device fabricated by self-assembled wiring, we demonstrated the formation of ohmic contact in the nanowire device. These results suggest the possibility of self-assembled interconnection of nanostructures for a variety of applications.Our results demonstrate that Bi nanowire bridge can be in-situ formed by the stress-relief method, providing a motivation for exploring the high-efficiency thermoelectric properties of single-crystalline Bi_2Te_3 nanowires and a tool to study electronic transport in nanostructures without additional device fabrication process. Reference[1] Y. M. Lin, et al., Phys. Rev. B 62, 4610 (2000)

Ep-021 **Thermal stability and magnetic properties of metallic glass free layer of magnetic tunnel junction** 임 혜인, 이 원춘, 박 조영(*숙명여자대학교*) The development of soft magnetic metallic glass has become an important research topic because the soft magnetic properties are promising for many applications. Metallic glass has excellent soft magnetic properties (high saturation magnetization M_s and low coercivity, H_c) and high mechanical strength. These exceptional soft magnetic properties of metallic glass improve the performance of magnetic tunnel junctions (MTJs) when the metallic glass is used for a free layer. Tunneling magnetoresistance (TMR) effect in MTJs has been extensively studied in the last decade due to the large potential applications of MTJs in magnetic random access memory (MRAM). For better free layer performance in MTJs, studies on amorphous soft magnetic layer are important. Thermal and magnetic properties of amorphous materials are expected to be a good approach to study the application in the magnetic device fields.

Ep-022 **LCD용 엣지형 백라이트 시뮬레이션 모델 수립 및 이를 이용한 새로운 집광필름의 성능 평가에 관한 연구** 박 지희, 주 영현, 이 정호, 남 기봉, 고 재현, 김 중현[1](*한림대학교 전자물리학과.* [1]*삼성전자 AMLCD.*) LCD 백라이트(BLU)의 설계에는 광선 추적 기법이 많이 사용되고 있으며, 이러한 기법을 통하여 BLU 전면으로 출사되는 빛의 휘도, 균일도, 광효율 등을 수치적으로 예측할 수 있다. 정량적 예측이 가능한 시뮬레이션 모델이 수립되면 실제 BLU의 광학구조 및 성능 최적화에 걸리는 시간을 단축할 수 있게 된다. 본 연구에서는 15인치 엣지형 백라이트의 광학필름별 휘도의 출광특성을 측정한 후에 광선추적기법이 적용된 광학 시뮬레이션 소프트웨어를 이용 하여 실제 측정 결과를 근사적으로 재현할 수 있는 시뮬레이션 모델을 구현하였다. 또한 이를 토대로 여러 가지 새로운 구조의 마이크로 렌즈 패턴을 가지는 광학시트를 설계하여 보았으며 이들의 성능을 기존 광학필름과 비교해 보았다. 새로운 마이크로 렌즈 패턴으로는 피라미드, 원뿔 등을 이용하였고 이들의 집광 성능을 기존의 일차원적 프리즘 필름의 성능과 비교하였다. 1 본 연구는 지방대학 혁신역량 강화사업(NURI)인 문화콘텐츠인력양성사업(HEGA)의 4차년도 연구비와를 지원받아 이루어졌음을 밝힙니다.

Ep-023 **TCO/SiO_2-ZnO/PEN 구조의 플랙서블 기판의 구조적 전기적 및 광학적 특성** 권 오정, 조 도현, 방 태복, 김 동영, 류 성원, 이 병로, 홍 우표, 김 종재, 박 승환, 김 화민(*대구가톨릭대학교, 전자디스플레이공학과*) 본 연구는 고주파 마그네트론 스퍼터링 방법을 사용하여 PEN 기판위에 $(SiO_2)_{30}ZnO_{70}$ 타겟에 의한 Gas Barrier 층을 증착하였다. $(SiO_2)_{30}ZnO_{70}$ (SZO) 박막은 $10^{-3}g/m^2day$ 이하의 매우 우수한 투습 방지 특성을 나타내는 것이 MOCON Test로부터 확인되었다. 한편, 플랙서블 디스플레이의 기판으로 사용하기 위한 플랙서블 투명전도기판을 제작하기 위하여 gas barrier 층 위에 ITO, IZO, AZO등의 다양한 TCO 박막들이 고주파 마그네트론 스퍼터링 방법에 의해 증착되었다. 이 다양한 플랙서블 투명 전도 기판들에 대해서 X-선 회절 분석으로 각 박막들의 결정성과 우선 성장 방향을 확인하였다. AFM 상을 측정하여 SZO gas barrier 층위에 성막 된 다양한TCO 박막들의 표면 상태 및 표면 거칠기의 변화를 확인 하였으며 Hall 효과 측정으로부터 TCO 박막들의 운반자 농도 및HALL 이동도 변화에 다른 비저항의 변화를 분석하였다 이 실험결과들의 분석으로부터 플랙서블 디스플레이용 기판에 대한 최적의 공정 조건들을 제시하고자 한다. *본 연구는 산업자원부가 주관하는 지역혁신인력양성사업의 재정지원을 받은 것임.

Ep-024 **FTS 방법으로 성막된 SiO_x, SiO_xN_y Gas barrier 층의 특성** 왕 태현, 배 강, 조 도현, 김 지환, 박 용진, 류 성원, 이 병로, 양 정민, 홍 우표, 김 종재, 박 승환, 김 화민(*대구가톨릭대학교, 전자디스플레이공학과*) 본 연구에서는 OLED 소자에 적용하기 위하여 수분 투과를 억제할 수 있는 봉지층 개발을 위하여 대향 타겟식 스퍼터링(Facing Target Sputtering) 방법을 사용하여 PET, PC, PEN과 같은 플라스틱 기판 위에 SiO_2와 SiO_xN_y 박막을 성막하여 이들의 gas barrier 특성을 조사하였다.특히, 공정 조건을 다양화하여 성막 된 gas barrier 층 들은 Mocon 장비를 이용하여 그들의 투습율(Water vapor Transmission rate)과 투산소율(Oxygen Transmission Rate)을 측정하였으며, 그 결과는 공정 조건에 따라 성막 된SiO_2와 SiO_xN_y 박막들의 Packing density 와 결함 모델에 의해 설명되어진다. 한편, gas barrier 층으로서의 SiO_2와 SiO_xN_y 박막들의 광학적 특성으로는 UV-VIS spectrophotometer(Shimadzu Co.)를 사용하여 200～1100 nm의 파장영역에서 광 투과도를 측정하였으며, FE-SEM (Digital Instrument Co.)과 XRD(Rigaku Co.), AFM(Digital Instrument Co.) 상에 의해 박막의 결정구조와 표면morphology 등을 분석하여 플랙서블 기판의 gas barrier 층으로서 뿐만 아니라 OLED 소자의 봉지층(Passivation layer)으로서의 적용 가능성을 제시한다. *본 연구는 산업자원부가

주관하는 지역혁신인력양성사업의재정지원을 받은 것임.

Ep-025 **RF 마그네트론 스퍼터링법에 의해 성막된 SiO_2가 첨가된 ZnO 박막의 전기적 및 광학적 특성에 관한 연구** 배강, 지 승훈, 하 재영, 서 성보, 윤 현오, 김 상헌, 이 병로, 양 정민, 홍 우표, 김 종재, 박 승환, 김 화민(*대구가톨릭대학교, 전자디스플레이공학과*) 본 실험에서는 RF 마그네트론 스퍼터링법을 사용하여, SiO_2-doped ZnO 박막 (SZO박막)을 유리기판에 제작하였다. 박막 제작을 위한 sputter용 타겟은 ZnO 분말에 SiO_2 분말을 (2 wt% -5 wt%) 혼합하여 400℃ 소결하고, 압착한 후 다시 1000℃에서 고형화 시켜 2인치 타겟을 제작 하였다. SZO박막은 SiO_2의 도핑양에 따른 SZO박막의 전기적·구조적·광학적 특성을 알아보았으며, 박막의 두께별 특성과열처리 후의 특성을 조사 하였다전기적 특성으로는4-point probe로 면저항을 측정하였고, 광학적 특성으로는 UV-Vis. Spectrophotometer를 사용하여 200～1100 nm의 파장 범위에서 측정된 광투과도를 측정하였고, 광투과도를 이용하여 박막의 굴절율과 밴드갭을 계산 하였다. 본 실험의 결과로 광투과율은 전체적으로 80%이상을 나타내고 있으며, 면저항은 200 Ω/□을 나타내고 있는 것으로 확인이 되었다. *본 연구는 교육인적자원부가 지원하는 제2단계 BK21사업의 재정 지원을 받은 것임

Ep-026 **Photoluminescence of nano-scale fullerene (C_{60}) aggregates in solvent mixture of different compositions** YEO Seung Jun, PODE Ramchandra, AHN Jeung Sun(*Department of Physics, Kyunghee University.*) Recently, we have demonstrated the formation of C_{60} aggregates in solvent using photoluminescence spectroscopy. In the present investigation, dependence of the photoluminescence of nano-scale fullerene (C_{60}) aggregates in single solvent (benzene) at different temperatures, as a typical example of the formation of C_{60} aggregates by liquid-solid transition of solution, and in benzene-ethanol mixtures of different compositions at various temperatures between room temperature and 120 K are presented. Upon comparing the photoluminescence spectra of C_{60} in benzene-ethanol mixtures with those in single solvent and single-crystal, the drastic spectral change in photoluminescence emission of C_{60} in benzene-ethanol mixtures of different composition is strongly attributed to the formation of C_{60} aggregates. With the ethanol volume fraction in the solvent mixtures lower than 50 %, the photoluminescence spectra show spectral shape of aggregates at 120 K. Change of spectral shape reveals the formation of C_{60} aggregates at the liquid-solid transition temperature of the solvent mixture like in single solvent (benzene, toluene, or CS_2). C_{60} aggregates are formed in solvent mixtures from the un-aggregated C_{60} by reducing temperature like a single solvent. The 0-0 transition energy was shifted to a high-energy region in comparison with that of C_{60} crystal. It is assumed that the quantum-size effect in the clusters is mainly due to the confinement of translational motion of excitons. In a high ethanol volume fraction of the solvent mixtures (> 70 %), 0-0 transition shows no shift, and located at almost the same region as that of C_{60} crystal photoluminescence spectrum. The size of C_{60} aggregates in benzene-ethanol mixture of high ethanol volume fraction is not scale of several nm, much bigger than C_{60} aggregate in single solvent (2.3 nm in benzene). *This work has been supported by the Seoul R&BD Program (Grant No. 10583).

Ep-027 **Hysteresis of Resistance by hydrogenation in Pd thin film** LEE Eunsong-yi, CHO Chunghwan, LEE Young Taek, JEON Kye Jin, LEE Wooyoung(*Department of Materials Science and Engineering, Yonsei University.*) The Palladium-hydrogen system has constantly taken attention in the field of the metal-hydrogen system. There are a lot of the intrinsic academic interests related to the various applications such as catalysis, high pressure device, hydrogen storage and hydrogen sensor. One of the important issues is the process of hydrogen absorption- desorption since the palladium has unique diffusion properties for hydrogen[1]. Although there are several investigations on the process of the absorption-desorption by the gas phase method[2], the phenomena which are induced by the process have not been studied in detail. In this study, we want to present the induced phenomena during the hydrogen absorption-desorption process. First of all, we prepared the Si(111) substrate on which is thermally oxidized with 5000Å-thickness. On the substrate, the Pd thin film was deposited by the UHV magnetron sputtering system with the base pressure of 4×10^{-8} Torr. The thickness of the film generated by the control of the deposition time was varied at 5 nm ~ 400 nm. After the deposition, Au wires were attached on the thin film for the four-probe measurement then the resistance of the thin film was measured. When the thin film was exposed to the hydrogen gas, the resistance increased according to the increase of the H_2 concentration. For the concentration of the hydrogen over critical value, which depends on the thickness of the thin film, the dramatic increment of the resistance was observed. Also the peel-off phenomena on the thin film were simultaneously occured at the critical point, and which is observed for the film thicker than 20 nm. Whereas during the desorption process the thin film exposed to the N_2 gas instead of the H_2, the resistance returned to the original value. But the concentration of the H_2 was decreased stepwisely from the saturated resistance, the resistance was maintained at almost constant value until the H_2 concentration decreased to 0.5 %. The resistance suddenly decreased at 0.5% H_2 concentration, which means the hysteresis of resistance. Such hysteresis was observed for the all the thin film. The height of hysteresis curve tended to be low for the thinner film. Hysteresis is attributed to the adsorption enthalpy between palladium and hydrogen atom of the thin film. And the lowering of height may be originated from tensile stress between films and substrate, which suppresses the volume expansion induced by hydrogen absorption. Relation to the practical application such as hydrogen storage,[1] T.Graham, Phil.Trans. Royal.Soc. XVIII(1866), 399 [2] Y Sakamoto, *et al.*, J.Phys: Condens.Matter 8(1996), 339

Ep-028 **수직로에서의 탄소나노튜브 합성 및 특성 분석** 김 태민, 최 원철, 송 우석, 김 유석, 박 종윤(*성균관대학교*) 극미세 영역에서 새로운 물리현상과 향상된 물질특성을 나타내는 연구결과가 보고되면서 나노기술이라는 새로운 분야가 열렸다 탄소나노튜브(carbon nanotube)의 우수한 물성과 다양한 응용가능성에도 불구하고 현재까지 실용화된 탄소나노튜브 관련 제품이

거의 없는 것이 현실이다. 탄소나노튜브의 광범위한 실용화를 위해서는 고순도 탄소나노튜브의 대량생산이 필수적이지만 기존의 합성방법으로는 아직 그러한 단계에 이르지 못했다. 탄소나노튜브 합성에 있어서 고순도 합성과 대량생산은 반드시 넘어야 할 과제이다. 기존의 탄소나노튜브의 합성 방법은 아크방전법(arc-discharge)과 레이져 증발법(laser ablation), 화학 기상 증착법(chemical vapor deposition)등이 있지만 이와 같은 방법에 의해 합성된 탄소나노튜브의 생산량이 매우 적다는 단점을 가진다. 이를 극복하기 위한 해결책으로 수직로를 이용한 합성법이 있다[1] 본 연구에서는 수직로에서 고온의 열과 탄소원료를 이용하여 탄소나노튜브를 합성하는 실험을 하였다. 탄소나노튜브의 원료로는 에탄올과 ferrocene을 혼합하여 사용하였고 이러한 원료의 분산을 위해 초음파 분해(처리)를 한 후에 원료를 수직로에 주입하였다. 캐리어 가스 및 반응가스로 수소와 질소를 흘려주었고 수소 유입량을 조절하면서 탄소나노튜브의 지름을 변화시켰으며 캐리어 가스의 유입량이 고순도의 탄소나노튜브 합성에 어떠한 영향을 주는지 실험하였다. 또한 반응 시 온도의 변화를 통해 양질의 탄소나노튜브를 생성하였다. 에탄올과 ferrocene(촉매)의 적절한 비율에 따른 탄소나노튜브의 형상과 결정성을 연구하였는데 이러한 특성들을 Scanning Electron Microscope(SEM), Raman spectroscopy 및 Transmission Electron Microscopy(TEM)으로 확인하였다. [참고문헌] 1. Ya-Li Li, Ian A. Kinloch, and Alan H. Windle. Science 304, 276 (2004)

Ep-029 **Ni-Mn-Ga-In 합금에 대한 자기적 성질과 자기열량효과 연구** 유 광균, 허 철민, 민 성기, 유 성초(*충북대학교 물리학과*) 현재 일반적인 냉동기는 증기 압축식 냉동으로 CFC, HCFC, HFC 등의 냉매를 사용함으로써 오존층 파괴나 지구 온난화 등의 문제를 발생시키는 원인이 되고 있다. 따라서 이러한 냉매를 사용하지 않는 냉동기를 사용한다면 대기오염을 크게 줄일 수 있을 것이다. 자기냉동기는 자성체를 냉매로 이용하여 냉동기를 구현하는 장치이다. 이것은 자기열량효과를 이용하여 자성체는 냉매로 사용하는 것이다.자성체에 자기장을 가하거나 제거할 때 자성체가 가지고 있는 엔트로피는 변화를 하게 된다. 특히 자기장을 가할 때 엔트로피는 증가를 하고 반대로 자기장을 가하고 있다가 제거할 때 엔트로피는 감소하게 된다. 자기장을 변화 시킬 때 엔트로피뿐만 아니라 자성체의 온도 또한 변화하는데 이러한 현상을 자기열량효과라 한다. 본 연구에서는 결정상변화와 자기적 상변화를 갖는 Ni-Mn-Ga 합금에 대해서 Ga을 In으로 치환한 합금인 $Ni_{54}Mn_{21}Ga_{25-x}In_5$ (x=0, 5, 10)에 대한 자기적 성질의 변화와 자기열량효과의 변화를 연구하였다. In의 첨가량이 증가할수록 큐리온도와 함께 결정상변화 온도가 감소함을 알 수 있었다.그러나 엔트로피 변화 ΔS_M은 거의 변화가 없었다.

Ep-030 **$Fe_{11}Ni_{70}Zr_7B_{12}$ 합금에 대한 자기열량효과 측정** 장 영덕, 민 성기, 유 성초(*충북대학 물리학과*) 자성체에 자기장을 가하거나 제거할때 자성체가 가지고 있는 엔트로피는 변화를 하게 된다. 특히 자기장을 가할때 엔트로피는 증가를 하고 반대로 자기장을 가하고 잇다가 제거할때 엔트로피는 감소하게 된다. 자기장을 변화 시킬때 엔트로피 뿐만아니라 자성체의 온도 또한변화하는데 이러한 현상을 자기 열량 효과라 한다 따라서 자기열량효과를 측정하는 방법에는 엔트로피 변화 뿐만아니라 단열온도변화를 통해 자기열량효과를 측정할수 있다. 본 연구에서는 비정질 합금인$Fe_{11}Ni_{70}Zr_7B_{12}$에 대해 자기적 특성과 자기열량효과의 변화를 연구하였다. 열처리온도에 따라큐리온도가 증가 하였고 큐리온도가 증가하엿다.

Ep-031 **Study of DNA hybridization variant by Fluorescence Resonance Energy Transfer** 이 자은, 김 태곤, 이 상욱, 김 수용, 김 석원[1](*KAIST, 물리학과.* [1]*울산대학교, 물리학과.*) Formation of double strand DNA (dsDNA) can be detected by Fluorescence Resonance Energy Transfer (FRET) when donor and acceptor fluorophores are properly located in each strand. However molecular dynamics show that there exist not just dsDNAs but the other variants even though we put perfectly complementary strands in solution. Furthermore the ion concentration may help to form the packages of arbitrary strands. According to these points, we should suppose that this system has heterogeneity. We used the bulk measurement of FRET with DNA resolved in various ion concentrations. Intensity changes were monitored with passing time. With the assumption of constraint, the data analysis let us to access the heterogeneity, which was examined by the simulation.

Ep-032 **Regulation of End-to-end distance of DNA Strand and Its Thermodynamic Property** 장 재범, 김 태곤, 김 수용, 김 석원[1](*KAIST, 물리학과.* [1]*울산대학교, 물리학과.*) Regulation of conformation of nucleic acid chain was widely studied because of its potential applicability to medicine, nano-electronics and so on. It implies that the regulation of end-to-end distance could take certain role in those fields. We introduced non-complementary sequence in the middle of objective DNA strand which would be bent like a ring. The objective DNA strand was contracted, which was examined by fluorescence resonance energy transfer. 'Guide DNA' (complementary strand to the objective DNA partially) has the toe sequence which does not bind with the objective DNA. With the toe sequence, we could dehybridize 'objective-guide DNA,' and such process gave the possibility to form a cycle of the distance variation. We analyzed the regulation of end-to-end distance of DNA strand in the viewpoint of Gibbs free energy, and also investigated the possibility of reaction cycle formation.

Ep-033 **$Zn_2SiO_4Mn,X(X=Ga, Mg, Ti)$형광체의 발광 특성** 이 지영, 유 일(*동의대학교*) Zn_2SiO_4:Mn 형광체에 Ga을 첨가한 경우 Ga의 농도가 증가함에 따라 발광파장이 장파장대로 이동함을 관찰 하였다. 이것은 Si자리에 Ga가 치환됨에 따라 Mn^{2+}이온이 영향을 받아 Mn^{4+}의 $^2E \rightarrow {}^6A_2$ 전이 때문인 것으로 생각된다. $(Zn_{1-x}Mg_x)_2SiO_4$:Mn 형광체의 경우 Mg의 농도가 0.5mol인 경우 Mg를 첨가하지 않은 경우보다 발광휘도가 증가하는것을 확인 할 수 있었다. 이것은 Zn에서 Mg로 치환된 모체에서 에너지 전이가 증가한 것이 원인인 것으로 생각된다. Zn_2SiO_4:Mn형광체에 Ti를 첨가한 경우 Ti 농도가 증가 할수록 발광 휘도가 감소하는 것을 확인 할 수 있었다. PL 측정 결과로부터 Ti 첨가에 따른 휘도개선 효과가 나타나지 않았다.

Ep-034 **Hard x-ray microscopy of *in-vivo* and *ex-vivo* animal organs** KIM sang-yoeb, KIM Ki-Hong, KIM Jong-Ki[1], KIM

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Hong-Tae[1], KANG Bo-Sun[2](*Department of Visual Optics, Kyungwoon University. [1]College of Medicine, Catholic University of Daegu. [2]Department of radiological science, Catholic University of Daegu.*) X-ray microscopy with synchrotron radiation(SR) will be a useful tool for innovation of x-ray imaging in clinical and laboratory settings. Microscopically, it enables us to observe detailed structure of animal organs samples with a great magnification power and an excellent resolution. The different contrast mechanisms in image by x-ray are described. The phase-contrast X-ray imagings with SR from in-vivo and ex-vivo angiograpy, thyroid tissue, lung, bone and nerve were obtained with an 10 Kev monochromatic beam and 20-μm thick CsI(Tl) scintillation crystal. The visual image was magnified using 20x microscope objective and captured using an analog CCD camera. The results showed more structural details and high contrast images with SR imaging system than conventional X-ray radiography system. The SR imaging system may have a potential for imaging in biological researches, material applications and clinical radiography. X-ray radiography from synchrotron source is an effective tool to observe microstructures of organs in living condition and could expand its application in various medical fields

Ep-035 **Effect on the doped metal of CNT/MEH-PPV photovoltaic cell** 안 준호, 진 성환[1], 홍 순형[1](*KAIST, 나노융합연구소. [1]KAIST, 신소재공학과.*) 최근 유가의 급등과 세계적인 에너지 자원의 활용에 대한 관심으로 그 어느때보다 태양전지에 대한 관심이 높다. 하지만 실리콘 태양전지의 높은 가격과 낮은 효율의 염료감응형 및 유기태양전지는 아직 실용적인 이용에는 제한을 받고 있다. 최근에는 이러한 단점을 극복하고자 나노기술을 활용한 나노기반의 태양전지가 연구되고 있으며 유기와 무기 재료의 장점을 이용한 유무기 하이브리드 태양전지의 개발이 진행되고 있다. 본 연구에서는 높은 전도도와 결정성을 가지는 탄소나노튜브를 이용한 태양전지를 제작하여 이에 대한 특성을 살펴보았다. 또한 CNT/고분자 하이브리드 나노태양전지의 효율 향상을 위해 나노크기의 금속입자를 도핑하여 효율향상을 꾀하였다.

Ep-036 **Direct Laser Patterning of Ag Nanoparticle Thin Films Solution-Deposited on Transparent Substrates** 신 현권, 김 현준, 이 명규(*연세대학교 신소재공학과*) 금속 박막의 패터닝은 현대 전자기기에서 필수적인 요소이며 이러한 금속 박막의 패턴은 일반적으로 기상 증착 후 에칭을 이용해 패터닝하는 포토리소그래피에 의해 형성된다. 이러한 리소그래피는 높은 해상도를 지니지만 고가의 진공 장비가 필요하고 필름 증착과 에칭의 반복적인 복잡한 공정이 필요하다. 근래에 들어 flexible display의 필요성과 더불어 flexible 기판위에 금속 박막의 패턴 형성이 중요시 되면서 저비용, 저온 및 대면적화 공정의 개발이 중요한 요소로서 연구되고 있다. 본 연구에서는 유리 및 플라스틱 기판위에dip-coating, spin-coating 및 drop-casting 등의 용액 증착법으로 은 나노입자 박막을 형성시킨 후 공간적으로 변조된Nd:YAG 펄스 레이저를 이용해 은 나노입자 박막을 직접 패터닝하였다. 펄스 레이저에 의한 다공성 은나노 입자 박막의 패턴 형성은 펄스 레이저와 은 나노입자의 직접적인 상호작용에 의해 야기되는thermal desorption에 기초한 방법으로 펄스 레이저의 조사에 의해 은나노 입자의 급속한 열적 팽창이 발생하고 이로 인한 열탄성력에 의해 은 나노입자 박막이 기판으로부터 떨어져 나오게 된다. 빔과 나노입자 박막의 상호작용에 의한 패턴형성 시 가장 중요한 요인은 박막과 기판 사이의 adhesion과 박막의 cohesion으로 레이저에 의해 야기되는 열탄성력에 의해 물질의 국부적인desorption이 가능하다. 이러한 방식은 빔의 공간변조가 기존의 포토리소그래피와 동일하므로 패턴의 해상도가 동일한 반면 고온 진공과정과photoresist layer를 필요로 하지 않으므로 저온공정화 및 대면적화에 유리하고 일반적인 포토리소그래피에 수반되는 전체 공정의 수를 획기적으로 줄일 수 있다. 실험에서는 펄스 width가 6ns인 Nd:YAG 펄스 레이저(l = 1064nm)를 사용하였고 은 나노입자 박막은 평균 사이즈 25nm±10nm의 Ag colloidal solution을 사용하여 용액 증착하였다.

Ep-037 **Luminescent Properties of Eu^{3+}-doped Bulk and Nanocrystalline $GdVO_4$ Phosphors by Planetary Ball Milling and Solvothermal Method** 양 현경, 문 병기, 정 중현, 이 성수[1](*부경대학교, 물리학과. [1]신라대학교, 전자재료공학과.*) In this research, a facile synthetic route for the preparation of nanocrystalline $GdVO_4:Eu^{3+}$ by planetary ball milling and solvothermal method is reported, the as-grown powders by planetary ball milling were found to be amorphous, which crystallized to the tetragonal phase without $GdVO_4$ by product after various temperature condition for 100 hours and as grown powders by solvothermal were found to be amorphous, which crystallized to the GdVO4 by product after calcination at 700 °C in air for 2 hours. The corresponding bulk $GdVO_4:Eu^{3+}$ were synthesized by high temperature solid-state reaction. All the products were systematically characterized by powder X-ray diffraction (XRD), infrared spectroscopy (IR), field emission-scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM), photoluminescence (PL) and photoluminescent excitation spectra (PLE). The luminescence mechanism and the size dependence of their fluorescence properties are also discussed.

Ep-038 **Luminescence behavior of $CaTiO_3$: Pr^{3+} nanopowder phosphors by solvothermal method with Li contents** 정 종원, 김 금주, 문 병기, 정 중현, 김 중환[1](*부경대학교, 물리학과. [1]동의대학교, 물리학과.*) The achievement of red phosphors is one of the challenging goals in the field of display and lighting technologies. Recently, much work has been concentrated on the novel red emitting phosphors of Li doped $CaTiO_3:Pr^{3+}$. Because of a strong absorption to ultraviolet light by $CaTiO_3$ and an excitation of Pr^{3+} by the 322 nm, $CaTiO_3:Pr^{3+}$ is a highly efficient red-emitting material.$CaTiO_3:Pr^{3+}$ and Li-doped $CaTiO_3:Pr^{3+}$ nanopowders were synthesized by using a solvothermal reaction. The crystallinity and photoluminescence of nanopowders were highly dependent on Li ion content, The doped concentration of Li was various 0, 1, 2, 3, 4 and 5 w%. $Ca(AcAc)_3$, $Pr(AcAc)_3$, Titanium butoxide and $Li(AcAc)_3$ were used as starting materials and they were dissolved in 2-PrOH.. Stoichiometric amounts of above solutions were mixed and the solution was initially heated at 250℃ in air and continuously stirred in a mixture for 10h. The samples were dried at 50℃ in air for 5h. The as-prepared samples were sintered temperature at 900℃ for 10h. Their crystalline structures, surface morphol-

ogies and phase transitions were investigated for the samples prepared at various annealing processes by using X-ray diffraction (XRD), scanning electron microscopy (SEM), photoluminescence (PL) and cathodoluminescence (CL), respectively. The room temperature PL spectra of $CaTiO_3:Pr^{3+}$ nanophosphors showed red emission peak 613 nm. The bands at 613 result from the $^1D_2$à$^3H_4$ transition of the Pr^{3+} ion. The PL intensity of Li doped $CaTiO_3:Pr^{3+}$ nanopowders had a macimum at Li^+ ion was 3 w%. The purpose of this study is to compare the luminescence characteristics of Li doped $CaTiO_3:Pr^{3+}$ phosphors which were synthesized at Li ion concentration.

Ep-039 **Synthesis and luminescent properties of nanocrystalline Eu^{3+}-doped pyrochlore oxide $M_2Sn_2O_7$(M=Y and Gd)** FU Zuoling, MOON Byung Kee, YANG Hyun Kyoung, CHOI Byung Chun, JEONG Jung Hyun(*부경대학교, 물리학과*) Recently, there has been a growing interest in strong luminescence of europium ions activated nanocrystals due to their promising applications in fluorescent lamps, field emission display and plasma display panels. $M_2Sn_2O_7$ stannates (M=rare earth) are conventionally prepared from solid state reactions at high temperatures (≥1400 °C). Besides their high energy consumption, these solid state reactions involve a series of laborious heating cycles at high temperatures and repeated grinding of starting oxide components. The resulting powders show extensive agglomeration and compositional inhomogeneity. Therefore, there is a real need to develop an alternative synthesis route for pyrochlore stannates. The hydrothermal synthesis technique has been shown to be promising in the preparation of complex oxides in terms of the relatively low reaction temperatures employed, high quality of the crystals obtained and, in some cases, reduction in sizes of the particles of the product solids. In this paper, $M_2Sn_2O_7:Eu^{3+}$ (M=Y, Gd) nanocrystals were prepared by hydrothermal synthesis method. Well-crystallized and phase-pure $Y_2Sn_2O_7:Eu^{3+}$ and $Gd_2Sn_2O_7:Eu^{3+}$ particles of 40nm and 20nm in size can be readily obtained at 900 °C, a temperature much lower than that of the conventional solid-state method, respectively. Furthermore, photoluminescence characterization of the Eu^{3+}-doped $M_2Sn_2O_7$ (M=Y, Gd) nanocrystals was carried out and the results show that the materials display intense and prevailing emission at 589nm belonging to the $^5D_0$-$^7F_1$ magnetic dipole transition.

Ep-040 **Magneto resistance and thermoelectric power of iodine doped single wall carbon nanotubes** YOO HoNam, AHN SeJung, NAM YoungWoo, KIM YuKyung, PARK JiHyun, BAEK SeungJae, JIN Zhaoxia[1], PARK YungWoo(*Department of Physics and Astronomy &Nano Systems Institute-National Core Research Center, Seoul National University. [1]Department of Chemistry, Renmin University of China, Beijing 100872, China.*) We measured temperature dependence of four-probe dc conductivity and magneto resistance (MR) and thermoelectric power of the iodine-doped single-wall carbon nanotube (SWNT) mats. The temperature dependent conductivities of undoped and iodine doped SWNTs met are similar to those of previous reports [1]. The MR is measured up to 14 tesla as a function of temperature. Negative MR is observed at T<20K. At T=4.2k, there is a negative minimum near H=8 tesla. As the temperature becomes higher, the negative minimum is flattened at high magnetic field. For 10K30K, there exist small positive MR peak at low field becoming negative at high field.. Above T=70K, the MR remained positive up to 14 tesla. Another sample shows similar temperature dependent MR but the turning point temperatures are higher than the previous sample. At zero magnetic field, the room temperature TEP is positive and +14μV/K. It decreases upon cooling to T=2.7K. The positive TEP indicates that the majority carrier in iodine doped SWCNT is hole. The magneto-TEP has been measured at H=7 tesla for T<100K. The magneto TEP becomes smaller than the zero field TEP value. At T=2.5K, the zero field TEP is +0.15μV/K and the 7 tesla magneto TEP is +0.13μV/K. For 20K100K. The reduction of TEP under magnetic field at low temperature could be due to the reduction of entropy per carrier since the magnetic field induces more ordered state of spins in the system. Detailed analysis of the magneto TEP including the slope change as function of temperature are on going. Reference [1] L. Gregorian, K.A. Williams, S. Fang, G.U. Sumanasekera, A.L .Loper, E.C. Dickey, S.J. Pennycook, and P.C. Eklund, *Phys. Rev. Lett*. 80, 5560 (1998)

Ep-041 **X-ray Absorption Fine Structure study of TiO_2 Nanoparticles** JEON Jong-Sul, KIM Byung-Hyuk[1], HAN Sang-Wook[2](*전북대학교 과학교육학과. [1]전북대학교 물리학과. [2]전북대학교 과학교육학부*) We investigate the chemical and the structural properties of TiO_2 nanoparticles with mean particle size of 100 nm using X-ray absorption near edge structure (XANES) and extended X-ray absorption fine structure (EXAFS) at Ti K-edge. From XANES measurements on TiO_2 nanoparticles with anatase and rutile structures, clear A_1, A_2, A_3 pre-edge peaks were observed from the both structures meanwhile the only A_1 peak was sharp in Ti metal. The A_1 and A_3 peaks in the anatase structure are very similar to those in the rutile structure while the A_2 peaks slightly depend on the structure. The only A_2 peak was slightly changed as a small amount of sulfide was added. These results imply that the d-electrons in the A_2 level is more sensitive to the environment than the electrons in the A_1 and A_3 levels. We will discuss the XANES and EXAFS from the TiO_2 nanoparticles in detail, comparing with those of Ti metal. We also present the results of TiO_2 resistance effects to pathogenic bacteria and fungi.

Ep-042 **Reducing Oxidation Layer of Co and Ni Metal Nanowires Using High Energy Ion Implantaion** 주 진수, 홍 영기, 이 용백, 박 성규(*하이브리드 나노구조체 연구실*) 전기도금방법을 사용하여 Al_2O_3 나노 다공물질속에서 Co, Ni 금속 나노선을 합성하였다. 나노선의 직경은 ~200 nm이며 나노선의 길이는~10 μm로 조절하였다. 3단자 방식의chronopotentiometry 방법을 사용하여 working 전극과 reference 전극 사이의 전압을 -1 V로 유지하여 금속나노선을 제작하였다. Ni 나노선의 제작을 위해 사용된 용액은 $NiSO_4 \cdot 6H_2O$ (270 g/L)과 H_3BO_3 (40 g/L)을 증류수에 섞어 구성하였다. Co 나노선의 제작을 위해 사용된 용액은$CoSO_4$×

P2 포스터세션

$7H_20$ (266 g/L)과 H_3BO_3 (40 g/L) 을 증류수에 섞어 구성하였다. 3 MeV Cl^{2+} 이온을 $3X10^{15}$ ions/cm^2 dose로 Co와 Ni 나노선에 주입하였다. 표면변화를 관측하기 위해 SEM과 AFM을 측정하였다. Laser confocal microscopy를 사용하여 Raman spectroscopy를 측정하였다. 산화정도를 파악하기 위해 Co와 Ni의 binding energy를 XPS를 사용하여 측정하였다. I-V 특성은 conducting AFM을 사용하여 측정하였다. 나노선의 coercivity는 VSM를 사용하여 측정하였다. HR-TEM과 XPS 실험결과 분석을 통해서 이온빔 주입 후에 Co, Ni 나노선 표면의 산화막이 감소하는 것을 관찰하였다.

Ep-043 **Synthesis and Red Luminescence of $CaTiO_3$: Pr by Mechanochemical Alloying** 김 현구, 박 경화, 명 화남[1](*조선대학교 물리교육과.* [1]*전남대학교 물리학과.*) The preparation and photoluminescence of Pr^{3+}-doped $CaTiO_3$ by mechanochemical alloying was investigated by X-ray diffraction, scanning electron microscope, energy dispersive X-ray spectrometer, thermogravimetric/differential thermal analysis and luminescence spectrometer. The corresponding emission spectra showed a emission range with a maximum peak at 615 nm, which was ascribed to be the characteristic transition of Pr^{3+} ($^1D_2 \rightarrow {}^3H_4$), which can be expected for visible light conversion materials. The optimal condition of photoluminescence emission for $CaTiO_3$: Pr mixtures was 0.1mol% of Pr^{3+}concentration.

Ep-044 **나노입자 어레이의 변형에 따른 플라즈몬 특성 변화** 하 동한, 윤 용주, 김 상훈, 박 형주, 윤 완수, 송 정훈[1](*한국표준과학연구원 전략기술연구부.* [1]*공주대학교, 물리학과.*) Au나 Ag와 같은 귀금속 종류의 나노입자 용액에 백색광이 입사되면 특정파장의 빛은 흡수되어 나노입자 표면에서의 전자들의 집단적인 운동인 표면플라즈몬의 여기에 이용되므로 나노입자 용액은 모양이나 크기 등에 따라 고유한 색을 띠게 된다 최근에는 나노입자들을 주기적으로 배치한 나노입자 어레이를 이용한 웨이브가이드나 안테나 등 새로운 나노 포토닉스소자 개발이 시도되고 있다 독립된 나노입자와 달리 나노입자 어레이의 플라즈몬 특성은 어레이를 구성하는 나노입자들의 모양과 크기뿐만 아니라 입자들의 배치 형태나 거리에 의해서도 영향을 받기 때문에 플라즈몬 특성을 다양하게 설계할 수 있으며, 나노입자의 모양이나 크기가 변할 때 플라즈몬의 특성이 훨씬 더 민감하게 변한다 본 연구에서는 전자빔 리쏘그래피법으로 직경이 100 nm정도인 Au 나노입자의 어레이를 제작하고, 나노입자의 모양 및 크기가 변할 때 수반되는 플라즈몬의 특성변화를 관찰하였다 용액 속에서 특정분자의 작용에 의하여 Au 이온들을 각 나노입자 표면에서 환원/석출시킴으로써 나노입자의 모양과 크기를 변화시켰으며 각 나노입자의 크기가 증가함에 따라 전체 어레이의 플라즈몬 공명피크의 위치는 장파장 쪽으로 100 nm이상 크게 이동하였다 어레이의 패턴형태와 입사광의 편광방향에 따른 플라즈몬 특성도 함께 측정하였으며 이러한 실험결과는 나노입자 어레이를 미세농도의 분자 검출기개발에 이용할 수 있음을 보여준다.

Ep-045 **Growth mechnism of ZnO nanowires tailored by vapor transport method** 신 정호, 송 재용[1], 박 현민[1](*과학기술연합대학원대학교 나노재료공학과.* [1]*한국표준과학연구원*) ZnO is a wide band gap semiconductor (3.37 eV) and has received much interest for piezoelectric nanogenerator with large piezoelectric coefficients, low voltage and short wave length electro-optical devices such as light emitting diode, and chemical sensor. There are so many studies of fabricating ZnO nanowires such as CVD, MOCVD, carbothermal reduction process, and solvent-based methods. In present study, we present a low cost deposition process of ZnO nanowires with or without a catalyst on any substrates using a vapor transport method. Growth mechanism of ZnO nanowires, which were produced by vapor phase transport method, was analyzed. Vertical and site-selective growths on substrate are discussed in the view of supersaturation and supercooling related to driving force. It is shown that ZnO nanowires were site-selectively grown on the patterned catalyst layer, which was produced by lift-off and photolithography processes. It is presented that ZnO nanowires can be tailored to have a needle-like tip, which is better to enhance the efficiency of field emission. The mechanism of forming a needle-like shape is discussed in the view of growth kinetics and anisotropy in crystallographic planes.

Ep-046 **Optical characterization of In_2O_3 nano-particles embedded in the polyimide layer** KIM Seon Pil, LEE Dong Uk, LEE Tae Hee, HAN Seung Jong, KIM Eun Kyu, KIM Young-Ho[1](*Quantum-Function Spinics Lab. and Department of Physics, Hanyang University.* [1]*Department of Materials Science and Engineering, Hanyang University.*) We have fabricated metal-oxide nano-particles in polymeric matrix. This polymer layer has a possibility as tunneling and control layers for nano-floating gate memory. Specially, In_2O_3 has a direct band gap with energy of 3.6 eV and has been widely used in microphotoelectronic devices, such as solar cells, organic light-emitting diodes, panel displays, and gas sensors. The In_2O_3 nano-particles in a polyimide (PI) film were formed by a chemical reaction between the indium thin film and polyamic acid (PAA). Then, the indium film with thickness of 5 nm was deposited on the glass substrates by thermal evaporator and the PAA was spin coated on the deposited metal layer. The PAA precursor used in this study was prepared by dissolving biphenyltetracarboxylic dianhydride-phenylene diamine (BPDA-PDA) commercial polyamic acid (PI2610D) in N-methyl-2-pyrrolidon (NMP). During the metal dissolving process, PAA and indium layer were maintained at room temperature for 24 hours. The PI precursor was treated at 135 °C for 30 min removing the solvent. Finally, the PAA/indium layers were cured at 300 °C ~ 500 °C for 1~ 2 hour in N_2 atmosphere for creates the In_2O_3 nano-particles. The In_2O_3 nano-particle size and distribution could be controlled by the curing temperature and time. In this study, the morphology and optical properties of In_2O_3 nano-particles formed in the PI layer were characterized by using transmission electron microscopy and UV-Vis spectrophotometer. We will be discussed the relation between size and abortion spectra of In_2O_3 nano-particles in the polyimide layer.

Ep-047 **Hydrogenation of Proton Beam Irradiated Quasicrystals** JEON Jae-kyun, LEE Sang-hwa, LEE Yunman, SHIN Hyemin, KIM Jae-yong, YOUN Sang-pil[1], KIM KyeRyung[1]

(*Department of Physics, Hanyang University.* [1]*Division of Proton Engineering Frontier Project, Korea Atomic Energy Research Institute, Daejeon.*) Ti-based quasicrystals are known to be excellent materials for hydrogen storage applications because, first, they have high number of tetragonal and octagonal interstitial sites that are suitable for hydrogen atoms, and, second, Ti and Zr atoms are chemically attractive to hydrogen. However, the oxygen barrier on the surface of quasicrystals hinders the hydrogen absorption so that hydrogen could penetrate the surface only at high temperature and in high pressure of hydrogen. Surprisingly, irradiation of proton beam (20MeV, 10mA) on Ti-Zr-Ni quasicrystal ingots overcame these surface barrier problem. Ti-Zr-Ni quasicrystal ingots were prepared by an arc-melting method in an Ar atmosphere. The atomic compositions of the Ti, Zr, and Ni were 39.5, 39.5 and 21, respectively. Hydrogen absorption was performed by using a gas absorption apparatus which can measures the maximum hydrogen pressure of 3000 psi. Structural changes of quasicrystals upon hydrogenation and the possible reasons for removing the oxygen barrier by the proton beam irradiation will be demonstrated.

Ep-048 **Er^{3+}이온이 첨가된 $Y_3Al_5O_{12}$와 $YAlO_3$ 나노 결정의 upconversion 형광의 에너지 전달과정** 김 중환, 최 혜영, 노 현미, 문 병기[1], 정 중현[1], 이 성수[2](*동의대학교물리학과.* [1]*부경대학교 물리학과.* [2]*신라대학교 광공학과.*) Solvo-thermal 방법으로 250도의 낮은 온도에서Er^{3+}이온이 첨가된 입방상의YAG와 YAP 나노결정을 합성하였다. Er을 3mole%를 첨가한 YAG와 YAP 나노결정을 980nm 파장의 LD로 여기하여 녹색($^2H_{11/2}$, $^4S_{3/2}$,→$^4I_{15/2}$)과 적색($^4F_{9/2}$→$^4I_{15/2}$)의 upconversion 형광스펙트럼을 확인할 수 있었다. YAG와 YAP 내의 Er^{3+} 이온의 upconversion 형광은 여기준위 흡수과정과 첨가된 Er 이온 사이의 에너지 전달과정 등을 통하여 이루어진다. YAP의 경우, 최대 광학 포논 에너지(~800cm^{-1})가 YAG에 비해 높아 이온간 에너지 전달이 용이하여 형광효율이 증대되었다. 이러한 에너지 전달과정의 차이는 형광의 시간적 거동으로부터 확인할 수 있었다. 에너지 전달과정은 5준위 모형으로 설명하였으며 각 준위의 여기준위흡수과정과 에너지전달과정의 크기를 계산하였다.

Ep-049 **Numerical Approach to the Dielectrophoretic Assembly of ZnO nanoparticles** 강 대준, 이 아람(*성균관대학교 물리학과.*) Nanoparticle assembly is currently of great interest as nanoparticles are considered as a fundamental building block in the fabrication of viable nanodevices. Various methods have been developed for the assembly of nanoparticles. Dielectrophoresis (DEP) utilizes differences in the electric polarizability of materials and the surrounding aqueous media. This phenomenon can be exploited to position suitable nanoparticles in-between the narrow gap of electrodes, enabling us to form electrical connections, expandable to a large area assembly. We investigated the different forces appropriate for controlled manipulation of discrete ZnO particles at the sub-micron levels as necessary for the device applications. These manipulating forces are derived from AC electrokinetic phenomena and include various forces such as DEP, electro thermal force, electro osmotic force, and Stokes drag force on the fluid and buoyancy, Brownian motion directly on immerged particles. Detailed study on electric field and flow field distribution for better understanding and optimizing conditions for the real experiment are discussed.

Ep-050 **Nanometer Scale Patterning of Langmuir Blodgett Film of palladium Nanoparticles by Electron Beam Lithography** 강 대준, SHAHID MUHAMMAD[1](*성균과대학교 물리학과/성균관대학교 성균나노과학기술원.* [1]*성균관대학교 성균나노과학기술원.*) The conventional methods of palladium nanowires patterning are based on electrochemical deposition and lift-off. We describe palladium nanowires narrower than 100nm by means of electron beam lithography with palladium collide. A thin palladium collide film consisting of thiol stabilized Palladium nanoparticles is made by LB method on silicon oxide wafer the resulting layer is directly pattern by electron beam irradiation. The partially decomposed irradiated film regions show a marked decrease of solubility in toluene. The un-exposed region of the film is easily removed by rinsing in toluene hence leaves narrow lines of partially reacted metal organic precursor. High temperature treatment of electron beam defined palladium features in argon atmosphere completes the decomposition to quite pure palladium, as is confirmed by electron diffraction XRD and EDX analysis. In theses preliminary experiments we obtained lines with room temperature electrical resistivity as low as 1.36 x $10^{-4}\Omega m$. The height of the metal line increases with increasing the electron dose in the range from 63nm to 209nm. The adhesion to the substrate increases with increasing electron dose. The thickness of the resulting lines depends mainly on the thickness of the metal organic precursor layer. The Pd resist has a sensitivity and contrast of ~0.61 mC cm^{-2} and 1.70, respectively.

Ep-051 **Adsorption of NH_3 and trimethylamine on carbon nanotubes** PARK Sunmi, KIM Sanghun, KIM Chang Duk, KIM Hong Jeong, LEE Sung-Youp[1], SHIN Byongwook, RYU Hyun-Woo, KANG Juntae, LEE Eui-Wan, LEE Hyeong-Rag[2] (*Department of Physics, Kyungpook National University.* [1]*Department of Nano-science and Technology, Kyungpook National University.* [2]*Department of Physics, Kyungpook National University, Department of Nano-science and Technology, Kyungpook National University,Nano Practical Application Center, Daegu 704-230, Korea.*) We studied the adsorption of Amine molecules like NH_3, trimethylamine(TMA) on carbon nanotubes (CNTs). Gas sensors were fabricated with the dispersed Single-walled carbon nanotubes (SWNT) by the AC dielectrophoresis technique on an interdigitated electrode (IDE). In case of CNT networks with p-type, the adsorption of Electron-donating amine molecules reduces their conductance. Charge transfer between adsorbed molecules and SWNTs at defect sites causes a steep and nonlinear conductance change at low concentration, while molecules physically adsorbed on the pristine surfaces result in the linear electrical responses at high concentrations. In addition, Coating Nafion(a polymeric perfluorinated sulfonic acid ionomer) on CNT networks prevents TMA molecules from reaching the CNTs and permits selective sensing of NH_3.

Ep-052 **Wall-controlled growth of carbon nanotube using the surface oxidation of the catalytic film** KIM Hong Jeong, KIM Chang-Duk, KANG Juntae, RYU Hyun-Woo, LEE Sung-Youp[1], SHIN Byong-Wook[2], PARK Sunmi, KIM Sanghun, KIM jaebum, LEE Eui-Wan, LEE Hyeong-Rag[3](*Department of Physics, Kyungpook National University, Daegu 702-701, South Korea.* [1]*Department of Nano-science and Technology, Kyungpook National University, Daegu 702-701, South Korea.* [2]*Department of Physics, Kyungpook National University, Daegu 702-701, South Korea,.* [3]*Department of Physics, Kyungpook National University, Daegu 702-701, South Korea, Department of Nano-science and Technology, Kyungpook National University, Daegu 702-701, South Korea, Nano Practical Application Center, Daegu 704-230, Korea.*) We discuss the wall control growth of films of vertically aligned small-wall multiwalled carbon nanotubes (MWNTs), by thermal chemical vapor deposition of $C_2H_2/H_2/Ar$ on a Fe/Al_2O_3 catalyst film deposited by electron beam evaporation system. The size and distribution of the Fe nano-particles varied according to the growth condition, heat exposure time and the thickness of the catalytic metal layer, resulting in a change in the wall number of the carbon nanotubes (CNTs) grown. We controlled the surface oxidation of the catalytic Fe film in order to control the wall number of the carbon nanotubes. We show here that oriented growth of singlewalled carbon nanotubes (SWNTs) among vertically aligned MWNTs. It was found that the growth of CNTs was significantly influenced by the surface morphology and structure of the Fe thin film.

Ep-053 **Development of Spin-coatable Iron Oxide Resist and Its Applications** 강 대준, 민 효선[1](*성균관대학교 물리학과/성균관대학교 성균나노과학기술원* [1]*성균관대학교 물리학과*) Magnetite, Fe_3O_4, is an extensively studied material because of several interesting properties and many applications as magnetic recording media or spin-valve. Sol-gel based spin coatable Fe based chemical precursor UV/electron beam resist has been developed for direct writing of magnetite micro- and nanostructures. This method eliminates the problems associated with lift-off process performed when it used conventional organic resist. Raman spectroscopy, X-ray Diffraction (XRD) and Fourier Transform Infrared spectroscopy (FT-IR) are used to confirm magnetite and Atomic Force Microscopy (AFM) is employed to study of sensitivity and contrast of electron beam. Characterization of the magnetic properties of magnetite micro- and nanostructures is carried out using Magneto-optical Kerr Effect (MOKE). This technique shows a great promise as a versatile patterning tool applicable for magnetic recording media or spin-valve applications.

Ep-054 **Fabrication of Epitaxial Fe Nanodot Arrays and Anisotropy Engineering** 김 승호, 황 현미, 이 한석, 이 재용(*연세대학교 물리학과*) 자성 나노 구조체의 물리적 특성은 자료 저장 및 센서 응용에 장래성 이 있기 때문에 많은 흥미를 준다. 자성 재료의 중요한 특징중의 하나는 자기 이방성인데 나노 구조체의 자기 이방성은 나노 구조체의 형태나 크기, Aspect Ratio의 선택 뿐만 아니라, 나노 점 사이의 간격 및 나노 점의 배열 모양에 따라 제어될 수 있다는 장점이 있다. 특히, 적층 자성 나노 구조체는 결정자기 이방성과 패터닝 후에 유도된 자기 이방성 사이의 경쟁관계를 연구할 수 있는 좋은 기회를 제공한다. 이번에 우리는 레이저 간섭 석판술(Laser Interference Lithography)를 이용하여 적층 Fe 나노 점을 제작하고 나노 점 사이의 간격을 조절 함으로서 그들의 자기 이방성을 제어하였다. 적층 Fe나노 점은 UHV 챔버에서 적층 Fe(20nm)/Cu(150nm)/Si(001)박막을 증착 한 후, 레이저 간섭 석판술을 이용하여 패터닝 된 후에 chemical 에칭 함으로서 얻어졌다. 나노 점은 박막의 자기 곤란축 의 방향으로 배열되었고, 한쪽 방향을 따라 나노 점 사이의 간격이 조절되었다. 나노 점은 SEM(Scanning Electron Microscope)으로 관찰되었고, 그들의 성분 분석을 위하여 EDS(Energy dispersive spectroscopy)을 사용하였다. 또한, 그들의 자기적 성질은 MOKE(Magneto-optic Kerr Effect)로 측정되었다. 나노 점들의 배열 형태로부터 우리는 자기 등방 상태에서 일축 자기 이방성을 실현시켰다. 나노 점 체계에서 제어된 자기 용이축은 박막의 자기 곤란축이었으며, 나노 점의 직경 이상의 거리에서도 쌍극자 상호작용이 나타났다. 쌍극자 상호작용이 극적인 효과를 보인 것은 우리의 나노 점의 배열이 정사각형 배열이 아닌 직사각형 배열이었기 때문이다. 본 연구는 자성 나노 점에서 그들의 배열로 인한 자기 이방성 제어를 확인 하였다.

Ep-055 **강자성 나노선의 제작과 자기장에 의한 자구벽 운동** 이 한석, 강 진혁, 김 승호, 이 재용(*연세대학교 물리학과*) 강자성 나노선(nanowire)은 스핀트로닉스 소자개발에 있어 중요한 역할을 담당할 것이다. 자구벽에 대한 연구는 이러한 역할에서도 가장 기본이 되며 중요한 정보들을 가지고 있다. 우리는 자성 나노선 배열의 제작과 동시에 이것에 전류를 주어 자구벽에 대한 연구를 시도하였다. Laser Interference Lithography(LIL)와 Lift-off method를 이용하여 160-500 nm의 폭을 갖는 자성 나노선 배열을 제작하였다. 이때 사용된 Laser는 325 nm의 파장을 가진 He-Cd레이저를 사용하였으며, 두 입사빔의 입사각을 조절하여 다른 선폭을 가진 Fe 나노선을 제작하였다. Fe의 두께는 20 nm로 고정시켰다. 이들 나노선은 예상대로 잘 정의된 일축자기이방성(uniaxial magnetic anisotropy)을 가지고 있었으며, 선폭이 감소함에 따라 보자력과 자기이방상수(anisotropy constant)가 증가하였다. 자구벽(magnetic domain wall)의 운동을 관찰하기 위하여 먼저 나노선을 + 방향으로 포화시킨 후, 보자력보다 약간 작은 자기장을 -방향으로 계속 가하였다. 그 후 나노선위에 증착한 Cu wire에 pulse 모양의 전류를 흘려서 나노선을 부분적으로 반전시킨 후 -방향의 자기장에 의하여 자구벽이 움직이도록 하였다. 자구벽의 운동은 Cu wire로부터 일정거리가 떨어진 곳에서 광자기효과(magneto optical Kerr effect)를 이용하여 관찰하였다. 전류 pulse와 광자기 효과 신호를 동시에 오실로스코프에 입력하여 이들의 신호차를 바탕으로 자구벽 전파에 대한 속도를 구하는 연구가 진행 중이며, 다른 선폭을 가진 나노선배열까지 측정하여 보고할 예정이다.

Ep-056 **Optical properties and pump-probe optical switching of prism-coupled Au/SiO_2 nanocomposite slab waveguide** CHO Sunghun, LEE Soonil, LEE Taek Sung[1], KIM Won Mok[1], LEE Kyeong-seok[1](*Ajou University.* [1]*Korea Institute of Science and Technology.*) Nanocomposite (NC) films consisting of metal nanoparticles dispersed in a dielectric matrix have attracted considerable attention as a promising candidate for future all-optical switching

devices due to their peculiar optical properties, i.e. large third-order optical nonlinearity and ultra-fast temporal response, which originating from the excitation of so-called surface plasmon (SP). The NC films, despite their excellent optical properties, have not yet been applied to their potential field of integrated optics using guided wave. This is mainly due to the excessive optical loss related with the SP resonance (SPR) which necessarily accompanies absorption of the light. Our recent work addressed this problem by providing a way of generating a guided wave in the NC film while keeping the resonance properties as large as possible. We employed an attenuated total reflection type optical switch geometry and demonstrated a pump-probe optical switching for the prism-coupled Au(1 vol %):SiO_2 NC slab waveguide using cw laser. The guided mode was successfully generated using a near infrared probe beam of 1550 nm and modulated with an external pump beam of 532 nm close to the SPR wavelength. In this study, we extend our approach to ultra-fast operation using a pulsed laser with 5 ns pulse width. To improve the switching speed through the reduction in thermal loading effect accompanied by the resonant absorption of pump beam light, we adopted a metallic film as a coupling layer instead of low-index dielectric layer between the high-index SF10 prism and NC slab waveguide. We observed great enhancement in switching speed for the case of using metallic coupling layer, and founded a distinct difference in origin of optical nonlinearities induced during switching operation using cw and ns laser. (This research was supported by a grant (code #: 07K1501-02110) from 'Center for Nanostructured Materials Technology' under '21st Century Frontier R&D Program' of the Ministry of Science and Technology, Korea.)

Ep-057 **Effects of Etching Ions on the Growth of Carbon Nanotubes** DUY Dao Quang, KIM Hyun Suk[1], KIM Jae Hoon, LEE Hyung Joo, YOON Dang Mo, SHIN Seok Seung[1], HA Jung Woong, LEE Kang Jea[1], HWANG Yong Gyoo[1], LEE Choong Hun[1](*Division of Microelectronics and Display Technology, Wonkwang Univ.. [1]Regional Innovation Center for Next Generation Industrial Radiation Technology, Wonkwang Univ..*) We report on the growth mechanism and the structure of vertically aligned carbon nanotubes grown through the Ni catalyst by dc plasma enhanced chemical vapor deposition (PECVD). By controlling the pressure of reaction chamber, the etching ion concentrations have been varied and as the results the length, shape and crystallinity of CNTs has been altered. With the increasing of etching ion concentration, the length decreased from 5 μm to 800 nm, but the crystallinity strongly reinforced. Besides the tip of CNTs has also investigated, those results have clarified the role of etching ion on the growth mechanism of CNTs.

Ep-058 **SiC 나노 및 마이크로 분말의 분석과 특성평가** 유 인근, 김 성훈, 이 재휘, 김 명찬, 조 승연(*국가핵융합연구소*) SiC 단미 및 복합재료는 극한환경에서 사용할 수 있는 신소재로 우주산업(우주왕복선 표면 타일재료), 에너지 산업분야(가스터빈 등), 산업용 소재, 공구, 고온반도체 등에 활용할 목적으로10여 년 전부터 많은 연구가 진행되고 있다. 이 재료의 특성은 가볍고 부도체이면서 고온강도가 높고 내열성, 내식성, 내마모성이 뛰어나다는 것이다. 최근에는 우수한 고온저방사화 특성 때문에원자로, 핵융합로의 블랑켓(blanket), 제1벽(first wall), 디버터(divertor) 등에 직접 사용하기 위하여 많은 연구가 진행되고 있는 물질이다. 본 연구에서는SiC 나노 및 마이크로 분말의 형태, 구조, 크기, 불순물의 종류와 농도 등을 분석하고 평가했다. 이러한 과정은 구조재료를 제작하기 위한 기본소재인 분말의 특성을 분석하고 평가해서 보다 우수한 구조 재료를 제작하기 위해서실시되었다. SiC 나노분말은 크기에 따라 색깔이 다르고, 제조회사에 따라 불순물의 농도가 각각 다르게 나타났다. 불순물로는 Ba, Ca, Cr, Cu, Fe 등이 미량 검출되었으며 산소는 입자가 작을 수록 함유량이 많아지는 것을 확인할 수 있었다.

Ep-059 **Theoretical Study of The Solvent Effect for Adsorption of Pt Clusters on (5,5) Single Wall Carbon Nanotube** PARK Sora, DAM Hieu Chi[1], AHN Jeung Sun(*Dept. of Physics, Kyung Hee Univ.. [1]School of Materials Science, Japan Advanced Institute of Science and Technology.*) A theoretical study of the adsorption of Pt clusters on (5,5) single wall carbon nanotube in different solvent environments was conducted. The study used density functional theory calculations along with a COSMO (Conductor-like Screening Model) method, in which the solute molecule is covered by a dielectric continuum of permittivity that represents the solvent. Water, methanol, and ethanol were considered as solvent environments. The results showed that the charge transfer from the Pt clusters to (5,5) single wall carbon nanotube was stronger and the system (Pt clusters adsorbed on (5,5) single wall carbon nanotube) was more stable in the solvent environments than in a vacuum. The observed solvent effects on both electronic structure and stability suggest different catalytic activities of the system in different solvent environments. * This work was supported by the Seoul Research and Business Development Program (Grant No. 10583)

Ep-060 **Effect of Acetelene Flow Rate on the Structure of Carbon Nanotubes** KIM Hyun Suk, DUY Dao Quang[1], KIM Jae Hoon[1], LEE Hyung Joo[1], YOON Dang Mo[1], SHIN Seok Seung, HA Jung Woong[1], LEE Kang Jea, HWANG Yong Gyoo, LEE Choong Hun(*Regional Innovation Center for Next Generation Industrial Radiation Technology, Wonkwang Univ.. [1]Division of Microelectronics and Display Technology, Wonkwang Univ..*) The structure and crystallinity of multiwalled carbon nanotubes (MWNTs) grown through the Ni catalyst by dc plasma enhanced chemical vapor deposition (PECVD) have been investigated by using means of x-ray photoemission spectroscopy and transmission electron microscopy. By controlling the C_2H_2 flow rate during the growth process, the carbon concentrations of 52.38% to 84.94% were obtained and as the result nitrogen concentrations of 17.21% to 6.99% also were attained. According to the XPS measurements, the decreasing nitrogen concentration resulted in a decrease of the N-sp^3 C bonds as well as the reinforcement of the crystallinity of the MWNTs.

Ep-061 **Fe50Cr50 기계적 합금의 미세구조 분석 연구** 양 동석, 박 지연, 유 성초[1](*충북대학교, 과학교육학부. [1]충북대학*

P2 포스터세션

교, 물리학과.) 기계적 합금법으로 형성된Fe50Cr50합금의 자기적 특성 및 구조 분석을 실시 하였다합금의 자화도는 진동자력계에 의하여 측정하였고 합금의 미세 구조는EXAFS 분석법으로 분석하여 Fe 및 Cr 원자 주위의 원자 배열 구조를 조사한 결과 합금화 시간이 증가함에 따라 합금의 구조가 점진적으로 변화 하는 것을 관측하였다. 또한 합금의 자성과 미세 구조와의 관련성을 조사하였다.

Ep-062 **양극산화 시간에 따른 다공성 알루미나 박막의 표면, 구조적 및 광학적 특성의 변화** 안 성대, 서 수열[1], 이 광섭[1], 추 동철[2], 김 태환[3](*한양대학교 전자컴퓨터통신공학과.* [1]*한양대학교 정보디스플레이공학과.* [2]*한양대학교 디스플레이공학연구소.* [3]*한양대학교디스플레이공학연구소한양대학교전자컴퓨터통신공학과.*) 양극산화로 형성된 균일한 다공성 알루미나 박막은 제작방법이 간단하고 높은 균일성을 얻을 수 있기 때문에 나노구조형성에 많은 응용성을 가지고 있다. 전해연마 처리된 알루미늄 호일에 양극과 연결하고 음극으로 백금을 사용하여 양극산화하여 균일한 다공성 알루미나 박막을 제작하였다. 전해질로는 옥살산 용액을 사용하였으며, 항온조에 저온으로 일정하게 유지하고 일정한 전압을 인가하는 양극산화 공정을 제어하여 균일한 다공성 알루미나 박막을 제작하였다. 첫 번째 양극산화로 불균일하게 형성된 다공성 알루미나를 인산과 크롬산을 혼합한 용액을 사용하여 알루미나 박막을 제거하였다. 알루미나가 제거된 호일을 첫 번째 양극산화와 동일한 조건으로 두 번째 양극 산화를 하여 균일한 다공성 알루미나를 제작하으며 양극산화 시간을 제어하여 다공성 알루미나의 두께를 조절할 수 있었다. 제작된 다공성 알루미나를 염화수은을 이용하여 알루미늄에서 분리한 후 분리된 다공성 알루미나를 유리에 부착하여 원자힘 현미경으로 관측하였으며 광학적 투과도를 측정하였다. 원자힘 현미경 측정으로 다공성 알루미나의 기공의 크기가 균일함을 관측하였으며 다공성 알루미나의 양극산화 시간이 증가함에 따른 다공성 알루미나의 두께의 변화 및 광학적 투과도의 변화를 측정하였다.이와 같은 결과는 발광소자의 광추출 효율을 향상하기 위해 양극산화로 제작된 균일한 다공성 알루미나 구조를 적용한 구조에서의 광특성을 향상할 수 있는 응용가능성을제시한다.

*This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (No. R0A-2007-000-20044-0).

Ep-063 **Photoluminescence and Raman Spectroscopic Study of Single-Walled Carbon Nanotubes Dispersed in Aqueous Sodium Dodecyl Sulfate (SDS) Solutions** PARK June, SEONG Maeng-Je(*Chung-Ang University.*) The dispersion of single-walled carbon nanotubes (SWCNTs) in aqueous surfactant solution has recently become an important method of isolating SWCNTs. In this work we studied, using photoluminescence and Raman spectroscopy, material property change of SWCNTs in 1wt% sodium dodecyl sulfate(SDS) solution as a function of sonication time and CNT density. We have observed an increase of CNT photoluminescence intensity and a relative change of the radial breathing mode (RBM) Raman intensities of semiconducting CNTs with respect to those of metallic CNTs under 514.5nm laser excitations, with increasing sonication time to some extent.

Ep-064 **Fabrication And Measurements On Er Doped Silicon-rich Silicon Nitride (SRSN) Micro-disks** CHANG Jee Soo, LEE Shinyoung, KIM Myung-Ki, LEE Yong-Hee, SHIN Jung H., SUNG Gun Yong[1](*KAIST, 물리학과.* [1]*ETRI, 바이오센서연구팀.*) Micro-disk resonators were fabricated using Er doped Si-rich Si nitride (SRSN) films, prepared by reactive ion beam sputtering deposition followed by high temperature annealing. Disks with two different Er concentration (0.2 at.%, 0.02 at.%) were characterized using evanescent coupling with tapered fibers. From the transmission spectrum, the measured quality factors for the whispering gallery modes was found to be dominated by the fiber loss, and the intrinsic quality factor, after taking fiber loss into account, shows to be as high as $2'10^4$. A micro-disk was top pumped off-resonantly while coupled to a tapered fiber and showed Er^{3+} emission peaks at the same position as the dips in transmission. This result indicates the excitation of fundamental high-Q whispering gallery modes from a Si nanocluster (Si-nc) sensitized Er^{3+} micro-disk.

Ep-065 **실리콘 기판위에 성장된 산화 아연 나노 입자의 광학적 특성** KIM Su-Youn, LEEM Jae-Hyeon, NO Young-Soo, SON Dong-Ick[1], KIM Tae-Whan(*한양대학교 전자 통신 컴퓨터 공학과.* [1]*한양대학교 정보 디스플레이 공학과*) Presently there has been again a much interest in the zinc oxide (ZnO) materials. ZnO,as a wide band gap (E_g = 3.37 eV) photoelectric material, has unique electrical and optical properties, such as low dielectric constant, high chemical stabilization, and good photoelectric and piezoelectric properties. ZnO nanoparticles render new physical properties and potentials for new applications, such as blue luminescent devices, ultraviolet detectors, and optical nonlinear devices. There are a number of techniques, such as spray pyrolysis, precipitation, thermal decomposition, hydrothermal synthesis and electrochemical growth, for preparing ZnO nanoparticles. This paper reports data for the surface, structural, and optical properties of ZnO nanoparticles formed on Si substrate by using spin-coating and thermal treatment methods. Scanning electron microscopy (SEM), and X-ray diffraction (XRD) measurements were carried out to investigate the surface and structural properties of the ZnO nanoparticles. Photoluminescence (PL) measurements were performed to investigate the optical properties of the ZnO nanoparticles. These results can help to improve understanding of the surface, the structural, and the optical properties of ZnO nanoparticles formed on Si substrate by using a spin coating and thermal treatment method.

Ep-066 **Determination of surface morphology by x-ray diffraction measurement using 2-dimensional CCD** KIM CHAN, KIM SU NAM, MARATHE SHASHIDHARA, KIM SANG SOO, KANG HYON CHOL[1], NOH DO YOUNG(*광주과학기술원, 신소재공학과.* [1]*광주과학기술원, 고등광기술연구소.*) X-ray diffraction (XRD) techniques with one-dimensional point detector are widely used to characterize nano-scale materials. However, point detector is limited in measuring extended area in reciprocal space in short time interval. As an alternative method, we employed a two-dimensional charge-coupled device (CCD). It provides the

powerful combination of speed and sensitivity and angular resolution. So, we could get a wide q-range data in short time. The most profitable point is that we could get data on in-situ samples as well as ex-situ samples. With this benefit, we measured x-ray reflection of different feature-size trench structures which consist of periodic long narrow channels. We obtained the diffraction profiles from the trench structures on the Ewald sphere in reciprocal space.

Ep-067 **스핀코팅법에 의한 ZnO 나노파티클의 열처리 온도에 따른 구조적 특성 분석** 노 영수, 김 수연, 손 동익[1], 임 재현[1], 오 도현, 김 태환(*한양대학교 전자컴퓨터통신공학과, [1]한양대학교 정보디스플레이공학과*) 본 연구에서는 스핀코팅법에 의해 생성된 ZnO nanoparticle의 구조적 특정을 알아보았다. ZnO nanoparticle은 사파이어기판위에 Zinc acetate 을 이용하여 스핀코팅으로 성장시켰고 350 ~ 750 oC에 열처리를 각각 진행하였다. X-선 회절분석 결과 ZnO의 결정구조를 가짐을 알 수 있었고, SEM 이미지를 통해 ZnO nanoparticle 사이즈와 모양에 의해 확인할 수 있었다. X-ray photoemission spectrocopy (XPS)를 통해 ZnO nanoparticle의 조성과 화학적 결합의 특성을 조사하였다이 결과 사파이어 위에 ZnO nanoparticle의 구조적 특성과 조성의 이해 향상의 도움이 될 것이다. *This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (No. R0A-2007-000-20044-0).

Ep-068 **Micro-photoluminescence study of pyronine B molecules confined in long channels of zeolite L** LIM hyunjin, CHEONG hyeonsik, LEE Jin Seok[1], YOON Kyung Byung[1](*Sogang University, Department of Physics. [1]Sogang University, Department of Chemistry.*) Micro-photoluminescence study of pyronine B molecules confined in long channels of zeolite L The polarized micro-photoluminescence (PL) spectroscopy was used to understand the properties of zeolite-dye composites as light-emitting nano-building blocks. We prepared nanoporous zeolite-L rods and pyronine B dye molecules as the host and guest materials, respectively. Since zeolites are nanoporous and materials with uniform structures, it can be used as nano-building blocks. We synthesized long zeolite-L rods in lengths of ~10 μm, and then inserted pyronine B molecules to the pores of each zeolite. Individual zeolite L-pyronine B composite crystal rods (L-PyB rods) were separated and laid on slide glass with vacuum grease as refractive index matching material. Each rod was scanned with a micro-PL spectroscopy system, and we obtained the polarized PL images from a single rod. The pyronine B molecule inside zeolite pores absorbed the light when its dipole moment is in the direction of the incident polarization direction. In the middle part of the L-PyB rod, it emitted luminescence in the same polarization direction. However, we have observed the luminescence in different polarization direction at the ends of the L-PyB rod. From these result, we can infer that the pyronine B molecules at the ends of the zeolite pore are not uniform. This can be a critical problem in the commercial applications of the nano-building blocks. We could also obtain the PL peak position and FWHM of PL, in addition to the image of intensity using the micro-PL spectroscopy. These could provide useful information in the study of nano-materials.

Ep-069 **약산을 이용한 단중벽 탄소나노튜브의 효과적인 정제** 강 하나, 류 승철[1], 정 다미, 주 상현, 홍 완식[2], 박 경완[2], 석 중현[2](*서울시립대학교,나노과학기술학과, [1]서울시립대학교,나노과학나노공학과, [2]서울시립대학교,나노과학기술학과,나노공학과.*) 탄소나노튜브는 물리적, 기계적, 화학적인 물성에서 우수한 특성을 가지고 있어서 각종 장치의 전자방출원, FED(field emission display), 백색광원, 수소저장 연료전지, 단전자 소자, 바이오센서 등 고기능 복합체 등에서 많은 응용가능성을 보여주고 있다. 최근에는 탄소나노튜브의 전자방출 특성을 이용한 디스플레이 응용 및 분산 및 기능화를 시켜 바이오센서로의 응용 연구에 대한 초점이 모여지고 있다. 본 연구에서는 이러한 탄소나노튜브의 전자방출 및 기능화 특성에 적합한 고품질의 단중벽 탄소나노튜브를 효과적으로 정제하였다.합성된 탄소나노튜브에서의 일반적인 불순물로는 탄소나노물질, 성장을 위해서 촉매로 사용된 전이금속과 비정질 탄소입자가 있다. 나노크기의 입자로 존재하는 전이금속은 일반적으로 탄소막으로 둘러싸여 있어서 산(acid) 용액으로 쉽게 제거하기는 어렵다.전자방출 및 다양한 응용분야에 탄소나노튜브를 적용하기 위해서는 단중벽 탄소나노튜브의 결정성 및 구조에 영향을 주지 않는 효과적인 정제법이 필요하다. 실험에 사용된 합성된 단중벽 탄소나노튜브는 합성공정에 사용되었던 철 몰리브데늄 촉매금속과, 담지체로 사용된 다공성 산화마그네슘 그리고 비정질 탄소입자를 포함하고 있다. 정제 공정은 크게 2단계에 걸쳐서 진행하였다. 1단계로 촉매금속과 산화마그네슘을 둘러싸고 있는 비정질 탄소막을 효과적으로 제거하기 위해 수직형 산화로를 이용하여 420℃에서 기상산화법을 30~120h 동안 실시하였다. 2단계로는 기상산화법에 의해 비정질 탄소막이 제거된 단중벽 탄소나노튜브에 약산인 아세트산(CH3COOH)에서 1~4시간 동안 침전시켜 산화마그네슘을 제거한 후 염산에서10~20분 동안 침전시켜 촉매금속을 제거하였다.본 연구에는 정제에 사용된 약산인 아세트산이 단중벽 탄소나노튜브에 적은 손상을 주고 효과적으로 정제하는데 이상적임을 알 수 있었다.

Ep-070 **Calculated Optical Scattering Properties of Plasmonic Au Nanodisc and the Effect of Adhesion Layer** 김 주영, 조 규만, 이 택성[1], 김 원목[1], 이 경석[1](*서강대학교, 물리학과, [1]한국과학기술연구원, 박막재료연구센터*) Metallic nanostructures have great potential for bio-chemical sensor applications due to the excitation of localized surface plasmon and its sensitive response to environmental change. Unlike the commonly explored absorption-based sensing, the resonant optical scattering provides single particle detection scheme. For the localized surface plasmon resonance (LSPR) spectroscopy, the metallic nanostructures with controlled shape and size have been usually fabricated on adhesion-layer pre-coated transparent glass substrates. In this study, we investigate the optical scattering properties of plasmonic Au nanodisc as a function of size and shape factor using a discrete dipole approximation method. The effect of adhesion layer on the plasmonic properties was analyzed in more detail, as well. Our result indicates that there is a trade-off between the surface plasmon damping and the capability of supporting nanostructures in determining the optimal thickness of adhesion layer. Marginal thickness of Ti adhesion

layer for supporting Au nanostructures fabricated on a silica glass substrate was experimentally analyzed by an adhesion strength test using a nano-indentation technique. This research was supported by a grant (code #: 07K1501-02110) from 'Center for Nanostructured Materials Technology' under '21st Century Frontier R&D Program' of the Ministry of Science and Technology, Korea.

Ep-071 **Influence of Solvation-Induced Morphology in organic photovoltaic cell with blends of self-organizing poly(3-hexylthiophene) and soluble fullerene** LEE Cheol Eui, KIM Namkyoon, LEE Kyu Won, OH In Hwan, LEE Eunmo(*Department of Physics, Korea University.*) Organic photovoltaic cells based on poly(3-hexylthiophene):[6,6]-C61-butyric acid methyl ester (P3HT:PCBM) were fabricated by using two different solvents. The photo-induced current and the open-circuit voltage show a strong dependence on the polymer processing conditions. It was found that the photovoltaic devices fabricated with chloroform (non-aromatic solvents) have smaller photocurrents under same reverse bias as well as higher open circuit voltages than the devices fabricated with chlorobenzene (aromatic solvents). After post thermal treatment, a strongly enhanced photo-induced current was observed in photovoltaic devices fabricated with chloroform and a slight photocurrent change was shown in the devices fabricated with chlorobenzene. The dependence on the solvent and post thermal treatment was attributed to the different morphology of solvation-induced interpenetrating network.

Ep-072 **Efficient Organic Photovoltaic cell with Nano-domain Control of the Interpenetrating Network Morphology through Post thermal treatment** LEE Cheol Eui, KIM Namkyoon, YOON Sungmin, LEE Kyu Won, LEE Eunmo(*Department of Physics, Korea University.*) Regioregular poly(3-hexylthiophene) (rr-P3HT) is a promising candidate for polymer photovoltaic research due to its stability and absorption in the red region. We obtained more efficient bulk heterojunction organic photovoltaic cells, using blend films of regioregular poly(3-hexylthiophene)(P3HT) and 1-(3-methoxycarbonyl)-propyl-l-phenyl-[6,6]-C61-butyric acid methyl ester(PCBM) that are subjected to a post thermal treatment process. Blend films (P3HT:PCBM = 1:0.8 weight-ratio) were prepared using chloroform. Through a thermal annealing at temperatures approaching the glass transition temperature, we examined the formation of nanodomains within the matrix. The improved nanoscale morphology, the increased crystallinity of the semiconducting polymer, and the improved contact to the electron-collecting electrode facilitate charge generation, charge transport to, and charge collection at the electrodes, thereby enhancing the device efficiency by lowering the series resistance of the organic photovoltaic cells.

Ep-073 **AB INITO STUDIES ON INTERACTION BETWEEN CARBON NANOTUBES AND VARIOUS ORGANIC MOLECULES** PARK sohee, KONG Ki-jeong, SO Hye-Mi, LEE Jeong-O, CHANG Hyunju(*한국화학연구원*) Single-walled carbon nanotubes (SWNTs) have been studied widely with experimental and theoretical interests in their various applications. Particularly, chemical treatments of carbon nanotubes with various molecules have been intensively investigated in many applications, such as chemical and biological sensors and nanodevices. Recently, it was reported that some electrophilic molecules could selectively attack the SWNTs depending on their chiralities[1]. However, the detailed mechanism of selectivity has not been clearly understood yet. In previous study, we presented a systematic theoretical investigations of the interactions between the SWNTs and several electrophilic molecules, such as 4-bromobenzene diazonium tetrafluoroborate (4-BBDT), 2,4,6-triphenylpyrylium tetrafluoroborate (2,4,6-TPPT), 1,3-benzodithiolylium tetrafluoroborate (1,3-BDYT), and benzendiazonium tetrafluoroborat (4-CBDT)[2] . By scrutinizing the results of first-principles calculations based on the density functional theory(DFT), we have established some evidences that organic molecules can selectively attack the sidewall of the metallic nanotubes according to chiralities. In this work, we will present further investigation on the interaction between the 4-CBDT molecule and SWNTs, focusing on the electronic structure changes of SWNTs upon molecular adsorption. We have successfully explained the disappearance of metallicity with attacking of electrophilic molecules by analysing the Fermi level shift, the change in density of states, the shape of highest occupied molecular orbitals.

[1] Strano, M. S et. al, *Science* 301, 1519 (2003). [2] Hye-Mi So et. al, *J. Am. Chem. Soc.* 129 , 4866 (2007).

Ep-074 **Electrical Properties of Carbonized Polyacetylene Thin Films** KIM YoungSu, CHOI AJeong, MATSUSHITA Satoshi[1], AKAGI Kazuo[1], PARK Yung Woo(*Department of physics and Astronomy &Nano Systems Institute-National Core Research Center, Seoul National University*. [1]*Department of Polymer Science, University of Kyoto.*) Pyrolysis treatment on organic polymers is a well known method to make carbon materials. But carbonized polyacetylene(PA) thin films have not been investigated so far. The macroscopically aligned PA thin films were carbonized at 1000℃ for 1 hour in a vacuum or in an argon gas. After that the remaining black char was further annealed at 2600℃. It contains aggregated carbon nanorods of about 10nm in width [1].We have measured temperature dependent resistance and I-V characteristics of carbonized PA thin films by four-probe method at temperature down to 1.4K. Also, negative magnetoresistance(MR) at various temperatures was obtained at high magnetic field up to 13 tesla by using superconducting magnet. It is described using the weak electron localization effect.

[1] Kyotani, M., S. Matsushita*, et al.,* Synthetic Metals, 157(13-15): 546-550 (2007).

Ep-075 **2T Cryogen Free 고온초전도 자석 개발(1)** 손 명환, 박 해용, 김 석호, 심 기덕, 김 호민, 성 기철, 이 언용, 권 영길 (*한국전기연구원 초전도기기연구그룹*) 고온초전도체의 발견과 극저온 냉동기의 성능향상으로 실험테이블 위에 놓을 수 있는 수

테슬라의 이화학실험용 자석 개발이 가능해졌다.초전도 연구를 20년간 진행해온 한국전기연구원에서도 지름50mm이상의 상온 보아를 가진 2 테슬라의 고온초전도 자석을 개발하는 과제를 진행 중이다. 운전전류는 120A이고 여덟 개의 더블팬케이크 코일, GM 냉동기, 한 쌍의 고온초전도 전류리드 및 금속 전류리드 그리고 크라이오스타트로 구성된다. 코일은 스미또모에서 제작한 임계전류 140A 이상인 DI-BSCCO 도체를 사용하였고 wet-winding법으로 권선하였다. 코일의 내경은 110mm였고, 외경은 약 195mm였다. 더블팬케이크 코일 내부의 지지판은 GFRP판을 사용하였고, 외부의 지지판은 아노다이징한 알루미늄 판을 사용하였다. 제작한 각 서브 코일들의 임계전류를 액체질소 속에서 측정하였는데 57A 이상이었다. 이 값은 예측한 값 55A보다 높은 값이다. 본 연구에서는 고온초전도 자석의 설계와 각 서브코일의 제작 및 특성평가에 대해 소개하고자 한다.

*본 연구는 한국전기연구원기본연구사업비로 수행되었습니다.

Ep-076 **분무열분해법으로 성장된 In_2O_3:Zn 박막의 구조와 광학적 전기적 특성** 서 동주, 오 상미, 임 수경, 이 관교, 김 건호[1](*조선대학교.* [1]*경상대학교*) In_2O_3:Zn 박막을 분무열분해법으로 유리기판 위에 성장시켰다. In_2O_3:Zn 박막을 성장시키기 위해 사용한 시약은indium chloride, zinc chloride이며, 이차증류수에 이들 시약을 녹여0.02 mole 수용액을 만든 후 증류수를 혼합하여 분무용액을 만들어 사용하였다. 성장온도와Zn 농도 변화에 따른 In_2O_3:Zn 박막의 결정구조를규명하기 위하여 X-선 회절분광기(XRD)를 이용하였으며, In_2O_3:Zn 박막의 표면과 미세구조는 주사전자현미경(SEM)을 이용하여 관찰하였다. In_2O_3:Zn 박막에 입사한 빛의 파장을 변화시키면서 광투과와 광흡수 스펙트럼을 측정하여 광학적인 특성과 에너지 간격을 구하였다. 시료에 대한 Hall의 효과를 van der Pauw법으로 실온에서측정하여 비저항, 운반자 농도 등의 전기적 특성을 규명하였다.

Ep-077 **Surface Structure of Ionic Liquids Determined by X-ray reflectivity and Sum-Frequency Generation Spectroscopy** KIM Doseok, JEON Yoonnam, SUNG Jaeho, BU Wei[1], DAVID Vaknin[1], YUKIO Ouchi[2](*Department of Physics and Interdisciplinary Program of Integrated Biotechnology, Sogang University.* [1]*Ames laboratory and Department of Physics and Astronomy, Iowa State University.* [2]*Department of Chemistry, Nagoya University.*) X-ray reflectivity and surface sum-frequency generation spectroscopy were used to study the surface of [BMIM][X] ionic liquids (BMIM = 1-butyl-3-methylimidazolium, X = BF_4, PF_6, and I). Sum-frequency signal strength from the terminal methyl groups of the cation at the surface indicates the topmost surface of these ionic liquids are occupied by polar-oriented hydrophobic butyl chains having ~1/3 of the alkyl chain density of fully-packed hexadecanol Langmuir monolayer. X-ray reflectivity could be fitted well by the assuming the first layer with low electron density followed by the electron-rich second layer on top of bulk ionic liquid. Detailed analysis of the reflectivity data in conjunction with the sum-frequency findings strongly suggests the molecules forming the top-most layer are on average oriented with their butyl chains (loosely packed) towards the gas/liquid interface while the core/anions (densely-packed) are in contact with the bulk liquid.

Ep-078 **Investigation of inorganic-organic interface properties on organic optoelectronic devices using Kelvin Probe Microscopy system** SOHN Sunyoung, LIM Jung-Ran, LEE Jouhahn, EOM Seung hun[1], LEE Soo-Hyoung[1](*Jeonju Center, Korea Basic Science Institute.* [1]*Division of Chemical Engineering, Chonbuk National University.*) The poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT:PSS) have been widely using as a hole transport layer of organic optoelectronic devices including organic light emitting diodes (OLEDs) and organic solar cells (OSCs), and also it become known as a candidate material for substituting ITO anode because of many advantages such as low cost, high work function, conductivity, and transparent property. In order to improve the performance of the devices, the studies on interface property between the ITO anode layer and the PEDOT:PSS layer is very important for enhance the charge carrier injection in the OLEDs or the effective transport of separated charges in the OSCs. In this work, we believed that the hole injection barrier and the hole collection barrier in respectively OLEDs and OSCs can be suggested by measuring the surface potential difference at the inorganic-organic or the organic-organic interface using the Kelvin Probe Microscopy (KPM) analysis.

Ep-079 **나노 Al2O3 박막의 XRR 특성 변화** 박 재환, 신 대근, 김 창수[1], 오 병성[2], 최 용대[3](*한국 표준과학 연구원충남대학교 물리학과.* [1]*한국 표준과학 연구원* [2]*충남대학교 물리학과.* [3]*목원대학교 광.전자 물리학과.*) 반도체 소자의 고직접화로 얇은 두께와 고유전율의 박막이 필요로 되고 있다. 따라서 고유전율 산화막은 두께가 수nm로 얇아지고 정확한 두께 측정을 필요로 하고 있다. 따라서 반도체 소자용 나노 두께의 초박막에 대하여 높은 신뢰성으로 측정하고자 많은 노력이 이루어지고 있다 XRR(X-ray reflectometry)은 나노 스케일 박막의 두께를 측정하는 유망한 도구로 인식되고 있고 XRR 측정 결과의 신뢰성을 향상시키기 위하여 많은 연구가 이루어지고 있다. Si 기판 위에 성장시킨5 nm 두께의 Al_2O_3 박막에 대하여 세척과 가열 등 전처리 조건을 변화시킨 조건에 따른 반사율 곡선의 변화와 분석 결과를 살펴보았다.세척과 가열은 IPA(isopropyl alcohol)와 초음파세척기를 이용하였고 약 200℃ 까지의 온도로 가열하였다. 전처리 조건의 변화에 따라X-선 반사율곡선이 변화하였고 이에 따라XRR 측정 두께가 영향을 받았고 이것을 TEM 결과와 비교 분석하였다. 또한 XRR 곡선의 Fourier Transform(FT) 분석을 통하여 기판과 Al2O3 박막 사이의 중간층을 확인할 수 있었다. 본 연구에서는 세척과 가열 등 전처리 조건의 변화에 따른 반사율 곡선의 변화와 이에 따른 박막 두께의 변화를 살펴보고FT과 TEM 분석을 통하여 XRR 측정 결과의 신뢰성을 향상시켰다.

Ep-080 **The study of anodic films formed on AZ91D magnesium alloy in annealing** 유 재인, 유 재용, 한 병하, 박 창훈, 김 진희, 김 재근, 김 기홍[1](*(주)태양기전 제2기업부설연구소.* [1]*경운대학교 안경광학과.*) The anodization behaviors of Mg and Mg-alloys depend on the process parameters employed, the chemical compositions of the materials anodized, and the electrolytes used. The current density and potential applied during anodization have great influence on the reactions taking place and the properties of

the resulting anodic films. Mg and its alloys have been considered as one of potential implant biomaterials due to their low weight and inherent biocompatibility. The main elements in anodizing products were Mg, O, Al and Si, indicating that both alloy substrate and electrolyte solution were involved in anodization. Anodic film developed early was mainly comprised of periclase MgO and forsterite Mg_2SiO_4. And The composition and microstructure of the anodic fi lms formed on AZ91D Mg alloy, with or without annealing, were investigated.

Ep-081 **Plasma surface treatment to control degradability of polymers with hydrolytic linkages using carbon dioxide by ICP method** 김 명찬, 유 인근, MASUOKA Toshio[1](*국가핵융합연구소.* [1]*NIMC (AIST, Japan).*) In recent years, interest and emphasis in biomaterials engineering have moved from stability of biomaterials in the biological environment to its degradability in the human body. Biodegradable materials are considerated to degrade gradually and be replaced properly by newly formed tissue in the body. Poly lactic acid and polyhydroxybutyrate-polyhydroxyvalerate are organic materials found in many products of natural orgin. These materials, therefore, have been studied generally as new biomaterials, which is a biodegradable copolymer, to produce new biomaterials for potential medical applications. These systems moreover, could be utilized to design effective drug delivery systems. Inductively coupled plasma(ICP) is more efficient than others due to its advantages, for example, low-temperature, high charged-particle and reactive speciese densities in plasma space, althouth treating time is very short. The purpose of this study is to control biodegradability of polymers with hydrolytic linkages using carbon dioxide by ICP treatment and to understand the surface phenomena.

Ep-082 **DBR 다공질규소에 염화나트륨을 흡착 및 방출시킬 때의 반사율 스펙트럼** 김 한중, HORCHHONG Cheng, 박 찬웅, 박 선화, 이 기원, 김 영유(*공주대학교 물리학과*) DBR (Distributed Bragg Reflector) 다공질규소(Porous silicon)를 제작하고 그 표면에 염화나트륨을 흡착 및 방출시키면서 반사율 스펙트럼을 조사하였다. DBR 다공질규소에 염화나트륨을 흡착시키면 반사율 스펙트럼의 세기는 감소하고, 최대봉우리는 장파장 쪽으로 이동하였다. 이어 방출시키면 시간이 지나가면서 본래의 스펙트럼으로 거의 회복되었다. 이러한 특성은DBR 다공질규소를 염화나트륨 등과 같은 약물을 감지 또는 전달할 수 있는 매체로의 응용에 기초 자료가 될 것으로 기대된다.

Ep-083 **중성자감속재 HDPE의 장기조사후 효과** 박 광준, 주 준식, 강 희영, 신 희성, 김 호동(*한국원자력연구원*) 중성자계수기의 구성품 중 중성자 감속재로 사용되는 고밀도 폴리에틸렌(HDPE)에 대한 장기 감마선조사후 효과를 관찰하였다 대부분의 폴리머재료는 방사선환경에 노출되면 방사선유도산화로 인하여 본래의 분자구조가 일부 다른 분자구조로 변화되며,또한 일부 원소가 생성 또는 증발된다. 따라서 여러가지 물리/화학적 특성이 변하게 된다. 본 연구에서는 감마선조사후1년 6개월이 경과한 시점에서, 10^5 rad -10^9 rad 로 조사된 HDPE 감속재 구조물에 대하여 중성자 감속능 평가시험을 수행하였다. 시험결과 10^5 rad 조사 HDPE의 경우, 3% 대로 감소폭이 상대적으로 큰 것으로 나타났다. 이러한 결과는 감마선조사 직후의 중성자 감속능 시험결과와 거의 같은 경향을 나타내는 것으로서 중성자 감속능이 감마선 조사선량에 직접 비례하지 않고 특정 선량에서 감소한다는 것을 재확인해준 것이다. 이러한 시험결과는 핵물질 측정분석시 반영하여 측정정밀도를 높이는데 활용될 것이다.그리고 좀 더 자세한 감마선조사 HDPE의 중성자 감속능 변화 메카니즘은 더 많은 연구를 통하여 앞으로 해결해야할 문제이다.

Ep-084 **Excitation-wavelength dependent fluorescence behavior in ionic liquids** SHIM Taekyu, CHA Sunchul, KIM Doseok(*Department of Physics and Interdisciplinary Program of Integrated Biotechnology, Sogang University.*) Unusual fluorescence properties are recently discovered from several room temperature ionic liquids; (1) even if they did not significantly absorb in the near-UV region, the fluorescence in the visible region was readily observed, and (2) the fluorescence peak redshifted following the increase in the excitation wavelength. About the latter phenomenon, fluorescence maxima of certain dye molecules dissolved in ionic liquids also redshifted when the excitation wavelength was changed at the red-edge of the absorption spectrum (red-edge effect). We investigated the fluorescence characteristics of ionic liquids ([BMIM][BF_4], [BMIM][PF_6], and [OMIM][BF_4]) and hemicyanine dyes dissolved in ionic liquids by varying the excitation wavelength. The peak of the fluorescence from hemicyanine dyes in conventional solvents hardly changed as the excitation wavelength increased. On the other hand, the fluorescence peak shift of the above neat ionic liquids was more than 200 nm. Furthermore, the fluorescence peak shift of hemicyanine dye molecules in ionic liquids is found to be also strongly dependent on the excitation wavelength.

Ep-085 **단일 기판에 다공질규소 어레이를 제작하는 방법의 구현과 이의 구조적, 광학적 특성** 박 선화, 김 한중, 김 영유, 이 기원(*공주대학교, 물리학과.*) 지금까지 다공질규소(porous silicon) 제작을 위해 lateral anodisation cell, single-tank cell, double tank cell 등의 방법이 사용되어 왔다. 이 방법들의 공통점은 규소기판과 백금전극을 불화수소 용액 속에 담근 상태에서 양극산화가 진행되어 한 기판에 특정 조건을 갖는 시료만을 제작할 수 있다. 이 때문에 여러 조건에서 제작된 다공질규소를 묶어 하나의 어레이(array)를 구성하기 위해서는, 각각의 규소 기판에 서로 다른 조건으로 다공질규소를 제작해야 했다. 이로 인해 어레이의 크기가 커지고 실험시스템이 복잡하게 구성됨으로서 소형의 어레이 구성은 어려운 실정이었다. 이러한 문제점을 해결하기 위해 본 연구에서는 기판 재활용 기술을 이용하여 단일기판에 소형의 다공질규소 어레이를 제작하는 방법을 구현하고 그 구조적 광학적 특성을 조사하여 현재의 방법과 비교하였다. 단일 기판에 여러 조건을 갖는 다공질규소 어레이는 단백질 크기 선별 매체, 약물전달 매체, 기체 및 액체 감지용 전자코(electronic nose) 등으로의 이용이 기대된다.

Ep-086 **Effects of Y Substitution on Structure and Ferroelectric Properties of $BiFeO_3$ Thin Films** CHO Kwang-

Hwan, KANG Chong-Yun, YOON Seok-Jin, LEE YoungPak[1] (*Thin Film Materials Research Center, KIST.* [1]*q-psi and Dept. of Physics, Hanyang Univ.*.) $BiFeO_3$ and $Bi_{1-x}Y_xFeO_3$ (BYFO) (x=0.03, 0.05, 0.07, 0.10, and 0.15) thin films were deposited on $SrRuO_3$-buffered $SrTiO_3$ (001) substrates using a pulsed laser deposition (PLD). Influence of Y dopant on dielectric properties of $BiFeO_3$ films were studied X-ray diffraction results show that a gradual phase transition from rhombohedral to pseudotetragonal structure may occur in BYFO films with the increase of Y content. Due to the lower leakage currents resulting from the smaller grain sizes and smoother surfaces, well saturated *P-E* hysteresis loops can be observed in all BYFO films at room temperature.

Ep-087 **Transport Properties and Thermoelectric Power of Individual Single-Crystalline Bi Nanowires** LEE Seunghyun, HAM Jinhee[1], CHOI Wonjin[1], ROH Jong Wook[1], JEON Kye Jin[1], LEE Wooyoung[1](*Nanomedical National Core Research Center, Yonsei University, 134 Shinchon, Seoul 120-749, Korea.* [1]*Department of Materials Science and Engineering, Yonsei University, 134 Shinchon, Seoul 120-749, Korea.*) Over the last decade, bismuth (Bi) nanowires have been of great importance in nanophysics to both theorists and experimentalists, as Bi is known to be a Group V semimetallic element that exhibits unusual transport properties due to its highly anisotropic Fermi surface [1]. Moreover, single-crystalline Bi nanowires are expected to usher in new class of thermometric devices with high thermoelectric figure-of-merit (*ZT*) values. In this work, we present the transport properties and thermoelectric power of individual single-crystalline Bi nanowires grown by a novel stress-induced method. With this method, the diameter, shape, and aspect ratio of Bi nanowires can be tuned by controlling the growth conditions. Furthermore, five-terminal devices based on individual Bi nanowires were successfully fabricated using a hydrogen annealing method to remove an oxide layer from the outer surface of the nanowires. It was found that a Bi nanowire with a diameter of 120 nm exhibits an electron mobility of 76,900 cm^2/Vs and an extraordinary mean free path of 1.35 mm at room temperature, as measured by the electric field effects [2]. A micro-heater was fabricated adjacent to the end of a Bi nanowire for measurements of thermoelectric power (TEP). When the bias voltage was applied to the heater, the temperature of the electrodes was monitored by the resistance changes of electrodes as a thermometer. The resistance changes were mapped to the temperature changes of the electrodes. The resulting temperature gradient across the nanowire was 0.1 - 0.5 K/mm, while typical power consumption in the micro-heater was less than 100 mW. The thermoelectric voltage across the nanowire can be readily measured using a lock-in amplifier. The modulation of TEP of individual single-crystalline Bi nanowires by electric-field effect is presented. References[1] X. Sun, Z. Zhang, and M. S. Dresselhaus, *Appl. Phys. Lett.* 74, 4005 (1999)[2] Wooyoung Shim, Jinhee Ham, Kyoung-il Lee, Won Young Jeung, Mark Johnson and Wooyoung Lee, "On-Film Formation of Bi Nanowires with Extraordinary Electron Mobility", *submitted to Science* (2007)

Ep-088 **KPM studies of organic nano device using Anodic Aluminum Oxide (AAO) template** 임 정란, 손 선영, 박 종배, 이 주한(*한국기초과학지원연구원 전주센터, 유기나노소자연구팀*) 알루미늄을 양극으로 하여 일정한 온도와 전압에서 전해할 경우 알루미늄 표면에 일정한 크기와 길이를 갖고 형성된 나노스케일의 산화층을 Anodic Aluminum Oxide (AAO)라 한다. 나노스케일의 AAO 템플레이트를 이용하여 제작된 나노소자는 스핀주입이 용이하여 고효율을 가지므로 차세대 광전자 소자로써 많은 연구가 이루어지고 있다. 본 연구에서는Si 기판 위에 100 nm의 포어와 5 μm의 길이를 갖는 AAO 템플레이트 안에 유기 발광 물질인 Alq_3를 증착한 후 Kelvin Probe Microscopy (KPM)를 이용하여 AAO 템플레이트 안에 주입된 Alq_3의 dot array를 관찰하였다. 또한, KPM 측정을 통해 증착 조건에 따른 유기물/전극의 표면, 유기물/전극 계면에서의 거칠기, 그리고 표면에너지 차이로부터 유기나노소자의 전하 전달 메커니즘을 규명할 수 있다. 다양한 길이와 포어 사이즈를 갖는 AAO 템플레이트를 이용하여 제작된 소자의 전기, 광학적인 특성분석을 통해 차세대 광전자소자로써의 가능성을 제안하고자 한다.

Ep-089 **Electrical properties of sol-gel derived $(Bi,La)_4Ti_3O_{12}$ films preapred on $LaZrO_x$/Si cubstrates** JEON Ho-Seung, KIM Joo-Nam, LEE Gwang-Geun, PARK Byung-Eun (*University of Seoul, School of Electrical and Computer Engineering.*) The electrical properties of $(Bi,La)_4Ti_3O_{12}$ (BLT) films prepared on $LaZrO_x$/Si substrates were investigated. The $LaZrO_x$ thin film was used in this structure as a buffer insulating layer. Both BLT and $LaZrO_x$ films were deposited by a spin-coating method. The results from capacitance-voltage (C-V) measurements showed that the $LaZrO_x$ thin film had good electrical properties. It is worth noting that a hysteresis width in the C-V curves was negligibly small. Atomic force microscopy (AFM) surface images indicated that the film had a very flat and smooth surface. The BLT films on the $LaZrO_x$/Si structure showed clockwise ferroelectric hysteric loops in C-V curves indicating a good ferroelectricity. The memory window width increased with the increase of an applied voltage. The leakage current density was lower than 1×10^{-6} A/cm^2 at 10 V. These thin films have been characterized using, X-ray diffraction (XRD), scanning electron microscopy (SEM) and electrical and dielectric measurements. These properties will be discussed in terms of feasibilitystudy for 1-transistor-type ferroelectric memory.

Ep-090 **Fabrication and Characterization of Metal-Ferroelectric-Metal-Insulator-Semiconductor Field-Effect Transistor Using $(Bi,La)_4Ti_3O_{12}$ and $SrTa_2O_6$** KIM Joo-Nam, JEON Ho-Seung, PARK Byung-Eun(*University of Seoul, School of Electrical and Computer Engineering.*) To investigate the Au/$(Bi,La)_4Ti_3O_{12}$ (BLT)/Pt/$SrTa_2O_6$ (STA)/Si structure, we used the BLT as a ferroelectric layer and the STA as a buffer layer for the metal-ferroelectric-metal-insulator-semiconductor field-effect transistor (MFMIS-FET). A sol-gel method was applied to prepare the STA thin film and BLT film. The root-mean-square surface roughness of STA thin film annealed at 900 °C, was only 0.3 nm and equivalent oxide thickness value was about 5.2 nm. The leakage current den-

sity for STA/Si structure was lower than 3.9×10^{-8} A/cm^2 at an applied voltage of 5 V. The 100 nm-thick Pt electrode was deposited on STA/Si structure by ion-sputter. We deposited the 420 nm-thick BLT film on Pt/STA/Si structure. We fabricated the Au/BLT/Pt/STA/Si MFMIS-FET with different area ratio (A_F/A_I) varied from 1 to 8. From the drain current–gate voltage characteristics at the drain voltage of 0.2 V, the memory window is only 0.5 V for the device with A_I/A_F = 1 but it is increased to 1.8 V with A_I/A_F = 8. However, the on/off ratio is decreased from 5×10^3 to 2×10^2. The data retention characteristics can be improved by increasing the area ratio. For the area ratio of 4, the drain current of $1.2\text{x}10^{-5}$ A was rapidly dropped after $1.4\text{x}10^4$ s to $4\text{x}10^{-6}$ A. The retention time was improved as the area ratio is increased to 8 and we achieved that it was dropped after $8.5\text{x}10^4$ s.

Ep-091 **Design and Simulation of GSO Based Detection System for Continuous Blood Sampling** 김 종국, 김 진수, 우 상근, 김 경민, 천 기정(*한국원자력의학원 방사선의학연구소 분자영상연구부*) Minimal dispersion and high sensitivity with background rejection are important for quantitative measurement of radioactivity concentration in blood sampling system. We propose GSO based detection system, which has been newly designed for continuous blood sampling with high sensitivity. This detection system consists of four GSO scintillation crystals, photomultiplier tubes assembly with lead shield. Two paralleled GSO detectors with PMTs are facing to another two paralleled detectors, and polyethylene tube line of a continuous blood flowing is introduced to unique designed acryl guide at the detection position. The two paired GSO detectors providing a sensitivity in single photon based simulation were ~94 % for Tc-99m, ~ 60 % for F-18 respectively. The relation between thickness and detection efficiency of the GSO for annihilation photons were also studied. We estimated the sensitivity from 20mm square GSOs of various depths. In addition, the geometrical effect and efficiency of crystal, and absolute sensitivity were also investigated using GATE simulation code. In the near future, the GSO based detection system for Continuous Blood Sampling will be used in clinical as well as in small animal studies for PET tracers.

Ep-092 **Resistance Switching Behaviors of Pt/NiOx/Pt structures** CHANG Seo Hyoung, LEE Jae Sung[1], JANG Jae Hyuk[2], CHAE Seung Chul, LEE Shin Buhm, KAHNG Byungnam[1], KIM Dong-Wook[3], JUNG Chang Uk[4](*ReCOE & FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea. [1]Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea. [2]School of Materials Science and Engineering, Seoul National University, Seoul 151-744, Korea. [3]Division of Nano Sciences and Department of Physics, Ewha Womans University, Seoul 120-750, Korea. [4]Department of Physics, Hankuk University of Foreign studies, Yongin, Kyeonggi 449-791, Korea.*) Resistance switching (RS) phenomena in metal/oxide/metal structures have been studied extensively due to their application possibilities, resistance random access memory (RRAM). In spite of extensive studies, there are still lots of unsolved questions on details of these RS phenomena. In this study, we observed transitions of RS type between memory and threshold RS, depending on bottom electrode and measurement temperature. We varied Pt bottom electrode thickness in Pt/NiOx/Pt structures and investigated the current-voltage (*I-V*) switching characteristics. The samples with thick bottom electrode showed memory RS. And the samples with thin bottom electrode showed memory RS at low temperature and threshold RS at room temperature. The bottom electrode thickness and temperature dependence of the RS type transitions may give us some insights to reveal mechanism of RS phenomena. The detailed RS mechanism will be discussed.

Ep-093 **The Characteristics of PVDF-TrFE Film Using $LaZrO_x$ Buffer Layer with MFIS Structure** HUI-SEONG Han, GWANG-GEUN Lee, BYUNG-EUN Park(*School of Electrical and Computer Engineering, University of Seoul, Seoul, Korea.*) Recently researches to make ferroelectric nonvolatile memories with polyvinylidene fluoride–trifluoroethylene (PVDF-TrFE) begun in the 1990s, but the most of the activities faced a significant problem in reducing the operating voltages.In this work, the metal ferroelectric insulator semiconductor (MFIS) structure capacitors using PVDF-TrFE as the organic ferroelectric layer and lanthanum zirconium oxide (LZO) as the insulator layer were fabricated on a p-type Si (100) substract. The thin films were prepared by using a spin-coating method. The LZO thin films were crystallized at 750 ^{o}C for 30minutes in O_2 ambient. Then the PVDF-TrFE films were annealed at 165 ^{o}C for 30 minutes. The thickness of LZO was 30 nm and its memory window width in the C-V (capacitance-voltage) curve of the Au/PVDF-TrFE/LZO/Si structure was about 2.5 V with a voltage sweep of ± 10 V and the saturated about ± 5 V. The value of the leakage current density, at a sweeping range of ± 10 V, was about 5.5×10^{-7} A/cm^2 for 100 nm thick films. From these results, we expect the combination of PVDF-TrFE and the LZO thin film is useful and promising for the 1-T type ferroelectric random access memory (FeRAM) at a low voltage.

Ep-094 **Stress of Electric Stimulus in Reset process of Resistance Switching Behaviors of TiO_2 Thin Films** CHAE Seung Chul, CHANG Seo Hyoung[1], LEE Shin Buhm[1], NOH Tae Won[1], LEE Jae Sung[1], KAHNG Byungnam[1], KIM Dong-Wook[2], JUNG Chang Uk[3], CHOI Won Sup[4], SHIN Hyunjung[4](*Dapartment of Physics and Astronomy, Seoul National University. [1]Department of Physics and Astronomy, Seoul National University. [2]Department of Physics, Ehwa Womans University. [3]Department of Physics, Hankuk University of Foreign Studies. [4]Center for Materials and Processes of Self-Assembly, School of Advanced Materials Engineering, Kookmin University.*) Recently, the resistance switching phenomena have gained renewed research interests due to their potential in realizing high density resistance random access memory (RRAM) devices. The phenomenological description of resistance switching behavior, namely random circuit breaker network model, was reported that the resistance switching behaviors show the percolative electric switching. However, the details in resistance switching are not clear. In this

presentation, we report more detailed current(*I*)-voltage(*V*) characteristics of resistance switching in TiO_2 thin films using conventional *I-V* measurement and conducting atomic force microscopy. In the unipolar resistance switching, it is commonly believed that conducting filaments will become ruptured when TiO_2 changes from a low resistance to a high resistance. Wherein, we found that this resistance switching could occur along the rather electric bias stress compared with the set process, namely resistance switching from high resistance state to low one.

Ep-095 **Quantum Transport Characteristics of Graphene For Nanoelectronic Device Applications** VENUGOPAL Gunasekaran, SAINI Shrikant, KIM Sang Jae(*Nano Materials and System lab, Dept of Mechatronics Engineering,Cheju National University,Jeju 690756 South Korea.*) We demonstrate the quantum electronic transport measurements forgraphene sheets through which their properties at low temperature have beenstudied. Highly oriented pyrolytic graphite (HOPG) is a periodical stack of twodimensional (2D) graphene sheets along the c-axis.The graphene is a monolayer of carbon atoms which have hexagonal lattice structure.Its charge carriers are massless Dirac fermions. We present a technique forpreparing graphene sheets out of bulk graphite, method of electrical ohmiccontacts, device pattern done by using Focused Ion Beam (FIB) and transportmeasurement results, for nanoelectronic device applications. We also report thetemperature dependent electrical transport measurement for ab-plane as well as for c-axis.The in-plane resistivity measurement results reveal that the resistance showsbasically a linear decrease as temperature decreases (like metallic behavior). We have observed the electric potential fluctuations on the surface of thegraphite.Interestingly, at 28 K, we have observed less potential fluctuations. However when we increase the temperature to 300 K,the fluctuation rate is also increases linearly to approximately 250%. This paper will further discuss the fundamental quantum transportproperties by using c–axisconductivity as well as I-V characteristics.

Ep-096 **SnO_2 박막을 이용한 CO_2 가스센서의물리적 특성에 관한 연구** 김 영국, 손 인호[1], 김 일홍[2], 우 종철[2], 황 동규[2](*경남대학교, 물리학과.* [1]*경남대학교 물리학과.* [2]*경남대학교, 자연과학부.*) ITO 기판 위에 SnO_2 박막을 스프레이 열소성법을이용하여 첨가물로 F와 La을 첨가하여 ITO-SnO_2: F, ITO-SnO_2: La 박막을 제작하였다. 제작한 각각의 박막을 이용하여CO_2 가스에 대한 가스감지기구로서의 특성을 알아보기 위하여 CO_2 가스의 양을 500~2500 cc/min의 양으로 변화를 주면서 동작온도를100~250℃까지 각 50℃ 간격으로 나누어 저항의 변화를 관찰하여 각각의 소자에 대한 전기전도도, 반응감도 및 반응율을 분석하여CO_2 가스에 대한 가스감지소자로서의 특성을 알아보았다.제작한 각각의 박막을X-선 회절분석과SEM 분석 결과 SnO_2: La, F 박막은(110), (101), (200), (211), (310)의 Miller 지수를 가진 다결정으로 격자상수가 4.8Å인 tetragonal 구조로 안정된 결정임을 알 수 있었으며, 첨가물은 모체의 결정 구조에는 큰 영향을 미치지 않았으며, 첨가물에 의해 주면의 상이 커져 가스와 반응에 영향을 주었다고 생각된다. 제작한 각각의 박막은430 nm～780 nm의 파장 영역에서F를 첨가한 경우 30～60%의 광투과율을 나타냈으며, La을 첨가한 경우 80%의 광투과율을 보였다. CO_2 가스와 반응 시 전기저항의 변화는 반응초기에는 급격한 저항의 감소를 보이며, 반응 후 전기저항의 증가는 감소시보다 다소 완만한 형태를 보였다. 단, 첨가물을 첨가한 경우 빠른 복귀시간을 가짐을 나타내었다. CO_2 가스의 양이 증가할수록 전기저항의 변화율이 증가함으로 전기전도도의 변화량, 반응감도 및 반응율의 증가를 보였다. 첨가물의 양을 증가할수록 좋은 센서적인 특징을 보였으나 일정량 이상의 경우 오히려 반응감도 및 반응율이 감소함을 보였다. 제작방법과 기판의 종류에 따른 각각의 박막에 대한 감지소자로서의 특징은 각각의 방법과 기판의 성질에 따른 것으로 보이나 대부분 유사한 결과를 보임을 알 수 있었다. 이는 기판의 종류에 관계없이 SnO_2의 기본 물성에 의한 결과로 보인다.

Ep-097 **Q-V Lissajous 곡선을 이용한 Xe 면광원의 방전특성 평가에 관한 연구(Study on the discharge characteristics of Xe-type flat fluorescent lamps by evaluating Q-V Lissajous curves)** 유 미연, 김 영엽, 이 병우, 고 재현, 유 시홍[1], 이 성의[1](*한림대학교 전자물리학과.* [1]*한국산업기술대학교신소재공학과.*) 환경 친화적 광원의 하나로써 Xe을 방전가스로 사용하는 무수은 광원에 대한 연구가 활발히 진행되고 있으나 Xe형 광원은 기존의 수은형 형광램프에 비해 낮은 휘도와 효율을 나타내는 단점을 가지고 있다. 본 연구에서는 LCD 백라이트나 일반 조명용으로 사용될 수 있는 Xe형 면광원(Flat fluorescent lamps, FFL)의 방전특성을 Q-V Lissajous 곡선 평가 방법을 이용하여 평가하였다. 즉 Xe형 FFL과 직렬로 표준 축전기를 연결하여 축전기에 걸리는 전압으로 FFL에 유도되는 전하를 평가하여 Q-V Lissajous 곡선을 구한 후 소비전력을 평가하였고 휘도계(BM-7)를 이용하여 광원의 휘도와 색좌표를 평가하였다. 이를 통해 (1) 면대향(coplanar) 전극구조와 상하대향방전을 통한 점등 및 방전 유도 비교, (2) 이차전자방출물질의 도포에 따른 방전 특성의 변화, (3) 구동주파수, duty의 변화에 따른 방전 특성의 변화 등을 체계적으로 조사하였다.1 본 연구는 지방대학 혁신역량 강화사업(NURI)인 문화콘텐츠인력양성사업(HEGA)의 4차년도 동아리 활동 지원비를 지원받아 이루어졌음을 밝힙니다.

Ep-098 **MC-50 사이클로트론을 이용한 Non-Destructive 빔 모니터 장치 개발** 이 화련, 양 태건, 이 민용, 홍 성석, 황 원택, 박 연수(*한국원자력의학원*) 한국원자력의학원의MC-50 사이클로트론은 P, D, He 입자의 인출이 가능하며 P의 에너지는 45~10MeV, 빔 전류는 nA~60uA까지 제공가능하다. 이러한 빔전류와 에너지 영역에서 실시간으로 빔 전류를 모니터링하는 장치는 반드시 필요하다. 본 연구에서는 이러한 non-destructive 빔 모니터장치를 개발하여 빔테스트를 하였다. 장치는 0.1mm 두께의 Al plate 앞, 뒤에 Al에서 발생하는 이차전자를 고려하여 mesh 구조를 가지는 Grid가 있다. Grid에는 + 전위를 인가하여 이차전자를 소멸하고 뒷쪽에 가속되는 전자를 막기위한 접지면이 있다.이 모니터장치의 교정을 위하여 이차전자를 고려한컵구조와 영구자석이 포함된 Faraday Cup을 제작하여 빔의 선형성 테스트를 하였다. Neutron Therapy 빔라인의 빔포트에서 10cm 떨어진 대기중에 non-destructive 빔 모니터장치가 있고 그 뒤에 제작된 Faraday Cup을 놓아 ~100nA 의 전류 영역에서 측정하여 모니터장치와 Faraday Cup 사이의 빔 전류의 관계를 구하였다.

Ep-099 **Resistive switching behaviors of Cu/TaO_x/Pt structures** CHA Dongjae, LEE S., MUN B.S., KIM Dong-Wook[1](*Hanyang Univ., Dept. of Appl. Phys.. [1]Ewha Womans Univ., Dept. of Physics.*) Resistance-based memories are potential candidates for future nonvolatile memory devices. Among various systems, metal-insulator-metal (MIM) structures have attracted great attention due to their compatibility to conventional semiconductor fabrication processes. The underlying mechanisms of the resistive switching phenomena have not been clearly understood yet. It has been believed that combination of physical and/or chemical effects contribute to the bistable resistive states of the MIM structures. The electrical properties of Cu/TaO_x/Pt structures were investigated. Cu top electrodes and TaO_x insulating layers were sputter-deposited on platinized Si substrates. Resistive switching occurred upon polarity reversal: the low-resistance state conduction is expected to have filamentary nature. To reveal the detailed mechanism, temperature dependence of the electrical properties will be presented.

Ep-100 **절대중력가속도계를 이용한 KRISS 중력측정 예비 결과** 우 삼용, 최 인묵, 송 한욱, 김 부식, 박 연규(*한국표준과학연구원 역학센터*) 한국표준과학연구원 역학센터에서는 미국 micro-g 사의 절대중력계 모델 FGL을 이용하여 실험실 내의 절대중력가속도 측정 실험을 실시하였다. 중력가속도는 중력에 의한 가속도를 나타내며 힘, 압력, 온도, 유량 등 질량 관련량의 측정 표준에 매우 중요한 변수이다. 또한 지질학, 광산학, 지구운동역학 등에 있어서도 매우 중요한 양이다. 지금까지 국내의 중력가속도 측정은 정밀한 스프링의 변형을 이용하는 상대중력계를 이용하여 간접적 비교 방식으로 측정되어 왔다. 하지만 이 방식은 중력값을 미리 알고 있는 중력기준점이 필요하며 만일 기준점의 중력값이 변화하면 그 변화에 따른정확도 문제가 발생한다. 따라서 기준점의 중력을 실시간으로 측정할 수 있는 절대 중력측정이 필요하며 이 방식은 물체를 진공 중에서 자유낙하시켜 이 때 레이저 간섭계를 이용하여 정확한 거리 측정을 수행하며 동시에루비듐 원자시계를 이용하여 정확한 시간 측정을 수행하여 이로 부터중력가속도를 유도한다. 지금까지 우리나라에서는 중력가속도의 절대측정이 2회 실시되었으며 한번은 일본 지리원의 도움을 받아 수원의 국립지리원에서 측정하였고다른 한번은 중국 표준연구소의 도움을 받아 대전 한국표준과학원에서 측정하였다. 본 연구에서는 최근 새로이 설치한 절대중력계를 이용하여 장치 특성에 대한 설명과 함께 표준과학연구원 역학센터내에서의절대중력측정 예비결과를 보이고자 한다.

Ep-101 **Shot Noise Characteristics of Resonant-Tunneling Diode** 김 영상, 김 동우, 정 희준(*한양대학교 응용물리학과*) 잡음(noise)은 전자공학분야에서 피해야하는 신호라고 인식되지만 최근에 들어서 중요한 신호라고 새로운 관점으로 연구되어지고 있다. 특히 터널링 소자에서는 산탄잡음(shot noise)이 중요한 요소인데 산탄잡음을 측정함으로 전자 터널링환경에서의 전류에 의한 전자의 잡음특성을 알 수 있다. 잡음을 측정하는 것은 그동안 어려운 작업이었는데 최근에 cross-correlation 방법이 개발되면서 잡음 연구에 새로운 방향을 제시하고 있다. 본 발표에서는 공명터널다이오드의 cross-correlation방법을 이용한 산탄잡음특성과 터널링 특성에 대해 논하고자 한다.

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Ep-102 **Comparison of Linear Magnetoresistance of NiO- and FeMn-Spin Valve Device** 박 영석, 이 상석, 황 도근[1], 이 장로[2](*상지대학교 동서의료공학과. [1]상지대학교 응용전자물리학과. [2]숙명여자대학교 물리학과*) The shape anisotropy effect of giant magnetoresistance-spin valves (GMR-SV) device with glass/NiO/NiFe/CoFe/Cu/CoFe/NiFe structure and glass/Ta/NiFe/CoFe/Cu/CoFe/NiFe/FeMn/Ta structure used in the detection of any magnetic property of molecules within a cell was investigated. Uniaxial anisotropy was applied to the patterned device during the sputtering deposition and vacuum post-annealing at 200 ℃ under the magnitude of 300 Oe, respectively. The pattern size of the device prepared through the photo lithography process was a 2×5 μm^2, which considered the magnetic shape anisotropy effect. Based on the experimental results, we confirmed that the optimum condition of GMR-SV biosensor should be decided by the same direction of the axis sensing current and the easy axis of pinned NiO/NiFe/CoFe and CoFe/NiFe/FeMn triple layers oriented to the direction of the device's width. Moreover, the direction of the easy axis of free CoFe/NiFe bilayer should be performed according to the device's longitudinal direction.

Ep-103 **Percolation Behaviors and Joule Heating Effects for Unipolar Resistance Switching** LEE Shin Buhm, CHAE S. C., CHANG S. H., LEE J. S.[1], PARK S.[2], JUNG M. H.[2], KAHNG B.[1], KIM D.-W.[3], SEO S.[4], NOH T. W.(*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul. [1]Department of Physics and Astronomy, Seoul National University, Seoul. [2]Quantum Materials Research Team, Korea Basic Science Institute, Daejeon. [3]Division of Nano Sciences and Department of Physics, Ewha Womans University, Seoul. [4]Samsung Advanced Institute of Technology, Suwon.*) The reversible resistance switching behavior has attracted considerable research attentions due to its potential for applications in nonvolatile resistance random access memory (RRAM). Even though the origin of switching behavior looks unclear, many researchers have reported the resistance switching behavior at various ternary and binary transition metal oxides. Especially for the unipolar resistance switching which shows the resistance switching along the single bias voltage, the filamentary model has been proposed. Some people think that abrupt resistance change from high resistance state (HRS) to low resistance state (LRS), vice versa, is attributed to forming or rupturing of filament as like as behavior near the percolation threshold (p_c). Empirical bias voltage independence and commonly observed voltage distribution for each resistance switching could also give a clue that the mechanism governing the unipolar resistance switching might be related to the percolation. In this work, characteristic features of percolation system using low frequency noise ($1/f$ noise) analysis are investigated for Pt / NiO / Pt capacitors. In percolation model, resistance fluctuation noise (S_R) shows universal behavior, $S_R/R^2 \sim R^w$ in metallic part (above p_c) and $S_R/R^2 \sim R^0$ in insulating part (below p_c). Our

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NiO capacitors also show percolation-like S_R behavior, *i.e.*, $S_R/R^2 \sim R^w$ for LRS and $S_R/R^2 \sim R^0$ for HRS. These results show that p_c exists during the resistance switching process. In as-grown state, thermally assisted tunneling is more dominant but in LRS, metallic conduction is. That conduction mechanism in HRS is determined by competition between thermally assisted tunneling and continuous metallic conduction. We systematically investigate w behavior by temperature and bias voltage change for RESET, *i.e.*, change from LRS to HRS. Those indicate that the mechanism of RESET is Joule-heating driven. Our results support that the switching mechanism can be understood by the filamentary model which can be governed by the percolation nature. Especially, RESET is driven by Joule heating effects.

Ep-104 **Rubrene thin-film transistors with crystalline channels achieved on optimally modified dielectric surface** CHOI Jeong-Min, JEONG Seong Hun, HWANG Do Kyung, IM Seong(*Yonsei University, Insitutue of Physics and Applied Physics.*) Rubrene transistors with single crystalline channels, as fabricated by solution- or vapor-induced processes, recently attracted much attention, displaying high mobilities exceeding those of pentacene thin-film transistors (TFTs), that usually have vacuum-deposited patterned channels. It is because rubrene TFTs may have higher potentials than those of pentacene TFTs even in patterned device form. However, until recent years rubrene TFTs could hardly show such a desirable device performance with vacuum-deposited patterned channels. It is mainly due to process-dependent difficulties of vacuum-deposition method in obtaining crystalline channels. We previously introduced specific vacuum deposition conditions including in-situ post-annealing for the growth of polycrystalline rubrene channels on SiO_2/p^+-Si substrate considering that the vacuum deposition (thermal evaporation of organic semiconductor) could be the most important and practical method leading to conventional device patterning. The patterned devices still showed quite a low mobility (~10^{-3} cm^2/V s) under 40 V. According to very recent report, the surface chemical state of the dielectric is also important for the formation of crystalline organic semiconductor layers. Therefore, in order to achieve a high performance rubrene TFT with vacuum-deposited channel pattern, it is very desirable to exploit the previously-found deposition conditions on an optimally-modified dielectric surface for a high performance rubrene crystalline TFT. We thus, as the first step, implemented a systematic study for the crystalline growth of vacuum-deposited rubrene film on several dielectric surfaces modified with such a variety of self-assembled-monolayers (SAMs) as Hexamethyldisilazane (HMDS), 7-Octenyltrichlorosilane (7-OTS), and Trichloro(1H,1H,2H,2H-perfluorooctyl)Silane (FTS) in the order of hydrophobic tendency. Then as the next step of research, we have fabricated channel patterned rubrene TFTs with those surface-modified dielectrics to determine an optimal SAM layer leading to the best performance rubrene TFTs with low operation voltage and enhanced mobilities. HMDS was finally determined to be the most effective SAM interlayer for polycrystalline rubrene channel formation, which involves an amorphous-to-crystalline phase transition during post-annealing. Our rubrene TFT with HMDS-coated SiO_2 dielectric showed quite a high field mobility of 0.007 ~ 0.01 cm^2/V s under 40 V.

Ep-105 **ZnO-based Low Voltage Transistors with Nano-hybrid Dielectrics Providing Gate-stabilities and High Capacitances** CHA Sung Hoon, OH Min Suk, LEE Kwang H., IM Seongil, LEE Byoung H.[1], SUNG Myung M.[1](*Institute of Physics and Applied Physics, Yonsei University*. [1]*Department of chemistry, Hanyang University.*) ZnO thin-film transistors (TFTs) have recently received much attention due to their potentials to replace amorphous Si TFTs as a new driving component for liquid crystal display (LCD) and to be used as components for other applications. Mostly bottom-gate ZnO-TFTs have been researched so far, adopting inorganic oxide dielectrics below ZnO channels although few top-gate devices were also reported. Moreover, low voltage ZnO-TFTs are still few in report and their gate-stabilities have even rarely been discussed, yet. In this research, we report on the fabrication of top gate ZnO thin-film transistors (TFTs) with nano-organic and nano-inorganic hybrid dielectric layers that take super lattice forms in their inside structures. The nano-hybrid dielectrics were deposited as alternating organic self-assembled monolayer and oxide monolayer using MLD* method on ZnO channel that was patterned by rf-sputtering at room temperature. Our ZnO-TFT has a 22 nm-thin AlO_x-based hybrid layer (dielectric capacitance C~129 nF/cm^2, strength ~4 MV/cm) showed very good electric characteristics of a field mobility of 0.36 cm^2/V s with high on/off current ratio of 10^5 operating at 8 V. The mobility increased up to 0.61 cm^2/V s with a 22 nm-thin AlO_x-based/TiO_x-based/AlO_x-based (5.5 nm/11 nm/5.5 nm, C ~230 nF/cm^2, strength 1.5 MV/cm) triple hybrid layer, while the new dielectric lowers the operation voltage to less than 2 V but also showed an increased gate leakage along with a little gate voltage-drain current (V_G-I_D) hysteresis. More details on gate stability and low voltage operation of ZnO-TFT or ZnO-TFT involving inverter are to be discussed in the conference. * MLD (Molecular Layer Deposition) : The deposition process similar to ALD (Atomic Layer Deposition) in the aspect of using gas phase reaction. One unit of oxide-SAM lattice is 1.1 nm thin in theoretical approximation.

Ep-106 **EUVL Test Bed 구축과정 및 평가기술 개발에 관한 연구** 김 성규, 정 성우, 전 영권, 정 윤하, 나 승유[1], 김 동수[2] (*포항나노기술집적센터*. [1]*포항가속기연구소*. [2]*(주)VMT.*) EUVL (Extreme Ultraviolet Lithography)은 기존의 반도체 집적화 한계를 극복할 수 있는 차세대 반도체 리소그라피 기술로서32nm급 이하의 DRAM, FLASH 메모리 등에 적용될 것으로 예상되며13.5nm의 파장영역을 사용한다. 그러나 현재 국내 연구실정은 광원개발, 레지스트 개발, 마스크 개발, cleaning 기술개발 등 성과를 보이고 있으나 개발을 위한 인프라 구축에 있어서는 발전이 필요하다. 본 연구에서는 전자 방사광을 이용하여13.5nm의 극자외선 파장을 얻을 수 있는 포항가속기연구소 11B 빔라인에 EUVL test bed를 설치하였다. 백색광으로부터 원하는 파장을 얻기 위하여 에너지 분해능이 1/2,000인 grating monochromator를 사용하였으며 에너지

영역은 70~150eV의 범위로 조절 가능하게 준비하였다. 또한 EUV의 경우에는 공기 중의 입자와의 충돌에 의해 흡수되기 때문에 빔라인 및 end station 전체를 고진공으로 유지하였으며 극자외선 광과 박막 물질간의 반사에 따른 광의 위상 및intensity 변화를 측정하는 장치인 reflectometer를 사용하여 EUVL용 기본 마스크 물질 및 PSM(Phase Shift Mask) 물질, 레지스트 등의 광학상수를 측정할 수 있는 metrology 시스템를 구축하였다. 이와 더불어, AIMS(Aerial Image Microscope) 장비는 고정밀스테이지를 포함하여 초고진공 영역에서 마스크의 결함 관찰 및 마스크의 패턴 관찰을 할 수 있다. * 본 연구는 지식경제부 지원 나노기술집적센터 구축사업과 나노급 반도체용 EUV 리소그라피 핵심기술 개발사업의 일환으로 수행되었음.

Ep-107 **Electro-Thermal Transport of Carbon Nanotubes and Electrical Burning for Mass-Production of Reliable Bio-Sensors** HWANG Jea Ho, SO Hye-Mi, LEE Jeong-O, KONG Ki-Jeong, CHANG Hyunju, BUH Gyoung-Ho(*Korea Research Institute of Chemical Technology.*) We analyze the electro-thermal transport properties of carbon nanotube (CNT) on insulating substrates over the bias range up to the electrical breakdown voltage in ambient condition. By measuring the drain current (I) as a function of drain bias voltage (V) with various pulse times, we found that typical electro-thermal breakdown requires the current level of a few tens of micro amperes and pulse duration of at least 100 milliseconds. The considerable reductions in drain currents during the Joule-heating are observed compared to those of the room-temperature at the same drain voltage, and attributed to mobility degradation at high temperature. By optimization of electrical sorting conditions, we achieved high gross yield (approaching 100 %) of bio-sensors.

Ep-108 **Synthesis of V_2O_5/RuO_2 Electrode Materials Suitable for a Positive Electrode in Lithium Ion Secondary Battery** 강 대준, DU Jimin[1], 강 미원[2](*성균관대학교 물리 학과/성균관대학교 성균나노과학기술원 [1]성균관대학교 성균나노과학기술원 [2]성균관대학교 물리 학과.*) Vanadium pentoxide (V_2O_5) has been considered as a promising positive electrode active material in a lithium secondary battery and the use results in a battery with a reasonably high energy density and a discharge voltage. V_2O_5 has, however, a disadvantage that the capacity of a battery is largely degraded through charge-discharge cycles because of its poor electronic conductivity and low melting point. We proposed a method for preparing a cathode having as active materials to improve charge/discharge capacity of Lithium ion secondary battery. This method concerns the synthesis of core-shell V_2O_5/RuO_2 nanocomposites to form the electronically conducting network in lithium intercalation electrodes. We have successfully synthesized V_2O_5/RuO_2 nanocomposites employing a simple chemical route and high temperature annealing process to overcome its drawbacks. V_2O_5/RuO_2 nanocomposites were studied at different heat treatment condition and various $RuCl_3$ solution concentrations. And discharge capacity of the prepared samples was measured over a number of voltametric cycles. This takes advantage of ruthenium dioxide's superior physicochemical and electrical properties. X-ray Diffraction (XRD) analysis, Raman Spectroscopy, Field Emission Scanning Electron Microscopy and Fourier Transform Infrared spectroscopy are used to characterize their morphology and microstructures. In this work V_2O_5/RuO_2 nanocomposites outperform pristine V_2O_5 in terms of electrochemical properties. And we will develop a facile synthetic route suitable for large scale positive active electrode material production. This may open up a great opportunity to develop a secondary battery with high performance charge-discharge cycle durability.

Ep-109 **Development of Cryogen-Free Superconducting Magnet** 김 동락, 최 연석, 이 병섭, 양 형석, 정 원묵(*한국기초과학지원연구원 고자기장연구팀*) 고자기장 하에서 물성측정을 하기 위해서는 여러 날에 걸쳐서 실험을 하여야 할 때도 있다. 이와 같은 경우 고가의 액체헬륨의 사용으로 인한 경제적 부담, 잦은 헬륨 이송 등으로 실험조건 변동요소 발생 및 번거로움 등의 문제가 있다. 이와 같은 점을 해소하기 위해 냉매를 사용하지 않고 소형냉동기를 이용하여 초전도자석을 저온으로 냉각함으로 자기장을 얻을 수 있는 시스템을 개발하였다.

Ep-110 **Heating Effect of CuPc based Organic Thin Film Transitor studied by Near Field Scanning Microwave Microprobe** 윤 영운, 김 기언, 이 한주, 이 승호, 김 태동, 이 기진(*서강대학교 물리 학과.*) OTFT의 active layer로 사용되는 Copper phthalocyanine(CuPc)를 열처리하여 소자에 삽입하였다. CuPc는 열처리를 함에 따라 150°C에서는 α-phase의 결정성을 가지고 250°C에서는 β-phase의 결정성을 가지는 것으로 이전의 연구에 보고되어있다. 결정성이 달라지면 carrier mobility가 변화하므로 이를 TFT 소자에 적용하여 소자의 전기적 특성 변화를 관찰하였다. 또한 열처리를 함으로써 일어나는 SiO2 층과 CuPc 층의 계면과 CuPc와 source, drain 사이의 계면에서의 변화를 비접촉 비파괴 측정 방법인 근접장 마이크로파 현미경(Near-field Scanning microwave microprobe:NSMM)을 이용하여 분석하였다.

Ep-111 **Fabrication and Photon Detection Experiments of Nb/Al Superconducting Tunnel Junctions** YOON Ho Seop, PARK Jang-Hyun, PARK Young-Sik, LEE Sungho, KIM Sug-Whan[1], LEE Jeon-Kook[2], YANG Min Kyu[2], CHONG Yonuk[3], LEE Yong-Ho[3], LEE Sang-Kil[3], KIM Dong-Lak[4](*Korea Astronomy and Space Science Institute. [1]Yonsei University. [2]Korea Institute of Science and Technology. [3]Korea Research Institute of Standards and Science. [4]Korea Basic Science Institute.*) Superconducting Tunnel Junctions(STJs) are next generation high-resolution detectors, capable of counting photons from X-ray to NIR while exhibiting a high quantum efficiency, a high temporal response and an energy resolution much better than that of semiconductor-based devices. We report the current progress in fabrication and photon detection experiments of Nb/Al based STJs. The layer(Nb/Al-AlOx-Al/Nb) of STJ thin films were fabricated using UV photolithography, DC Sputtering, RIE(reactive ion etching), and PECVD(plasma-enhanced chemical vapor deposition) techniques. The photon detection experiment were performed for variable STJ side-lengths (20~80μm) in two stage ADR(adiabatic demagnetization re-

frigerator) at an operating temperature below 50mK. The experiment used the target wavelength selected by a monochromator that receives multi wavelength photons from a Hg lamp. It was then fed, via an optical fiber, into a single pixel STJ located in an ADR. We compared their performance indicators, including energy gap, energy resolution, normal resistance, normal resistivity, dynamic resistance, dynamic resistivity, and quality factor from measured I-V curves and spectra.

Ep-112 **Bi-substituted Rare earth Iron Garnet (RIG; R=Y, Gd, Nd, etc.) 박막의 자기광학적 특성 연구.** 이 한주, 윤 영운, 김 기언, 이 승호, 김 태동, 이 기진(*서강대학교 물리학과.*) Bi-substituted Rare earth Iron Garnet (RIG; R=Y, Gd, Nd, etc.) 박막을 carboxylic acid를 사용한 metal-organic decomposition(MOD) 방법으로 Corning 7059 glass substrate에 성장시켰다. 화학 조성은 $Y_2BiFe_5O_{12}$이며 solution 을 substrate에 spin-coat 한 후 drying, annealing 과정을 거쳐 성장시켰다. 본 연구에서는 각 sample의 annealing temperature와 박막의 thickness를 다르게 하여 sample의 faraday rotation과 epitaxy를 분석하였다. 또한, sample을 indicator film으로 사용하여 sample 에 따른 Magneto-Optical Microscope의 특성을 연구하였다.

Ep-113 **RTLS 응용을 위한 능동형 RFID 태그 안테나 변화에 따른 성능 분석** 강 준희, 김 진영[1], 손 지명[1], 정 용섭, 최 형석(*인천대학교 물리학과.* [1]*(주)키스컴.*) RFID(Radio Frequency IDentification) 기술은 사물에 전자 태그를 부착하여 무선으로 사물의 ID를 인식하여 정보를 수집하고, 수집된 정보를 이용하여 실시간 추적, 보안, 관리 등의 서비스를 제공하는 기술이다. 이중에서 실시간 추적의 경우 대상의 위치를 실시간으로 파악함으로써 흐름을 제어하고 비용을 절감할 수 있다. 최근 들어 이러한 실시간 추적의 응용으로 RTLS(Real-Time Location System)에 대한 관심이 증가하고 있다. RTLS 시스템에서 리더의 경우 충분한 전력과 원하는 안테나의 이득 및 방사패턴을 얻을 수 있는 반면, 태그의 경우 크기의 제한으로 인하여 이러한 조건을 만족시키기 어렵다. 이에 본 논문에서는 2.4GHz 대역에서 동작하는 능동형 RFID 태그의 안테나에 따른 성능 분석을 하였다. 안테나의 성능분석을 위하여 2.4GHz RTLS시스템에서 사용하는 RSSI (Recieved Signal Strength Indication)값을 측정하였다. 분석 결과 안테나의 방사패턴과 이득에 따라 RSSI값의 차이를 보였으며, 안테나가 전 방향 방사패턴을 보일 경우 안정적인 결과를 얻을 수 있었다.

Ep-114 **Enhanced Durability of Pt/Pd/WO_3 Deposited by Reactive Sputtering** 심 재영, 이 재동, 정 현식, 진 정모[1](*서강대학교 물리학과.* [1]*동아공업 (주).*) 대체에너지로 주목받고 있는 수소에너지는 공기 중에서 4% 농도이상에서 발화하는 특성 때문에 수소에너지를 안전하게 사용하기 위해서는 수소누출을 검지하는 수소센서가 필수적이다. 그 중 다양한 종류의 수소 검지 센서 중 수소 안전 광센서는 수소 누출이 예상될 수 있는 공간에서 오랜 기간 동안 수소 누출을 원격적으로 검지하는 센서이다. 그러므로 수소 안전센서는 오랜 안정성과 수소 검지 감도가 필수적으로 요구된다. 이와 같은 수소 안전센서를 수소가 접촉되었을 때 물질의 색이 변화하는 가스채색 물질을 사용하여 수소 주입시 광투과도 변화를 측정하여 만들 수 있다. 본 연구에서는 공기 중의 오염물질에 의해 수소센서 박막이 열화되어 내구성이 떨어지는 것을 방지하기 위해 기존에 연구되었던 Pd/WO3 위에 Pt를 sputter로 증착하여 Pt 두께에 따른 광투과도 특성을 연구하였다. 이 때 가스채색 물질로서 최적화를 확인하기 위해서 제작 후 in-situ Raman 분광법을 이용하였으며 수소와 공기를 반복적으로 주입하여 박막의 반응성의 지속시간을 측정하였다. 결과, Pt의 두께가 두꺼워질수록 광투과도 변화는 줄어듦을 확인할 수 있었고 Pd/WO3에 비해 최적화된 Pt/Pd/wo3의 경우, 수소 반응성이 다소 떨어졌지만 박막의 내구도는 향상되었음을 알 수 있었다. 그러므로 Pt층이 공기 중의 오염물질로부터 박막을 보호하는 효과를 보였고 이를 바탕으로 보다 오랜 동안 수소를 검지할 수 있는 수소센서로 활용이 가능하다.

Ep-115 **초소형 전자컬럼을 이용한 전사 전자빔 리소그라피 연구** 이치무라 노리유키, 김 영철, 김 대욱, 안 승준, 김 호섭[1] (*선문대학교, 신소재과학과.* [1]*선문대학교, 신소재과학과/CNST.*) 초소형 전자컬럼은 전자방출원, 소스렌즈, 스캔 디플렉터, 포커스 렌즈로 구성된 10 mm 정도의 길이를 갖는 전자빔 장비이다. 각 렌즈는 반도체공정으로 정교하게 제작되므로 광학적 수치를 최소화할 수 있으며, 1kV이하의 구동전압에서도 고성능으로 작동된다. 일반적으로 전자빔 리소그라피는 나노 크기의 패턴이 가능한 기술이나, 패턴 형성에 시간이 많이 걸리는 단점이 있다. 이에따라 나노 패턴닝 속도를 증가 향상시키기 위하여 이미 형성된 패턴에 평행한 전자빔을 주사하는 방식인 '전사 전자빔 리소그라피' 방법이 사용된다.본 연구는 저에너지 전자컬럼을 이용하여 평행빔을 발생시켰다. 또한 이 빔을 전압이 인가된 사각모양 아퍼처를 통과시켜 샘플에 형성된 패턴의 특성을 연구하였다.

Ep-116 **Fabrication of Ta-based Superconducting Tunneling Junctions** YANG MinKyu, YOON Ho Seop, PARK Jang-Hyun[1], LEE Sungho[1], PARK Young-Sik[1], KIM Sug-Whan[2], LEE Young-Ho[3], LEE Sang-Kil[3], CHONG Yonuk[3], KIM Dong-Lak[4], KO Tae KuK[5], LEE Jeon-Kook(*Thin Film Materials Research Center, Korea Institute of Science and Technology.* [1]*Korea Astronomy and Space Science Institute.* [2]*Yonsei University,Seoul 120-123, Korea.* [3]*Korea Research Insititute of standards and Science.* [4]*Korea Basic Science Insititute.* [5]*Department of Electrical and Electronic Engineering, Yonsei University, Seoul.*) Experimental investigation of Ta/Al-AlOx-Al superconducting tunneling junctions(STJ) with a fixed Top Ta thickness of 50 nm, Al trapping layer thickness of 20 nm on r-plane sapphire substrates are reported. The layer of STJ thin films were fabricated using UV photolithography, D.C sputtering, ICP RIE and PECVD techniques. The details of experimental investigations for variable STJ side lengths (20~80 μm) are discussed. Both dc Josephson-tunneling and quasiparticle-tunneling I-V characteristics were measured. A STJ device is a candidate detector for next-generation optical astronomy, because it enables us to detect energy of a single visible photon.

Ep-117 **C_{60}와 고분자의 복합 소재를 정공수송층으로 구성된 고효율 유기발광소자** 서 승미, 추 동철[1], 김 태환[2], 이 석재[3] (*한양대학교 정보디스플레이공학부.* [1]*한양대학교 디스플렝공학연구소.* [2]*한양대학교 전자통신컴퓨터공학부.* [3]*홍익대학교 정보디스*

플레이공학부.) 전자와 정공의 이동도를 조절하여 발광층에서 엑시톤이 형성되는 양을 증가하여 외부양자효율을 증진시키는 연구는 고효율 유기발광소자에 대단히 중요하다. 전공의 이동도를 증가하기 위하여 전공주입층 내에 강한 전자 친화력을 가지고 전자받게 역학을 하는 C_{60}을 주입하여 전기적 인력으로 인한 전자수송층에서의 전자의 이동도와 발광층내로 주입되는 전자의 주입량를 증가함으로써 발광층 내에서 전자와 정공의 균형을 이루어 엑시톤이 형성되는 양을 향상시킬 수 있는 장점이 있다 본 연구에서는 C_{60}과 poly(2-methoxy 5-[2'-ethylhexyloxy]-p-phenylenevinylene) (MEH-PPV) 복합 소재를 정공수송층으로 사용한 유기발광소자를 제작하였고, 전기적 특성과 발광효율 및 색좌표를 조사하였다. C_{60}과 MEH-PPV 복합 소재를 정공수송층으로 구성된 유기발광소자의 발광효율이 MEH-PPV만을 정공수송층으로 사용하여 제작한 유기발광소자의 효율에 비하여 같은 구동전압에서 높게 나타났다. C_{60}과 MEH-PPV 복합 소재를 정공수송층으로 사용한 유기발광소자의 발광효율이 증진되는 이유는 정공 이동도가 뛰어난 MEH-PPV 정공수송층에 강한 전자 억셉터인C_{60}을 첨가함으로써 발광층으로 정공과 전자의 주입량이 증가되었으며, 이로 인하여 발광층에서 엑시톤의 형성양이 증가했기 때문이다 C_{60}과 MEH-PPV 복합 소재를 정공수송층으로 사용한 유기발광소자의 색좌표는 C_{60}을 첨가하지 않은 MEH-PPV만 사용한 유기발광소자와 비교하여 발광층 내에서 안정되게 관찰되었다 이와 같은 결과는 C_{60}를 첨가한 MEH-PPV 복합 소재를 정공수송층으로 사용하면 고효율 및 색안정성을 가진 유기발광소자를 제작할 수 있음을 제시하고 있다. This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Koreagovernment(MOST)(No.R0A-2007-000-20044-0).

P2 포스터세션

Ep-118 **Characteristics of Dual Emission Organic Light Emitting Diodes using Al:Au Cathode Layer by Aluminum Thickness** YOON Young Sung, LEE Seung Joon, YANG Hee-Doo, LEE Su Hwan, KIM Dal Ho, PARK Jea-Gun(*Division of Electrical and Computer Engineering Hanyang Univ Nano SOI Process Lab., Hanyang Univ.*) The Al:Au double-layer metal cathode for a dual emission organic light-emitting diodes (OLEDs) was fabricated**.** The device structure consisting of ITO / CuPc / α-NPB / Alq_3 / LiF / Al / Au was deposited by the vacuum thermal evaporation technique. Transmittance was observed throughout Al thickness variation of single Al:Au layer to find the optimized Al thickness and Current density-Voltage-Luminance (J-V-L) characteristics were compared throughout OLEDs Al thickness variation. The insertion of Al improved electron injection ability and luminance characteristics by lowering the potential energy of organic layers**.** In addition, threshold voltages of OLED device at Al thickness of 1 nm were 2 V, current density was 508 mA/cm^2 at 8 V, and luminance of bottom and top emission achieved 4880 cd/m^2 and 2020 cd/m^2, respectively.* This work was supported by Korea Research Foundation Grant. Funded by the Korean Government (MOEHRD) (KRF-2006-005-JO4102)

Ep-119 **Selective light emission from Organic bi-stable light emitting diode using Alq_3** KIM Dal Ho, LEE Su Hwan, YANG Hee-Doo, KIM Ji Heon, LEE Gon-Sub, PARK Jea-Gun (*Division of Electrical and Computer Engineering Hanyang Univ Nano SOI Process Lab., Hanyang Univ.*) In this presented, we suggest an organic bi-stable light-emitting diode (OBLED) which combines the organic bi-stable device (OBD) using Alq_3 and the electro-luminescence of an OLED. This structure makes the OBD can be precisely controlled OLED with a good uniformity and simple process because all fabrication process for OBLED was fabricated thermal evaporation process. Al nano-crystals surrounded by amorphous Al_2O_3. the current-voltage (I-V) characteristic of OBLED. The OBLED demonstrated the threshold (V_{th}), program (V_p), and erase (V_e) voltage were 3.9, 5, and 9 V, respectively. And during the first bias scan, it shows a very low current in the low-voltage range (0 ~ 10 V), indicating the device is at a high impedance state. However, the device programming throughout the second bias scan (~5 V), in case of next the third bias scan (~5 V) current density has a sharp increase of nearly 2 orders of magnitude, indicating that the device has had a transition from a high-impedance state to a low-impedance state. When the bias voltage is further increased, the device shows a very high current. However, the I-V curve recorded in the third bias scan is totally different from that observed in the first or second bias scan. Even in the low-voltage range, the device shows very high current, indicating that the device remains in the low-impedance state. This phenomenon can be explained by charge trap mechanism. While high-impedance state, Al_2O_3 nano-crystal surrounded by amorphous was charged current and interrupt current. During low-impedance state, Al_2O_3 nano-crystal surrounded by amorphous was not charged anymore and circulate the current. We obtained 12 cd/m^2 at 3 V of read voltage. And, after biasing 5 V as a program, we obtained 160 cd/m^2 at 3 V of read voltage. respectively. In this work, we studied effect of OLED structure with OBD using Alq_3 for switching device. By integrating OBD structure confirming the OLED structure was switched OLED effectively. * This research was supported by the National Development Program for 0.1-Terabit Non-volatile Memories financed by the Korea Ministry of Commerce, Industry and Energy.

Ep-120 **Thermophysical Properties of the Organic/ Inorganic Nanocomposites Prepared with Microwave Process.** 김석원, 이 재란(*울산대학교, 물리학과.*) Polymer/layered silicate nanocomposites in which an inorganic solid is associated with organic entities interacting at nano level have attracted great interest in many research fields because of their enhanced properties compared to conventional microcomposites. As a rule, the homogeneous dispersion of 3-5 wt% of thin clay layers improves the mechanical and thermal properties of the polymer matrix to the same extent as 30-50 wt% of micro-sized fillers. In this study, polymer/layered silicate nanocomposites were prepared by in situ polymerization with microwave process. The influence of the amount of clay on the structure and thermal properties for the synthesized nanocomposites were characterized by means of X-ray diffraction(XRD), transmission electron microscopy(TEM), differential scanning calorimetry (DSC), thermo-gravimetric analysis (TGA), and photo-acoustic spectroscopy (PAS). It was found that

the structure of nanocomposites, an intercalated/exfoliated structure, depended on the clay content.

Ep-121 **Thermophysical Properties of the Sn-Ag-Cu Based Pb-free Solders.** 김 석원, 이 재란, 정 은[1](*울산대학교, 물리학과.* [1]*울산대학교, 첨단소재공학부.*) Pb-Sn alloys are the dominant solders used for electronic packaging because of their low cost and superior properties required for interconnecting electronic components. However, increasing environmental and health concerns over the toxicity of lead, combined with global legislation to limit the use of Pb in manufactured products has led to extensive research and development works in lead-free solders, Sn-Ag-Cu ternary eutectic alloy is considered to be one of the promising alternatives. Except the thermal properties, much research about the several properties of Sn-Ag-Cu alloy has been performed. In this study, five kind of Sn-Ag-Cu alloys with the variation of Ag content (Sn-1.0Ag-0.5Cu, Sn-1.0Ag-2.5Cu, Sn-3.0Ag-0.5Cu, Sn-3.5Ag-0.5Cu, and Sn-4.0Ag-0.5Cu) were prepared and the thermal diffusivity and the specific heat of them were measured from room temperature to 150℃ and the thermal conductivity was calculated using the measured thermal diffusivity, specific heat, and density data. Also the CTE(coefficient of thermal expansion) was measured from room temperature to 170℃. The result shows that the Sn-3.5Ag-0.5Cu is the best because it has maximum thermal conductivity and minimum CTE which are the ideal conditions to be proper packaging alloy.

Ep-122 **Tritium을 이용한 디스플레이 보호막의 수분투과도 측정** 최 병일, 남 현수, 우 상봉, 김 종철(*한국표준과학연구원.*) 현재 세계 디스플레이 산업은 한국이 주도하고 있고 차세대 디스플레이로서 OLED는 여러 장점과 기능의 가능성으로 매우 각광 받고 있다. 하지만 현재 디스플레이에 사용되는 재료는 수분에 매우 민감하여 보호막에서의 수분투과도가 제품의 품질을 좌우한다. 최근 이를 극복하고자 보호막에 대한 많은 연구가 진행되고 있고 좋은 결과도 나오고 있으나, 기존의 방법으로는 이 영역의 수분투과도를 측정하는데 한계가 있다. 본 연구는 방사성 동위원소인 삼중수소(tritium T)가 포함된 물을 이용하여 디스플레이 산업에서 필요한 (10^{-4} ~ 10^{-6}) [g/m^2 day] 영역의 수분투과도 측정기술을 확립하였다. 제작된 HTO 측정장치의 불확도는 수분투과도가10^{-5} [g/m^2 day] 인 시료에 대해 약 2.23 x 10^{-6} [g/m^2 day] 불확도를 주었는데, HTO 챔버의 온도를 높여 측정할 경우5 x 10^{-7} [g/m^2 day] 불확도로 측정이 가능할 것으로 예측된다.

Ep-123 **ppb order humid gas generation technique** 최 병일, 우 상봉, 김 종철, 남 현수(*한국표준과학연구원*) As new technologies have emerged, more accurate measurement and control of water vapour mole fraction (10 nmol/mol and lower) are required in various fields such as semiconductor and microelectronic manufacturing process. To response these demand, low frost-point humidity generation technique was developed in order to extend the range of humidity standard to ppb level. The water vapor gas mixtures generated by saturating air with water vapor over a surface of ice coated in saturator under the condition of constant temperature and pressure. The temperature of saturator, which is controlled by thermoelectric devices and a two-stage mechanical refrigeration system, is stable within 5 mK, and the difference between the saturator temperature and dew-point generated, at the saturator outlet is less than 20 mK. This stability is achieved from using oxygen free high conductivity copper materials as the saturator body and applying precision PID temperature control system. This generator spans five decades in mole fraction of water vapour, covering the range 18 nmol/mol to 130 mmol/mol.

Ep-124 **자동차 브레이크 디스크의 열적 특성 평가** 김 석원, 최 병민, 김 진복[1], 이 봉현[2](*울산대학교, 물리학과.* [1]*명화공업(주).* [2]*자동차부품연구원*) 제동장치는 자동차의 안정성과 관련된 중요한 부품중의 하나로, 브레이크 디스크와 패드의 마찰을 이용하여 자동차를 멈추게 한다. 디스크와 패드의 접촉에 의한 마찰은 자동차의 운동에너지를 열에너지로 변환되고, 이 때 발생된 열은 자동차 제동장치의 성능에 큰 영향을 미친다. 디스크 표면에서 발생된 열은 대기에 의해 식게 되지만 반복되는 제동에 의해 디스크 표면에 더욱 많은 열이 발생되고, 디스크 표면의 극소부분에 열이 응집되는 현상이 발생하게 된다. 이러한 현상을 핫스팟(Hot Spot)이라고 하며, 핫스팟은 디스크 표면에 열탄성불안정성을 일으켜 디스크에 변형을 일으키게 된다. 핫스팟에 의한 브레이크 디스크 변형은 디스크 성능에 악영향을 미치며 저더링, 스퀼 등 여러 가지 문제가 일어나게 된다. 그래서 브레이크 설계 단계에 있어서 열적 특성이 고려되며 이를 바탕으로 브레이크 디스크가 제작되어야 한다. 본 연구에서는 브레이크 다이나모 미터를 이용하여 디스크의 표면 온도를 측정하여 이 결과를 바탕으로 브레이크 디스크 재질에 따른 열물성치인 열전도도, 열팽창계수를 적용하여 브레이크 디스크의 열변형을 해석하였다. 해석에는 Abaqus를 활용하였다. 실험에는 주철계통의 브레이크 디스크와 알루미늄 계통의 브레이크 디스크를 사용하였다.

Ep-125 **The Experimental Research for the Resonance Scattering of a Cylindrical Structure Using Obliquely incident Quasi-harmonic Waves.** 임 사회, 김 재률[1], 주 영상, 이 재한(*한국원자력연구원.* [1]*전남대학교 물리학과.*) The resonance scattering of a cylindrical structure immersed in a fluid by obliquely incident quasi-harmonic waves is studied experimentally. When some objects are insonified by acoustic waves, resonances are established at frequencies corresponding to the natural modes of a vibration of an object and scattered waves re-radiate in a fluid. The nondestructive evaluation technique utilizing the resonance scattering may be useful because a sensor is out of contact with the targets. In this work, we obtained the resonance spectrum based on the remote inspection of cylindrical structures using the quasi-harmonic waves and compared with theoretical results.

Ep-126 **ZnO로 코팅한 램프용 녹색형광체의 특성 조사** 서 정헌, 이 상목[1], 손 상호[1](*경북대학교 물리교육.* [1]*경북대학교 물리학과.*) 램프용 녹색 형광체를 ZnO 나노 입자로 코팅 하여 그 특성을 조사 하였다. ZnO 콜로이달 용액을 이용하여 변형된 졸겔법으로 코팅 하였다. 형광체의 표면을 관찰하기위해 SEM (Field

Emission Scanning Electron Microscopy)를 사용하였다. 또한, 광학적 특성을 조사하기 위하여Xenon 램프의 254nm파장을 광원으로 이용하여 PL스펙트럼(Photoluminescence Spectrum)을 조사하여 코팅되지 않은 것과 비교하였다. 이번 실험에서 ZnO로 형광체를 코팅 하였을 경우 PL의 휘도가 감소하였다. 하지만 교반시간이 길어짐에 따라, 코팅 전 보다는 낮지만, 휘도가 상승하는 경향이 있음이 보였다. 따라서, ZnO로 코팅 하여 특성이 향상될 것으로 기대된다.

Ep-127 **The effects of vision training on convergence insufficiency** KIM Ki-Hong, LEE Chang Sun, KIM In-Su (*Department of Visual Optics, Kyungwoon University.*) There is considerable and compelling support for the concept that visual skills, comfort, and efficiency can be enhanced via vision training. The efficacy of vision training has been shown in the past with children as well as adults. Not only do patients with reduced visual efficiency respond well, but vision training is deemed by some to be the treatment of first choice. Vision training programs are commonly individually prescribed to the patient and monitored by the optometrist. Vision therapy treatment almost always involves differing exercises and combinations of training tools such as lenses, prisms, computer programs, and vision training instruments (i.e., stereoscopes, cheiroscopes). This study was investigated for the effects of vision training on the phoria and positive fusion reverse(PFR) of patients with convergence insufficiency(CI). Subjects were included 11 patients with CI of T Vision Center (5 patients with distance orthophoria, 6 patients with distance exophoria). The vision training of this study had been processed daily during an average of 2 months for each patients. The result showed that After vision training, the phoria and PFR of CI patient were improved significantly than that before vision training.($p<0.05$) and when the groups were divided to the distance orthophoria convergence insufficiency (DO-CI)group and distance exophoria convergence insufficiency (DE-CI)group, these improvements were proved similarly in the both groups. This study proved that vision training for patients with C.I was effective for the improvement of the phoria and PFR of these patients

Ep-128 **Synthesis of $LiFePO_4$ Electrodes for the Applications to Li-ion Batteries** 정 의덕, 하 명규, 홍 태은, 양 호순[1], 홍 경수(*한국기초과학지원연구원하이테크부품소재연구지원센터. [1]부산대학교 물리학과*) We prepared carbon-coated $LiFePO_4$ using solid state reaction method by mixing humic acid. All materials were heat treated under argon atmosphere to reduce the oxidation of carbon. The synthesized materials were characterized using TGA, XRD, SEM, TEM, and XPS. We observed that carbon is deposited on the surface of the humic acid added $LiFePO_4$ powder in a form of a nanometer-thick layer through TEM image. For the electrochemical measurement, we prepared $LiFePO_4$ electrodes by mixing conducting compound and copolymer binder. We found that the carbon coating improved the cyclability of the cathode materials and humic acid added $LiFePO_4$ increases the electrochemical performance for rechargeable batteries.

Ep-129 **Synthesis and electrochemical studies of $LiFePO_4$ electrodes for lithium-ion batteries** 하 명규, 정 의덕, 홍 태은, 김 혜진, 도 칠훈[1], 홍 경수(*한국기초과학지원연구원 하이테크부품소재연구지원센터. [1]한국전기연구원*) In order to apply for the rechargeable batteries, we synthesized carbon-active $LiFePO_4$ using solid state reaction method by mixing chitosan. LiFePO4 is heat treated at 750 °C for 12 hours two times in argon atmosphere in order to prevent oxidation of Fe and then heat treated again at 600 °C for 12 hours. After heat treatment, we checked the amount of carbon incorporated in the synthesized powder using TGA, XRD, SEM, TEM, and XPS. We found that carbon is coated at the surface of LiFePO4 powders through TEM image and the iron ion is substituted from 3+ to 2+ with XPS measurement. We observed voltage characteristics and charge-discharge characteristics according to carbon rate in $LiFePO_4$ batteries.

Ep-130 **프레스 금형의 교체 시기 결정을 위한 AE 시스템 적용** 김 석원, 김 동훈[1], 박 상진[1], 이 원규[1](*울산대학교, 물리학과. [1]울산대학교, 기계자동차공학부*) 프레스 성형 제품 생산에 있어 금형의 교체시기를 놓치게 되면 생산되는 제품의 품질과 생산성에 막대한 손실을 가져오게 된다. 따라서 정확한 금형의 교체 시기 파악은 프레스 성형 공정에 있어 매우 중요한 요소이다. 반복적인 성형 작업으로 점차 금형의 마모가 발생하게 되고 결국 금형의 교체가 필요하게 된다. 금형의 교체 시기는 금형의 파손 등의 사고 외에는 정확하게 판단하기가 쉽지 않다. 일반적인 경우 금형의 총 작업 시간을 확인하거나, 작업자의 경험으로 판단하여 교체 여부를 결정한다 하지만 이러한 방식은 마모나 크랙의 판단 기준 일정하지 않고 대략적이다. 따라서 본 연구는 금형의 상태를 파악하기 위하여 프레스 금형에 AE(음향방출) 센서를 부착하고 프레스 성형 시 금형으로부터 발생되는 음향신호를 수집하고 증폭, 분석하여 금형의 연마 시기 혹은 보수의 시기의 기준을 정하고, 기준에 의해 유지 보수가 가능하도록 하는데 목적이 있다.

Ep-131 **Time-resolved luminescence spectroscopy of Er-doped and undoped calcium niobium gallium garnet crystal** 김 은식, 장 경혁, 시 량, 서 효진, TAIJU Tsuboi[1], KIYOSHI Shimamura[2](*부경대학교 물리학과. [1]Faculty of Engineering, Kyoto Sangyo University. [2]Optronic Materials Center, National Institute for Materials Science.*) Luminescence properties of Er^{3+} ions doped in Calcium Niobium Gallium Garnet ($Ca_3(Nb_{2-x}-zGa_z)_{2-x}Ga_3O_{12}$; CNGG) crystal are investigated by laser excitation spectroscopy in the temperature region 15 K – room temperature. CNGG crystal has a disordered structure due to enormous variety of different types of ions and cationic vacancies in the regular sites of host lattice. Time-resolved emission spectra of Er doped and un-doped CNGG are measured, together with the luminescence decay by the 355 and 266 nm pulsed laser excitations.Emission spectra of un-doped and Er-doped CNGG crystals show the kinds of broad exciton emission band peaking at around 475 nm in which one has very fast decay of less than 5 ns and the other has longer decay of about 200 μs. The broad band intensity of Er^{3+}-doped CNGG is remarkably decreased and the dips appear together with Er^{3+} emission lines in Er-doped CNGG. The decay of the broad band of un-doped CNGG has sin-

gle exponential while, that of Er-doped CNGG decays non-exponentially with sharp drop at initial time region which indicate that energy transfer occurs from host exciton band of to Er^{3+} ions in CNGG.

Ep-132 **Discussion on the Flood Image from 4-layer Micro-PET System** ITO Mikiko, HONG Byungsik, HONG Seong Jong[1], KWON Sun Il[2], LEE Geon Song[3], LEE Jae Sung[2], LEE Kyong Sei, LEE Seok Jae[4], PARK Kwang-Souk[3], RHEE June Tak[5], SIM Kwang-Souk, YOON Hyun Suk[2](*Department of Physics, Korea University, Seoul, Korea. [1]Institute of Radiation and Medicine, Seoul National University College of Medicine, Seoul, Korea. [2]Department of Nuclear Medicine, Seoul National University College of Medicine, Seoul, Korea. [3]Department of Biomedical Engineering, Seoul National University College of Medicine, Seoul, Korea. [4]Department of Biomedical Engineering, Seonam University, Namwon, Korea. [5]Department of Physics, Konkuk University, Seoul, Korea.*) We have developed the animal PET system with improve sensitivity and spatial resolution, achieved by employing long crystal blocks and the depth-of-interaction (DOI) analysis to eliminate the parallax error. This PET system consists of four crystal layers with a relative offset between consecutive layers. Each crystal is made of LGSO(Lu90%) with the dimension of 1.5 x 1.5 x 7 mm^3. The crystal layers are arrays of 29 x 29 for the 1st, 28 x 29 for the 2nd, 28 x 28 for the 3rd, and 27 x 28 for the 4th layer. The last layer is coupled to the flat multi-channel PMT (H9500), and 256 output anodes are connected to a charge division circuit with 4 output channels. The flood image has been calculated by using ADC values of four output signals. The DOI information is obtained in the flood image at the center of the PMT. In this presentation, we discuss the flood image which can be obtained by the PET system whose sensitive area determined by the PMT (49 x 49 cm^2) is filled by crystals.

Ep-133 **Temperature dependent luminescence dynamics of Eu^{2+} ions doped in $LiBaF_3$ crystals** 시 량, 장 경혁, 김 은식, 서 효진(*부경대학교 물리학과*) The pure and europium doped $LiBaF_3$ single crystals were grown by the Czochralski method. The details of the reagent preparation and the crystal growth of $LiBaF_3$:Eu^{2+} are described. The reaction conditions are discussed to get pure $LiBaF_3$ powder. The absorption and emission spectra were measured on pure and Eu^{2+} doped the single crystals of $LiBaF_3$. The emission spectra show two bands peaking at 359 and 410 nm corresponding to the parity forbidden 4f-4f transition and the parity allowed 5d-4f transition, respectively. The concentration quenching was not observed up to the Eu concentration of 2 mol %. By increasing temperature, the 410 nm emission completely disappears over the temperature at 75 K. The luminescence decays of 359 and 410-nm emissions show single exponential and the 410 nm decay shows two components, fast and slow. All the decays decrease by increasing temperature expect for the 410-nm emission in the temperature region between about 30 and 80 K in which the 410 nm emission exhibits unusual behavior of temperature dependence.. We have calculated the 4f-5d activation energy (△E) from was discussed and this value was 0.118ev. The discussed in relation with energy transfer and back transfer between the 5d and 4f excited levels by the configurational coordinate model for Eu^{2+} doped in $LiBaF_3$ crystal.

Ep-134 **X선 미세회절을 이용한 용융아연도금 강판 분석** 고 영동, 정 진석, 김 영은, 서 승실, 장 창환[1], 서 종현[1](*숭실대학교 물리학과. [1]RIST 특성분석실*) •용융아연도금공정으로 만들어진 용융아연도금강판은 내식성 및 도장성 등이 매우 우수하여, 금속가구, 가전제품 내외판, 도장강판 소재, 자동차 내판 등으로 사용되고 있으며, 그 사용범위가 점차 확대되고 있다. 용융아연도금강판 제조 시 최적의 아연(Zn)도금층 제작을 위하여 기지강판과 아연(Zn)도금층 간의 결정방위관계분석에 관한 기초 연구가 요구되고 있다. 본 연구에서는 아연(Zn)도금층 형성에 미치는 기지강판의 영향을 분석하기 위하여, 용융아연도금강판의 아연(Zn)도금층과 기지강판의 결정방위를 X선 미세 회절법을 이용하여 측정, 분석하였다. 측정 결과, 아연(Zn)도금의 orientation은 기지 강판의 orientation에 상관없이 (001)방향이 dominant하게 측정되었다. X선 미세회절은 포항가속기 연구소 1B2 beamline에서 실험하였다.

Ep-135 **New Evidence Concerning The Origin Of Resistive Switching In Binary Metal (Al, Nb) Oxide Films** IM hyunsik, KIM Yongmin, JUNG Kyooho, CHOI joonhyuk, JUNG woong, KIM hyungsang[1](*동국대학교 반도체과학과. [1]동국대학교 물리학과.*) We have investigated ON/OFF resistive switching characteristics in AlO_x and NbO_x binary oxide films. In each sample, a resistive switching I-V characteristic is clearly observed with a high ON/OFF ratio at room temperature. To understand the switching mechanism in detail, we carried the resistance switching *I-V* measurement into down to 300 mK. In this result, the temperature range between 300 K and 10 K, transport in the low resistance ON-state shows a typical metallic behavior. At ultra low temperatures below 1 K, some of samples show a dramatic change in transport. To further investigate the origin of the switching, we use modified focused ion beam SEM (FIB-SEM). We first observe resistance switching characteristics inside the SEM chamber depositing top Pt electrode on the oxide films, then we observe the SEM image of the cross-section for each resistance state, high resistance state (Before forming) and low resistance states(After forming). There are clear differences in the SEM images between the before and after forming states. In this study, we clearly demonstrate that in the low resistance *ON* state, metallic nano-wires are formed across the binary oxide films and these metallic wires result in the low resistance conduction.

Ep-136 **Raman images of single cell and tumor tissues using confocal micro Raman spectroscopy** 박 도영, 정 현식, 이 정운[1], 김 정호[1](*서강대학교 물리학과. [1]서강대학교 생명과학과.*) 생체 세포나 조직은 구성에 따라 생화학적 화합물의 분포가 다르다이 분포에 따라 각각 화합물에 해당하는 진동모드가 결정된다생체 세포나 조직의 생화학적 화합물의 변화가 생기는 경우(암조직), 진동모드 또한 변하게 된다. 라만 분광법은 이런 생체 세포나 조직의 화합물과 관련한 진동모드 정보를 다른 과정을 거치지 않고 조직 손상이 적으면서 쉽게 측정할 수 있다 공초점 라만 분

광은 514.5nm의 파장을 가진 아르곤 이온 레이저를 여기 광으로 이용 하였으며, 대물렌즈를 통과한 빛은 약 1㎛의 크기로 초점을 형성한다. Edge-filter와 전하 결합소자(CCD)를 이용하여 단일세포와 암조직의 라만 신호를 검출 하였다. 단일 세포(Chlamydomonas)의 경우 C=C 진동모드가 ~1500cm^{-1}에서 관찰되며, 암조직에서는 lipid and protein (CH2 deformatiom), Amide I의 진동 모드가 각각 ~1420cm^{-1}, ~1600cm^{-1}에서 관찰 할 수 있다. 또한, 이를 기준으로 단일 세포와 암 조직의 구성에 따른 진동 모드 변화를 측정하여 라만 이미지를 얻었다.

Ep-137 **Multiferroic $BiFeO_3$ thin films prepared by RF magnetron sputtering method in various O_2 pressure** CHA Jeong Ok, AHN Jeung Sun, LEE Kwang Bae[1](*Kyung Hee University, Department of Physics.* [1]*Sangji University, Department of Applied Physics &Electronics.*) Using self-made multiferroic $BiFeO_3$(BFO) ceramic targets, thin films of BFO were deposited on Pt/Ti/SiO_2/Si substrates by rf magnetron sputtering. The influence of the partial pressure of oxygen (P(O_2)) as well as the substrate temperature on the preparation of pure BFO films has been studied. BFO thin films with single perovskite phase were obtained for P(O_2) of 0.3 ~ 1.5mTorr at a substrate temperature of 400 °C, subsequently annealed at 500 °C in N_2 ambient. The impurity phase rather than perovskite BFO phase could be easily formed due to the excess Bi content for a low P(O_2) = 0.1 mTorr. The BFO thin film having high c-axis orientation could be obtained for P(O_2) = 0.3 mTorr, which has the maximum remnant polarization of 5.2 C/cm^2. The leakage current behaviors as well as the magnetic properties of BFO films are elucidated by the compositional analysis of Fe^{3+} and Fe^{2+} ions from the X-ray photoelectron spectroscopy studies. The P(O_2) influences on the ferromagnetic properties, such as M-H loops, and the leakage current of BFO films by the amount of Fe^{2+} ions with oxygen vacancy. * This work was supported by the Seoul Research and Business Development Program (Grant No. 10583).

Ep-138 **Numerical Analysis of Thermoluminescence from $MgAl_2O_4$** KIM Taekyu(*Jeonju National University of Education, Department of Science Education.*) Three-dimensional thermoluminescence (TL) spectrum was measured from the magnesium aluminum spinel ($MgAl_2O_4$) irradiated with ultraviolet (UV) light over the temperature range of 300 ~ 600 K and the wavelength range of 300 ~ 800 nm. TL spectrum of $MgAl_2O_4$ exposed to UV light shows the 472 K TL peak with 710-nm emission band and the 490 K TL peak with 520-nm. The 520-nm and 710-nm emission bands were revealed to be associated with the hole captured at the V^{2+} and Cr^{2+}sites, respectively. The glow curve accumulated with the TL spectrum intensity related to two sites can not be analyzed by the traditional method based on one trap with one recombination center. Because the difference of TL peak temperature between 520-nm and 710-nm emission bands is caused by the difference of holes capture cross section between Cr^{2+} and V^{2+}, its glow curve should be analyzed with the model of a single electron trap with two recombination centers to evaluate the parameters of activation energy, frequency factor and kinetic order from it. The rate equations for the model of a single electron trap with two recombination centers are numerically solved to interpret the glow curves completely. Then the best-fit parameters were determined by the minimum of chi square values between the theoretical TL and the experimental.

Ep-139 **TiO_2 Nanostructures on nanorod arrays for Photocatalytic Water Splitting** KIM R. G., KIM S. I., HA M. H., WHANG J. H., SON S. M., SHAISLAMOV U. A., YANG J. M.[1], YANG B.(*Department of Information Nano Materials Engineering Kumoh National Institute of Technology, 1 Yangho-dong, Gumi, Gyeongbuk, 730-701, Korea.* [1]*National Nanofab Center, KAIST, Yuseong-gu Yeun-dong, 53-3.*) Titania nanostructures have fabricated and developed aiming for applications including chemical sensing, photocatalysis, and photovoltaics. Titanium dioxide (TiO_2) nanotubes have been produced by a variety of methods such as deposition into a nanoporous alumina, seeded growth and anodization of Ti foils in fluoride based electrolytes. In this study we introduced a template wetting method using sol-gel and MOD TiO_2 sources to prepare TiO_2 nanostructures on Ni nanorod arrays. The nanorod arrays were fabricated by an electroplating technique using nanoporous alumina templates with metallic layers. After heat treatments at elevated temperatures, the amorphous TiO_2 nanostructures on Ni nanorod arrays could be crystallized into the mixture of Anatase and Rutile phases. Analysis results for the nanostructures by FE-SEM, TEM, and XRD will be discussed. Investigating results of relationship between the nanostructure analysis and properties of water photoelectrolysis photoconversion under UV illumination for the crystallized TiO_2 nanostructures will be also presented.

Ep-140 **Long TiO_2 Nanotube Arrays by Organic Electrolyte Anodization for Photocatalytic Hydrogen Generation** KIM S. I., KIM R. K., HA M. H., WHANG J. H., SON S. M., SHAISLAMOV U. A., YANG J. M.[1], YANG B.(*Department of Information Nano Materials Engineering, Kumoh National Institute of Technology, 1 Yangho-dong, Gumi, Gyeongbuk, 730-701, Korea.* [1]*National Nanofab Center, KAIST, Yuseong-gu Yeun-dong, 53-3.*) In this study we have fabricated and developed TiO_2 nanotubes aiming for applications of photocatalysis and photovoltaics. There have been numerous research works to study photocatalytic properties of TiO_2 nanopowders or thin films. However, their efficiency has been lower than that of one-dimensional nano-objects (nanotubes and nanowires). Therefore, it has been suggested to develop nanotubes or nanowires of TiO_2 due to their high surface-to-volume ratios and size-dependent properties. Titanium dioxide (TiO_2) nanotubes have been produced by a variety of methods including deposition into a nanoporous alumina, sol-gel template method, seeded growth and anodization of Ti foils in fluoride based electrolytes. In this study TiO_2 nanotubes arrays with long length were fabricated by anodization methods using organic electrolyte. Organic electrolytes such as ethylene glycol and formamide were used to stabilize the growth of the long nanotube arrays. Investigating results of the nanotubes by FE-SEM, TEM, and XRD will be discussed. It will be also pre-

sented that the crystallized TiO_2 nanotubes annealed at several temperatures show a superior property of water photoelectrolysis photoconversion under UV illumination.

Ep-141 **TiO_2 Nanotubes by a Template Wetting Technique for Hydrogen Production via Photocatalytic Water Splitting** KIM R. G., KIM S. I., HA M. H., WHANG J. H., SON S. M., SHAISLAMOV U. A., YANG J. M.[1], PARK K.[2], YANG B. (*Department of Information Nano Materials Engineering, Kumoh National Institute of Technology, 1 Yangho-dong, Gumi, Gyeongbuk, 730-701, Korea.* [1]*National Nanofab Center, KAIST, Yuseong-gu Yeun-dong, 53-3.* [2]*Faculty of Nanotechnology and Advanced Materials Engineering, Sejong University, Seoul 143-747.*) Over the past several years increasing interest has been focused on research of nanoscale materials, which has a great fundamental and technological potential exhibiting a wide range of magnetic, electrical, and optical properties as a result of their low dimensionality. Numerous research works to study photocatalytic properties had been related to TiO_2 nanopowders or thin films. However, their efficiency is lower than that of one-dimensional nanotubes and nanowires. In this study we introduced template-wetting method to prepare TiO_2 nanotubes array. In this method we used MOD and sol-gel TiO_2 sources with addition of polymer. In the template wetting method, templates such as nanoporous AAO or macroporous Si were infiltrated with MOD and sol-gel polymeric sources. After heat treatments at elevated temperatures in oxygen ambients, metallized nanotubes were released by etching-off the template for testing of photocatalytic hydrogen generation. Investigating results of water photoelectrolysis photoconversion under UV illumination for the crystallized TiO_2 nanotubes will be discussed in terms of nanostructural analysis of the nanotubes by FE-SEM, TEM, and XRD.

■ SESSION: P2
4월 18일(금), 09:00 - 10:45
장 소: 109호

Fp-001 **Scaling exponents and Crossover behavior of the Generalized conserved lattice gas model at zero temperature.** KWAK Wooseop, YANG Jae-Suk[1], KIM In-mook[1](*Dept. of physics, Chosun university.* [1]*Dept. of physics, Korea university.*) We study a generalized conserved lattice gas model on two dimensions by introducing an effective temperature to the conserved lattice gas model, where the number of particles is conserved during dynamical process. We apply Monte Carlo simulation with the Metropolis transition rate. At zero temperature we find two crossover behaviors; one between the localized active states and absorbing states, the other between the localized active states and active states. With new definition of the order parameter for the second crossover behavior, we obtain the critical exponents at the crossover point.

Fp-002 **Is there upper critical dimension in the majority voter model?** YANG Jae-Suk, KWAK Wooseop[1], KIM In-mook(*Dept. of physics, Korea University.* [1]*Dept. of physics, Chosun University.*) We study the critical properties of the majority voter model on d-dimensional hyper cubic lattices. On two dimensions, the majority voter model belongs to the same universality class as that of the Ising model. However, the critical behaviors of the majority voter model on four dimensions do not exhibit the mean-field behavior. Using the Monte Carlo simulation on d-dimensional hyper cubic lattices, we obtain the critical exponents up to d=7, and find that the upper critical dimension is 6 for the majority voter model. We also confirm our results using mean-field calculation.

Fp-003 **Yang-Lee Zeros of the Triangular Ising Antiferromagnets** HWANG Chi-Ok, KIM Seung-Yeon[1](*국가수리과학연구소(National Institute for Mathematical Sciences).* [1]*충주대학교(Chungju National University), 교양학부(School of Liberal Arts and Sciences).*) Using both the exact enumeration method (microcanonical transfer matrix) for small systems and the Wang-Landau Monte Carlo algorithm for large systems, we obtain the exact and approximate densities of states g(M,E),as a function of magnetization M and exchange energy E,for the triangular-lattice Ising model. Based on the density of states g(M,E), we investigate the phase transition properties of Yang-Lee zeros and obtain the magnetic exponents at various temperatures.

Fp-004 **Dependence of Cutoff Degree on Finite-Size Scaling in Annealed Scale-Free Networks** LEE Sang Hoon, HA Meesoon, JEONG Hawoong(*Department of Physics, KAIST.*) We test the validity of the finite-size scaling (FSS) theory and the FSS exponent proposed in quenched scale-free networks, through simulations of Ising model on annealed scale-free networks with different scaling of the upper cutoff degree where it diverges with the network size in some given ways. Contrary to nonequilibrium models, it is crucial how to implement the annealed version of scale-free networks in equilibrium models. We try several different networks, suggest the appropriate model for such a numerical test and physical implications, and discuss possible network cutoff dependence on FSS. Furthermore, we compare the results with those on the quenched networks and point out the difference from the case of nonequilibrium models, such as the contact process, which give some physical insight in the more general context of the mean-field theory and FSS in scale-free networks.

Fp-005 **Conserved-Mass Aggregation Model with Mass-Dependent Fragmentation on Weighted Scale-Free Networks** 김 엽, 이 동진, 권 성철(*경희대학교 물리학과.*) We study a conserved-mass aggregation (CA) model with mass-dependent fragmentation on weighted scale free networks (WSFNs). In WSFNs, the weight w_{ij} is assigned on the link between node i and j. We consider the symmetric weight $w_{ij} = (k_i k_j)^\alpha$. In the model, masses diffuse with unit rate. With rate ω, a mass m^{λ}_i is fragmented from a node i with mass m_i. In addition, the hopping probability T_{ji} from node i to j is given as $T_{ji} = \omega_{ij}/\sum \omega_{li}$. The sum runs over the linked nodes to node i. With T_{ij}, masses move to the one of the linked nodes. For $\lambda=0$, the model is known to undergo the condensation transitions at a certain ciritical density ρ_c for $\alpha <\alpha_c$, where $\alpha_c = (\gamma-3)/2$. However, for $\alpha \geq \alpha_c$, the condensation transition always occurs for any nonzero density. For $0<\lambda<1$, we numerical confirm that ρ_c diverges with network size N as $\rho_c \sim N^\beta$ for sufficiently small α. Hence, in the thermodynamic limit, the condensed phase disappears, and masses uniformly distribute. For sufficiently large α, the condensation with an exponential background distribution always takes place. As a result, we conclude that there is a crossover α_c for a given λ. The condensed phase of $\lambda=0$ and $\alpha <\alpha_c$ completely disappears as soon as one turns on the enhanced chipping by λ.

Fp-006 **Square-lattice Ising superantiferromagnet** 이 재환, 김 승연[1], 김 진민(*숭실대학교 물리학과.* [1]*충주대학교 교양학부.*) We study the square-lattice Ising model with nearest neighbour and next-nearest-neighbour interactions by using Wang-Landau Monte Carlo algorithm. It is believed that this model shows four different phases: paramagnet, ferromagnet, antiferromagnet, and superantiferromagnet. The properties of phase transition into superantiferromagnet are almost unknown for this model even though extensive studies have been performed. First, we calculate the density of states of the model via Wang-Landau algorithm. Then, the distribution of the partition function zeros are obtained in the complex temperature plane from the density of states. Finally, we investigate the properties of phase transition into superantiferromagnet based on the distribution of the partition function zeros.

Fp-007 **Models with conserved noise** 김 대호, 이 재환, 김 진민(*숭실대학교 물리학과*) We investigate restricted curvature (RC) model and restricted solid-on-solid (RSOS) model with conserved noise (CN) generated by diffusion, where the total number of particles is conserved. The conservation law leads to a new universality class following sixth (RC) and fourth (RSOS) order linear equations with conserved noise. Especially in four dimensional CNRSOS model the surface width does not follow power-law behavior and its saturation value approaches a constant with a scaling correction due to negative exponents. We discuss the relations between CNRSOS and RC models.

Fp-008 **Olympus FV500 레이저 주사 공촛점 현미경을 기반으로 자체 제작된 양광자 FRET 현미경** 민 철홍, 정 병하, 이 경진(*고려대학교 물리학과*) 형광이미징은 현대 생물학 연구에 있어 매우 유용한 핵심적 영상기술이다. 이와 관련 현재까지 다양한 방법들이 개발되어 왔는데, 근래에 와서는 긴 파장(730~820nm)/펨토초 펄스(100fs)를 광원으로 사용하는 다광자(multi-photon) 형광이미징 방법이 큰 각광을 받고 있다. 이 새로운 기술은, 단광자 공촛점 이미징보다 우수한 3차원 분해능을 주며, 시료에 광자손상(photo-damage)을 적게 주고, 염료의 광표백(photo-bleaching) 또한 최소화시키는 장점을 가진다. Zeiss사는 장파장 펨토초 펄스레이져를 이용한 다광자 이미징에 대한 특허권을 보유, 현재 상용 다광자 이미징 장비를 독점하고 있다. 이 Zeiss 장비는 매우 고가이며 본 연구단에 필요한 여러 연구 상황에 적합하지 못하여, 본 연구에서는 기 보유하고 있던 Olympus 단광자 공촛점 현미경 FV500을 토대로 FRET (fluorescent resonance emission transfer) 이미징이 가능한 양광자 이미징 시스템을 개발하였다. 본 발표에서는 이 시스템에(특히, FV-500에 별도로 추가된 광학 및 전기적 요소들) 대한 구체적인 내용을 기술하며, 구현된 장비를 이용한 여러 응용들에[Cameleon fluorescent protein을 이용한 calcium FRET, 양광자 염료 Laudan을 이용한 세포막 지질 뗏목 이미징, 양광자 염료 AL1을 이용한(acidic) 소낭/소포 이미징] 대하여 의논한다.

Fp-009 **Universality split in absorbing phase transition with conserved field on fractal lattices** LEE Sang Bub, LEE Sang-Gui(*Department of Physics, Kyungpook National University.*) The universality split in absorbing phase transition between the conserved lattice gas (CLG) model and the conserved threshold transfer process (CTTP) is investigated on a checkerboard fractal and on a Sierpinski gasket. The critical exponents θ, β, $\nu_{parallel}$, and z, which are associated with, respectively, the density of active particles in time, the order parameter, the temporal correlation length, and the dynamics of active particles, are elaborately measured for the two models on selected fractal lattices. The exponents for the CLG model are found to be distinctly different from those of the CTTP model on a checkerboard fractal, whereas the two models exhibit the same critical behavior on a Sierpinski gasket, indicating that the universality split between the two models occurs only on a checkerboard fractal. Such a universality split is attributed from the dominant hopping mechanisms caused by the intrinsic properties of the underlying fractal lattice.

Fp-010 **Violation of scaling relation in absorbing phase transition with a conserved field** LEE Sang Bub Lee, LEE Sang-Gui(*Department of Physics, Kyunpook National University.*) The scaling relations widely known in absorbing phase transition are studied for the lattice model with a conserved field. The critical indices θ, β, $\nu_{\parallel}$, and $\nu_{\perp}$,characterizing, respectively, the density of active particles intime, the steady-state density of active particles, the temporal and spatial correlation lengths, are measured elaborately for the conserved lattice gas model in two dimensions, and the results are confirmed by the off-critical scaling and the finite-size scaling analyses. It is found that the scaling relation $\nu_{\parallel} =\beta / \theta$ holds but the two finite-size scalings are satisfactory with twodifferent values of the spatial correlation-length exponents. This is in strict disagreement with the earlier observation by Rossi et al. [Phys. Rev. Lett. 85, 1803 (2005)] and also by L\"ubeck [Phys. Rev. E. 68, 056102 (2005)], in that the former scaling relation was claimed to be violated. It appears that the spatial correlation length exponent for the all-sample averages is distinct from that of the surviving sample averages.

Fp-011 **Effects of underlying topologies on roughening transition of propagation of innovations** KIM HongJoo, YOOK Soon-Hyung, KIM Yup(*경희대학교 물리학과*) The propagation of innovation is an essential mechanism for the advances of the technological level. Recently, Guardiola et al. proposed a simple model of diffusion of innovations [1]. The model have been studied only on 1d lattices and random networks. In this work we investigate the model on 2d lattices and various complex networks, and compared with the 1d results. From the numerical simulations, we find that the surface width decreases as we increase the system size, which indicates that the upper critical dimension for the roughening transition is d_c=2. The results are verified by measuring other physical quantities such as avalanche size distribution.

References:[1] X. Guardiola, A. Diaz-Guilera, C. J. P{'e}rez, A. Arenas, and M. Llas, Phys. Rev. E 66, 026121 (2002).

Fp-012 **Anomalous Scaling Behavior in Polymer Thin Flim Growth by Vapor Deposition** 손 승우, 하 미순, 정 하웅(*KAIST, 물리학과*) To understand anomalous kinetic roughening with multifractality in vapor deposition polymerization (VDP) growth, we consider a simple model for the polymer thin film growth by vapor deposition, along with monomer diffusion, polymer nucleation, limited active end bonding, and shadowing effects. Using extensive numerical simulations, we observe the power-law distribution of height differences, which is clear evidence of anomalous scaling and multiscaling behavior. It is argued that such anomalies in the VDP growth are attributed to the instability induced by the nonlocal shadowing effects in polymerization. As varying the ratio of diffusion coefficient to deposition rate, our results will be compared with recent experimental data.

Fp-013 **Morphological transition of pre-rippled surface by**

crossing ion beam 조 민웅, 김 재성[1], 강 병남(*서울대, 물리천문학부.* [1]*숙명여대, 물리학과.*) Ion-induced ripple formation from initially flat surface is well understood by the linear theory. However, when we consider sputtering on initially non-flat surface or pre-patterned surface, the morphological transition is hard to predict since mainly two processes are simultaneously occurred; destroying a existing pattern and generating a new pattern. Here, we study morphological transition of initially-rippled surface by ion beam, perpendicular to the ripple orientation in azimuth. Numerical integration is performed with the nonlinear Kuramoto-Sivashinsky (KS) equation. The morphological features at meantime depend on the dynamics of the ripple formation that can be controlled by changing value of parameters in the KS equation. Producing a new rotated ripple accompanies with kinetic smoothening which is characterized by e.g. merging of neighbor ripples or vanishing all ripples according to parameter values we choose. We discuss and compare these results with recent studies of pattern formation by multiple ion-beam sputtering and sputter-patterning on a rotating surface.

Fp-014 **Accurate estimation of fractal dimension from bio-images with finite resolution** LEE dongmyeong, MOON Jung-young, KIM seunghwan(*The Asia Pacific Center for Theoretical Physics and Nonlinear &Complex Systems Lab, Dept. Physics POSTECH.*) The Minimum Spanning Tree (MST) can be used to measure the dimension of various fractal sets effectively. We show that the MST method is more accurate than a traditional box counting algorithm in estimating the fractal dimension from images of some well-known fractals with a given resolution. Our method is applied to several complex bio-images with a limited resolution including vein structures of leaves for accurate estimation of their fractal dimension

Fp-015 **Torus Doublings in Symmetrically Coupled Period-Doubling Systems** LIM Woochang, KIM Sang-Yoon[1](*아주대학교 의과학연구소.* [1]*강원대학교 물리학과.*) As a representative model for Poincare maps of coupledperiod-doubling oscillators, we consider two symmetrically coupledHenon maps. Each invertible Henon map has a constantJacobian b (0<b<1) controlling the "degree" of dissipation.For the singular case of infinite dissipation (b=0), it reducesto the noninvertible logistic map. Instead of period-doublingbifurcations, anti-phase periodic orbits (with time shift of halfa period) lose their stability via Hopf bifurcations, and thensmooth tori, encircling the anti-phase mother orbits, appear. Westudy the fate of these tori by varying b. For large b doubledtori are found to appear via torus-doubling bifurcations. This isin contrast to the case of coupled logistic maps without torusdoublings. With decreasing b, mechanisms for disappearance oftorus doublings are investigated. These torus doublings are alsoobserved in two symmetrically coupled pendulums.

Fp-016 **Properties of synchronized clusters in complex networks** KO YOUNG JIN, YOOK SOON-HYUNG, KIM YUP(*KYUNG HEE UNIVERSITY.*) Synchronization of coupled Kuramoto oscillators has been attracted many researchers because of the theoretical and practical importances. In this work, we study the properties of dynamically formed clusters using Kuramoto oscillators. By measuring the size distribution of the merged clusters when the coupling coefficient increases, we show that the path to achieve the global synchronization does not depend on the underlying network topology, which contradict to the results of G{\'o}mez-Garde{\~n}es et al. [1] We also discuss the percolation phenomena of the synchronized clusters. References: [1] J. G{\'o}mez-Garde{\~n}es, Y. Moreno, and A. Arenas, Phys. Rev. Lett. 98, 034101 (2007)

Fp-017 **생체시계인 시교차상핵 (SCN)에서 보여지는 두 개의 독립된 칼슘 진동** 홍 진희, 민 철홍, 정 병하, 이 경진(*고려대학교 물리학과 세포동력학센터*) 생물계에서 일어나는 칼슘양의 변화 기전은 짧게는 수 초에서 길게는 며칠 단위의 시간적 다양성을 가지고 존재한다. 생체시계로 알려져 있는 시교차상핵 (suprachiasmatic nucleus (SCN))을 구성하는신경세포도 일주기로 나타나는 비교적 긴 세포 내 칼슘양의 진동(circadian rhythm)을 보인다고 잘 알려져 있다. 시교차상핵 내의 신경세포와 아교세포들은 10~50초 범위의 짧은 주기를 갖는 세포 내 칼슘양의 진동 (calcium spike) 또한 보여 준다. 그러나 이들 두 칼슘 진동간의 상관성에 대해서는 아직 알려진 바가 없다. 본 연구에서는 두 칼슘 진동 사이의 상관성을 조사하기 위해 쥐의 뇌조직 절편을 형광염료인 fluo-4 와 cameleon이라 불리는 칼슘 특이적 형광단백질을 사용하여 세포 내 칼슘양의 진동을 관찰했다. 그 결과 fluo-4 를 사용한 경우에만 SCN에서 calcium spike를 관찰할 수 있었으며, 이들의 발화빈도를 측정해 본 결과 일주기에 따른 차이를 관측 할 수 없었다. 이러한 결과는 두 칼슘 진동간의 특정한 관련성이 없음을 시사하고있다.SCN내의 신경세포와 아교세포에서 나타난calcium spike의 원인이 fluo-4 의 chelation효과일 가능성을 확인하고자 calcium spike가 나타나지 않는 cameleon 을 발현시킨 SCN 신경세포에 fluo-4와 BAPTA를 첨가해 보았다. 그 결과 calcium spike를 보이지 않던 SCN 세포들로부터 calcium spike를 관찰할 수 있었다. 세포 안으로 순간적, 다량 들어간 fluo-4와 BAPTA가 세포 내 칼슘 이온과 결합하여 자유 칼슘이온의 농도가 낮아지게 되는데 이때 세포는 자유 칼슘이온의 농도를 현상 유지시키기 위해 세포 내 저장고로부터 이를 방출하면서calcium spike를 보이는 것으로 판단된다. 다양한 형태의 calcium spike가 존재하는 이유 역시 세포 마다 다른 칼슘 농도 조절 기전을 가지고 있기 때문인 것 같다. 여러 가지 다른 세포들에서 보이는 calcium spike 현상이 이러한 형광염료의 chelation 효과 때문만은 아니다. 본 연구에서 관측한 형광염료의 chelation효과는 세포 내 칼슘양의 circadian rhythm을 가진SCN 신경 세포의 특이적 반응으로 볼 수 있다.

Fp-018 **Power-law Waiting Time Distributions in Interacting Queue Models** 민 병준, 고 광일, 김 인묵(*고려대학교 물리학과.*) The waiting times in human activities have been empirically shown to display a heavy-tailed distribution, typically following a power law with the exponent α=1 or 3/2. Queueing models for human dynamics assigning different priorities to individual tasks have been successful in accounting for the power-law waiting time distributions. These models, however, neglected an important

factor in human activities, namely, the human interactions. Recently, a new model of human dynamics taking human interactions into account was introduced, employing the AND-type protocol for interacting tasks between two individuals. Here we study a class of queueing models for human dynamics with other types of interaction protocol and interaction network structure. Numerical simulations of the model show that the waiting time distributions of both interacting and non-interacting tasks are heavy-tailed, following a power law asymptotically. This result provides a further evidence that the heavy-tailed waiting time distribution is a general property of priority-based queueing models of human dynamics.

Fp-019 **Long-range Interaction Among Calcium Puffs And Global Synchronization In Cultured Networks Of Glia** PARK Jin-Sung, JEONG Byeongha, KO Tae-Wook, LEE Kyoung Jin(*고려대학교 물리학과 세포동력학연구센터*) Together with neurons, glia are a major component comprising the brain. It is known that they support calcium waves as well as cytosolic calcium spikes in confluent populations. Here, we have quantified an interesting mode of calcium wave activity, termed as "calcium puffs," arising in confluent two-dimension in vitro glial tissue. According to our analysis, the calcium puffs seemingly random in space and time are, in fact, not quite random that there exist some well defined motifs in the spatiotemporal sequences of them. The macroscopic events of calcium puffs also provide a long-range correlation to the cell populations that eventually lead to a spatially synchronized oscillation. We discuss these findings in connection with neural synchronization and computation.

Fp-020 **미세아교세포의 상태전이 과정에 따른 세포구조 변화와 운동성 및 화학운동성에 대한 연구** 이 경진, 양 태석, 박 진성, 권 오규, 정 병하, 민 철홍(*고려대학교 물리학과 세포동력학 연구센터*) 뇌 세포 중에서 면역체계에 관여하는 것으로 알려져 있는 미세아교세포(microglia)는 손상된 신경세포로부터의 화학분비물의 인식을 통해 활성화(activaion)되고, 그 목표 저점을 향해 이동해서 세포사멸을 유도하는 대표적인 주화성(chemotaxis) 세포이다. 순수한 미세아교세포만의 운동양상을 조사하기 위하여 세포를 생체 밖으로 분리해 내어 높은 순도로 배양하였다. 분리해 내는 과정에서 미세아교세포는 활성상태로 전위가 일어나는데, 이 때 세포의 형태는 양방향(bipolar), 세방향(tripolar)의 모습을 갖게 되고 운동양상은 자기 몸의 크기 정도 내에서만 움직인다. 이후 시간이 지남에 따라 외부 환경에 의해2차적인 활성 상태로 전위가 일어나는데, 이 때 세포의 형태는 진행방향에 대해 세포의 몸이 늘어났다 줄어드는 형태를 갖게 되고, 운동양상은 자기 몸의 크기에 수배에서 수십 배의 거리를 움직이기 시작한다. 본 연구에서는 초기 활성상태와 두 번째 활성 상태에 대하여 세포의 형태와 그에 따른 운동양상 대해서 조사하였고, 충분히 활성화된 미세아교세포의 이동방향이 어떤 방향성을 갖게 되는지 조사하기 위하여 P2Y12 수용체를 자극하는 ATP의 첨가와 이를 억제하는 Wortmannin의 첨가를 통하여 화학물질의 인식을 통한 방향성에 대하여 규명하고자 한다.

Fp-021 **Wave dispersion in one-dimensional spiral track of cardiac cells** KIM Tae Yun, CHOI Eun Pyo[1], PARK Jungyul[1], LEE Kyoung J.(*Center for cell dynamics and Dept. Physics, Korea Univ.. [1]Dept. Mechanical Engineering, Sogang Univ..*) Various reports have been published regarding the waves arising in cardiac tissue. Among others, understanding their instabilities is very important because they potentially underlie the transition from cardiac tachycardia to fibrillation. As a step towards understanding the instabilities, we have built one-dimensional in vitro spiral track of cardiac cells in order to quantify the properties of wave dispersion in a systematic manner and to analyze the transition to alternans, a harbinger to fibrillation. Here, we describe our experimental system and discuss our preliminary data.

Fp-022 **On community detection using q-state Potts model** 이 재성, 강 병남, 김 두철(*서울대학교 물리천문학부*) The community detection problem using the maximization of the benefit function known as *modularity* is equivalent to obtaining the ground state of a q-state Potts Hamiltonian where q is the preset number of communities. We obtain the replica symmetric solutions for the ground state energy of the Potts Hamiltonian analytically on uncorrelated random dense graphs with arbitrary degree distribution. We find the maximized modularity is proportional to $\langle k \rangle^{-0.5}$ for any q when the mean degree $\langle k \rangle$ is large. We confirm it with numerical simulations. The result can be used as measure to provide a reference value for real world networks.

Fp-023 **Comparison of the small-world topology between anatomical and functional connectivity** PARK Chang-Hyun, KIM Soo Yong, KIM Kyungsik[1](*KAIST. [1]Pukyong Natl University.*) We applied graph analysis to both anatomical and functional connectivity in the human brain. Anatomical connectivity was acquired from diffusion tensor imaging data by probabilistic fibertracking, and functional connectivity was extracted from resting-state functional magnetic resonance imaging (fMRI) data by calculation of correlation maps of fMRI time series. Anatomical networks showed higher efficiency and smaller diameters than functional networks. It can be proposed that anatomical connectivity, as a major constraint of functional connectivity, has a relatively stable and efficient structure to support functional connectivity that is more changeable and flexible.

Fp-024 **Evolution of Complex Networks: Coauthorship and Word Collocation Networks** KAHNG Byungnam, GOH Kwang-il[1], LEE Deokjae(*Seoul National University. [1]Korea University.*) We study the evolution of complex network based on several empirical datasets such as the coauthor datasets working on complex network and string theory, and word collocation dataset by infants, etc. Those dataset contain the information to study the evolution of network from seeds. We find that for the coauthorship networks, a tree structure forms in early stage and large-scale loop structure follows in latertime. Growth of largest cluster is made by cluster aggregation. For the word collocation network for infants, however, the cluster aggregation behavior does not appear.We discuss the

construction of models associated with each case.

Fp-025 **개별주가의 변동에 대한 주식시장의 특성** 임규창, 김 수용, 이 동인[1], 김 경식[1](*KAIST. [1]부경대학교*) 본 연구에서는 S&P500 와 KOSPI 의 주가지수간에 상관성을 실증적으로 분석한다. 각 주가별 상관성에 대한 대용방법이 상관성 혼합조작에 의한 주식시장 전체 흐름의 구조적 특징에 어떠한 영향을 미치는지 살펴보고, 이에 따른 그물망 이론을 분석해 보았다. 두드러진 결과는 두 주식시장 전체의 외형적인 특징은 개별 주가의 변동에 민감하게 반영하지 않는 것으로 나타났음을 보였다.

Fp-026 **The equipoise centrality for uniform accessibility in complex networks** SHIN Jeongkyu, KIM Sungyun[1], KIM Seunghwan(*Nonlinear &Complex Systems Laboratory, Dept. Physics, POSTECH and Asia Pacific Center for Theoretical Physics. [1]Asia Pacific Center for Theoretical Physics.*) We propose equipoise centrality as a second-order measure for complex networks, which is an inverse of the standard deviation of the normalized shortest path length distribution for all nodes. We calculate equipoise centrality of all nodes for various model and empirical complex networks and investigate its distribution in the space of the shortest path length and the equipoise centrality. This distribution exhibits several interesting features which help to understand the degree of accessibility of complex networks. Our findings can be useful in exploring the delivery and transportation networks that require uniform access time.

Fp-027 **An experimental and theoretical study on the size dependence of QD incorporation into the lipid bilayer of liposomes** WI Haengsub, KYUYONG Lee, HYUKKYU Pak(*부산대학교 물리학과*) We prepare QD-liposome complexes(QLC) with spin-coating methods in conjunction with elctroswelling techniques experimentally. Green-emission QDs (4.4 nm including TOPO in diameter) of size comparable to lipid bilayer thickness (4～5 nm) are successfully incorporated into the lipid bilayer, which we verify through confocal microscopy, cryo-TEM, and positive staining TEM with sectioning. However, when red-emission QDs (8 nm in diameter) are used, only lipid-QD aggregations are observed . In order to explain this size dependence of QD-liposome incorporation, we model QLC system in terms of molecular geometry factor of lipids, such as packing parameter, QD core size and compression, stretching of lipid hydrocarbon chain surrounding QD.

Fp-028 **The Global Change In The Functional Wiring Scheme For The Conscious And Unconscious States Of The Human Brain** HWANG Eunjin, LEE Uncheol[1], CHOI Byung Moon[2], NOH Gyu-Jeong[2], KIM Seunghwan(*Nonlinear &Complex Systems Laboratory, Dept. Physics, POSTECH and Asia Pacific Center for Theoretical Physics. [1]Max-Planck Institute for the Physics of Complex Systems. [2]Department of Anesthesiology and Pain Medicine, Asan Medical Center.*) It has been hypothesized that a functional wiring structure of the human brain is connected to the level of consciousness. However, an experimental evidence for this hypothesis has been lacking so far. In this paper, we analyze electroencephalogram(EEG) signals recorded from a series of anesthetic experiments on healthy male subjects. We find an evidence for the structural difference in the functional wiring scheme between the conscious and unconscious states for the fronto-parietal network of the human brain. We observe that the feedback(FB) connectivity level is significantly lowered after the administration of the anesthesia drug, while the feedforward connectivity level is maintained almost constant. In addition, a global change in the functional structure throughout the loss of consciousness and its recovery has been observed with the help of a new measure of functional connectivity called conscious information flow(CIF). The conscious and unconscious states of the subjects are clearly classified into two groups through the hierarchical cluster analysis, which reveals the existence of a distinct connectivity pattern for each subject.

Fp-029 **Measuring the Fractal Dimension of Complex Networks** 문 준영, 오 갑진[1], 김 성윤[2], 김 승환[3](*포항공과대학교 물리학과. [1]포항공과대학교 수학과. [2]아시아 태평양 이론물리센터. [3]포항공과대학교 물리학과, 아시아 태평양 이론물리센터*) The minimum spanning tree (MST) method is used to measure the dimension of complex networks effectively. This technique is based on the fact that the MST of a point set from a metric space is closely related to the dimension of the space itself. Our method is tested for model networks of known dimension, yielding more accurate results than the box-counting method. The MST method has been applied to the accurate estimation of the fractal dimension of several complex networks.

Fp-030 **Power-law behavior in survival dynamics of complex networks based on stock markets** 오 갑진, 신 정규[1], 김 승환[2](*포항공과대학교 수학과(PMI). [1]포항공과대학교 물리학과(NCSL). [2]포항공과대학교 물리학과(APCTP).*) We investigate dynamical characteristics of complex networks based on stock data for Korean and US stock markets. The complex networks are constructed by the minimal spanning tree (MST) and percolation methods, which exhibit a power-law distribution in the survival time of links in the networks. Our results can be extended to investigate survival dynamics of complex networks from other applications.

Fp-031 **The Road-Map For The Microscopic Protein Folding Kinetics** PARK Jiyong, KIM Jinhong, KAHNG Byungnam(*Seoul National University, Dept. of Physics and Astronomy.*) Protein folding is a dynamical process driven by complex interactions between amino acids and surrounding environment. We have developed a novel modality which manifest the process in microscopic details. Performing molecular dynamics simulations, we generate series of snapshots at room temperature. Next we construct folding kinetic networks, where a node is a microscopic configuration and a link represents a time sequel of two states in a given time interval. The network embeds high degree of complexity due to the large number of microscopic states. We successfully reduced the complexity using a coarse graining scheme originally developed for complex network analysis. Finally, the dynamics is assumed to

be Markovian and corresponding transition probability matrix renders dynamical information such as mean first passage time (MFPT) between distinct states as well as mean life time of a state. Compared to conventional dynamical descriptions based on a priori defined gross variables, the new method enables far more detailed description and reflects dynamical correlation on the protein folding kinetics.

Fp-032 **Cyclization of a rigid chain under a compressive force** 남 기문, 이 남경(*세종대학교 물리학과*) We have performed Langevin simulations of a rigid filament that has a shorter contour length than its persistence length. We measured the force required to bring a rigid filament into closure form to investigate the influence of fluctuations on DNA loop formation. We also profiled the force vs. projected filament length curves under a compressive force in both 2D and 3D. Minimum energy configuration without thermal fluctuations are estimated in terms of Jacobi-Elliptic functions. We compared the solution of Euler-Lagrange equation with the results of Brownian dynamic simulation.

Fp-033 **Force-extension Curves of Locally Melted DNAs** 성 우경, 전 재형, 이 오철(*포항공과대학교, 물리학과*) It is widely known that double-stranded DNA (dsDNA) is a stiff polymer whose persistence length is 50 nm (equivalently, about 150 bases along contour). Recently, however, experimental evidences have been reported that, at length scale of several tens nm, dsDNA seems to be less stiff, having a persistence length less than 50 nm. It has been proposed that in a dsDNA locally melted region (i.e., bubble) gives rise to such flexibility. Motivated by this, we investigate how the overall flexibility of dsDNA is varied by the presence of bubbles and their sizes. First, we model dsDNA as a duplex of two worm-like chains whose persistence lengths vary depending on the base-pare distance. Via the Langevin dynamics simulation using this model, we obtain the force-extension curves of dsDNAs, from which we examine how their persistence lengths are influenced by the sizes and positions of the bubbles and DNA lengths.

Fp-034 **Superfluidity in para-H_2 Clusters doped by a Small Number of ortho-D_2 Molecules** 심 수민, 신 현덕, 권 용경(*건국대학교 물리학과*) The low-temperature properties of mixed clusters of $(D_2)_M(H_2)_N$ have been studied by using path-integral Monte Carlo calculations. It is found that H_2 clusters doped by a small number of D_2 molecules have significant superfluid fractions below 1.5 K, just like pure $(H_2)_N$ clusters. In addition, we find that the clusters at specific sizes show significantly suppressed superfluidity when compared to the clusters of the neighboring sizes. This magic number behavior is also observed in computation of the energy differences between the neighboring cluster sizes. Finally, the density distributions of H_2 and D_2 molecules around the cluster center are discussed as a function of the cluster size.

■ SESSION: P3
4월 18일(금), 13:00 - 14:45
장 소: 109호

Dp-071 **Coexisting phases in two-dimensional vanadium oxide/surfactant nanostructured composites** KWON hyocheon, LEE Kyu Won, LEE Cheol Eui(*물리학과*) We synthesized the cooperative 2D self-organization of inorganic vanadium oxides and organic alkylammonium ($C_{12}H_{28}NH$) surfactants ($VO_x(C_{12}H_{28}NH)_y$ just called "C12VO"). The coexisting periodic phases have been observed in the composites such as a 2-D centered rectangular (*cmm*) structure and lamellar structure through X-ray diffraction. The well-resolved XRD pattern can be indexed as a 2D centered rectangular (*cmm*) lattice with cell parameter a=57.9, b=33.9 Å and a/b = 1.71 < squrt3 = 1.73 at room temperature. The results from evolution of XRD patterns by heating are indicated that the rectangular phase is undergone structural distortion along a axis (a/b <1.73) at low temperature and progressively becomes perfect 90° rectangular (a/b = 1.73) until 320 K and rapidly returns to distorted rectangular, which is more tilted toward a direction phase as like lamellar phase. As temperature increase, another layered distance of lamellar phase is progressively broader.

Dp-072 **Selective synthesis of single-walled carbon nanotubes using a laminated (Al/Fe/Al) catalyst layer** W. Song, C. Jeon, W.C. Choi, C.-Y. Park(*BK21 Physics Research Division and Center for Nanotubes and Nanostructured Composites (CNNC), Sungkyunkwan University, Suwon 440-746.*) Synthesis of tailored single-walled carbon nanotubes (SWNTs) is a crucial issue for application of SWNTs-based electronic devices. Especially, diameter control in the SWNT synthesis is recognized as the primary and ultimate goal due to its electronic properties depending on their diameter and chirality [1]. It has been known that the diameter of SWNTs is determined by the catalyst size. Thus, preparation of catalyst with small and uniform size is the one of the essential factor to synthesize tailored SWNTs**.** In this study, we have investigated the selective synthesis of SWNTs using the laminated (Al/Fe/Al) films by conventional thermal CVD. Thermal diffusion characteristic of the Fe catalyst has been employed to synthesized the tailored SWNTs using a laminated catalyst layer. After annealing process, the behavior of Fe nanoparticles incorporated with Al top-layer has been investigated by X-ray photoemission spectroscopy (XPS) and transmission electron microscopy (TEM). As increasing annealing time, we confirmed that the size of Fe nanoparticles was decreased. As a results, the diameter of the synthesized SWNTs was also decreased, which investigated by TEM and confocal Raman spectroscopy. After annealing of laminated catalyst film for 30 min, metallic SWNTs with 0.9 nm in diameter were observed**.** Our experimental results show that SWNTs have been synthesized with controlled diameter, density, and electrical properties using the laminated catalyst film. This technique is a novel method to synthesized a tailored SWNTs and can be applied to the device application that employ SWNTs**.** Reference [1] R. Saito, G. Dresselhaus, M. S. Dresselhaus, Physical Properties of Carbon Nanotubes Imperial College, London (1998).

Dp-073 **The magneto-optical and structural studyin Co doped ZnO system** KIM Sung-Jin, CHO Yong Chan[1], LEE Seung hun, KIM Won-Kyung[2], JEONG Se-Young(*Departartment of Nano Fusion Technology, Pusan National University, Miryang 627-706, Korea***.** *[1]Center for Dielectric and Advanced Matter Physics, Pusan National University, Busan 609-735, Korea***.** *[2]School of Nanoscience and Technology, Pusan National University, Miryang, 627-706, Korea.*) Diluted magnetic semiconductors (DMSs) have attracted large interest as a candidate of new spintronic devices [1], and there are still debates on the origins of ferromagnetism in Co-doped ZnO[2]. It was reported that the hydrogen can mediate a strong short-ranged ferromagnetic spin-spin interaction between neighboring Co ions through the formation of bridge bond in ZnCoO[3,4]. In our previous studies, the enhancement of ferromagnetism in H doped ZnCoO system was shown through both SQUID and MCD hysteresis loops[4].In this study, we investigate the change of magneto-optical properties of hydrogenated ZnCoO films and the results are compared to the SQUID data and neutron scattering data. As a scenario to reveal the structure and the role of the hydrogen bonding between two Co ions, low temperature structure of ZnCoO and ZnCoO:H are compared to the high temperature structure. The study about the contribution of the hydrogen to the average bonding length between Co-O and Co-CO using neutron scattering will suggested some hint to the origin of the ferromagnetism in ZnCoO:H**.** [1] Shinji Kuroda et al., Nature Mater. 6, 440-446 (2007)[2] Hyeon-Jun Lee and Se-Young Jeong et al., Appl. Phys. Lett. 81, 4020 (2002).[3] C. H. Park and D. J. Chadi, Phys. Rev. Lett. 94 127204 (2005).[4] H. -J. Lee and S. –Y Jeong et. al., Appl. Phys. Lett . 88 062504 (2006).

Dp-074 **Energy-band-gap opening in graphene nano-constrictions** JEONG Dongchan, KI Dongkeun, CHOI Jae-Hyun, LEE Hu-Jong(*Department of Physics, Pohang University of Science and Technology.*) A mono-layer graphene sheet is a zero-gap semiconductor. However, an energy band gap of an order of a few tens of meV opens when a mono-layer graphene sheet is constricted to a width of about several tens of nanometer. Here, we report on the fabrication of nanoconstrictions out of a mono-layer graphene sheet and their low-temperature electrical transport properties at temperatures down to 120 mK. A graphene flake, exfoliated from a piece of natural graphite, was placed on a Si substrate with a 300nm-thick oxidation layer on its surface. Cr/Au electrodes were deposited on this graphene flake by employing e-beam lithography technique and oxygen-plasma etching. The graphene flake itself was then nanopatterned into a ~100 nm wide constriction. The contact resistance was in the range of 300- 500 Ω at room temperature and did not change significantly down to the base temperature. The single-layeredness of our graphene flake was confirmed by observing the half-integer quantum-Hall effect at 9 T. Two graphene nanoconstrictions fabricated in this study revealed, in the resistance ver-

sus gate voltage curve, the energy band gaps of an order of 130 meV centered at the Dirac points. The resistance decreased to about 11 k Ω for a 70 V gate voltage away from the Dirac point. The gap opening in the graphene nanoconstriction may be utilized for the application to active electronic devices because an off-state conductance can be easily one hundred times smaller than an on-state conductance.

Dp-075 **Weak localization observed in a monolayer graphene sheet** JEONG Dongchan, KI Dongkeun, CHOI Jae-Hyun, PARK Kee-Su[1], LEE Hu-Jong[2](*Department of Physics, Pohang University of Science and Technology. [1]Department of Physics, Pusan National University, Busan 609-735. [2]Department of Physics, Pohang University of Science and Technology, Pohang 790-784.*) A graphene sheet, a single layer of graphite, has remarkable features compared with other two-dimensional electron gas (2DEG) systems. Charge carriers in a graphene sheet are chiral and density of charge carriers can be tuned by using a back-gate electrode. In this work, we focus on the observation and the close examination of the electron weak localization in a graphene sheet exfoliated from a piece of natural graphite and nano-patterned by e-beam lithography and oxygen-plasma etching into a Hall-bar shape. The contact resistance of measurement electrodes made out of Cr/Au was about 400 Ω at room temperature that was quite insensitive to the temperature variation. The resistance of the graphene device was measured by the four-terminal technique at temperatures down to 120 mK. Negative magnetoresistance with a universal conductance quantization was observed at the base temperature. We interpret the results in terms of the weak localization. The magnetoresistance peak by the weak localization is largest near the Dirac point and significantly weakens as the back-gate voltage is about ±20 V away from the Dirac point.

Dp-076 **Ferroelectric Properties of $Bi_4Ti_3O_{12}$-$SrBi_4Ti_4O_{15}$ Thin Films Prepared by a Chemical Solution Deposition** 김 상수, 김 진원, 조 현경, 이 승우, 배 유리, 김 영민(*창원대학교 물리학과*) Bismuth layer-structured ferroelectric materials (BLSFs) are considered to be excellent candidates for application in ferroelectric random access memories (FeRAM). The BLSFs belong to family of Aurivillius phases which has a general formula $(Bi_2O_2)^{2+}$-$(A_{m-1}B_mO_{3m+1})^{2-}$. In this notation, A-site represents a mono-, bi- or trivalent ion and B-site denotes a tetra-, penta- or hexavalent ion and m is the number of BO_6 octahedra in each pseudo-perovskite block (m = 2, 3, 4,…). Among the prototype BLSFs, thin film of the $Bi_4Ti_3O_{12}$ (BIT) fails to meet industrial requirements due to its low remanent polarization ($2P_r$) and poor fatigue property. Another category of BLSFs, namely the $SrBi_4Ti_4O_{15}$ (SBTi), which has a crystalline structure similar to BIT, is a typical layer-structured ferroelectric (m = 4). Fatigue property of the SBTi thin films are shown better than BIT. In this work, the BIT-SBTi double layered thin film was prepared on Pt(111)/Ti/SiO_2/Si substrate by a chemical solution deposition method followed by rapid thermal annealing at 700°C for 3 min in oxygen atmosphere. It is found that the BIT-SBTi double layered thin film was randomly oriented without any observable secondary phases. Their electrical properties of the BIT-SBTi double layered thin film were investigated systematically. The BIT-SBTi double layered thin film exhibited a good *P-E* hysteresis loop with a large $2P_r$ and a low coercive field ($2E_c$).

Dp-077 **Chemical solution deposition 방법으로 제작된 다강체 $BiFeO_3$/$Bi_4Ti_3O_{12}$ 이중 박막의 특성 연구** 김 상수, 이 승우, 김 진원, 조 현경, 김 영민, 배 유리(*창원대학교 물리학과*) 변형된 페로브스카이트 구조의 다강체 물질인 $BiFeO_3$ (BFO) 박막은 다양한 응용가능성으로 인해 큰 주목을 받고 있지만 제작시 발생하는 산소 구성비 및 결함 등으로 인한 누설전류의 단점은 해결되어야 할 선행과제로 남아 있다. 최근 연구에서는 Bi-site나 Fe-site를 La, Nd 또는 Cr 등의 원소들로 치환하거나, $BaTiO_3$나 $PbTiO_3$와 같은 다른 페로브스카이트 물질과의 solid solution을 통한 박막제조 등 다양한 방법들을 통해 특성 향상을 시도하고 있다. 본 연구에서는 BFO 박막과 Pt(111)/Ti/SiO_2/Si(100) 기판간에 $Bi_4Ti_3O_{12}$ (BTO) 층을 성장시킨 BFO/BTO 이중 박막 구조를 화학적 용액 증착법으로 제작하여 BTO 박막에 의해 향상된 BFO의 다강체 특성을 연구하였다. X-ray diffraction (XRD) 패턴과 Scanning electron microscopy (SEM)를 통해서 제작된 박막의 상변화와 구조를 조사하였고, BFO/BTO 이중 박막의 전기적 특성으로서 *P-E*, *I-V* 특성과 유전특성 등을 조사하였으며, 자기적 특성으로 상온에서의 *M-H* 특성곡선을 측정하여 분석해 보았다.

Dp-078 **다강체 $xBiFeO_3$-$(1-x)Bi_4Ti_3O_{12}$ solid solution 박막의 화학 조성비에 따른 특성 변화** 김 상수, 조 현경, 김 진원, 이 승우, 김 영민, 배 유리(*창원대학교 물리학과*) 다강체 물질이란 강유전성, 강자성, 그리고 강탄성 등의 특성 중 두 가지 이상의 특성이 공존하는 물질이다. 이러한 물질 가운데 하나인 $BiFeO_3$ (BFO)의 경우 높은 큐리 온도(T_C ~ 850℃) 및 Néel 온도(T_N ~ 370℃)를 가지고 있어 다른 다강체 물질에 비해 응용 소자로써의 활용 가능성이 높다. 그러나 BFO 내의 Fe^{3+} 이온이 Fe^{2+} 이온으로 천이하기 쉬워 일어나는 화학양론적인 불균형은 산소 빈자리를 발생시키며 이러한 산소 빈자리 등의 문제로 인해 BFO가 가지게 되는 큰 누설전류 및 낮은 잔류 분극 값은 응용소자로써의 활용에 있어서 해결해야 할 과제로 남아있다. 이를 해결하기 위한 다양한 연구가 진행되어지고 있으며 대표적인 방식으로는 물질 내에 일정량의 불순물을 치환하는 방법, BFO 이외의 다강체 물질이나 강유전체와의 다층 구조에 대한 연구, 그리고 다른 강유전체와의 solid solution을 형성하는 방법 등이 있다. 본 연구에서는 화학적 용액 증착법으로 Pt(111)/Ti/SiO_2/Si(100) 기판 위에 다강체 $x$$BiFeO_3$-$(1-x)$$Bi_4Ti_3O_{12}$ (x=0.4, 0.5, 0.6, 0.7, 0.8) solid solution 박막을 성장시켜 x에 따른 특성 변화를 연구하였다. XRD, SEM 측정 결과로부터 제조된 박막의 미세구조 변화를 알아보았으며, 강유전성 측정장치(Radiant LC-percision) 및 미소 전류계(Keithley 6517A)를 이용하여 *P-E*, *I-V* 등 전기적 특성을 측정하고, 상온에서 *M-H* 특성곡선을 통해 자기적 특성을 분석해보았다.

Dp-079 **Room-Temperature Electrical Oscillation using Two-Terminal Device based on Vanadium Dioxide** LEE Yong Wook, KIM Bong-Jun[1], LIM Jung-Wook[1], YUN Sun Jin[1], CHOI Sungyoul[1], CHAE Byung-Gyu[1], SHIM Jae Yeob[1], KIM

Gyoungock[1], KIM Hyun-Tak[1](*Pukyong National University. [1]ETRI.*) In this letter, we report an observation of room temperature electrical oscillation in vanadium dioxide (VO_2), a representative strongly correlated material showing an metal-insulator transition. An electric circuit for the oscillation is simply composed of a voltage source and two-terminal VO_2 thin film device serially connected with a standard resistor. The systematic procedures where the oscillation occurred were analyzed based on the electrical relationship between the VO_2 device and resistor. Also, the generation window of the oscillation was determined. In particular, the oscillation frequency could be controlled by adjusting an external voltage and increased to more than 0.5 MHz.

Dp-080 **Ferroelectric and Piezoelectric Properties of $(Na,K)NbO_3$ Thin Films Prepared by Chemical Solution Deposition** 이 선영, 안 창원[1], 원 성식, 김 일원, 배 세환[2], 이 재신[3] (*울산대학교, 물리학과. [1]하이테크부품소재연구지원센터. [2]동아대학교, 신소재물리학과. [3]울산대학교, 첨단소재공학부.*) The development of lead free ferroelectric and piezoelectric materials was required because the environment problem come to the front. Among several lead-free ferroelectric materials, $(Na_{0.5}K_{0.5})NbO_3$ (NKN) is considered to be more promising candidate because it has a high Curie temperature and good ferroelectric and piezoelectric properties. So, we have fabricated $(Na_{0.5}K_{0.5})NbO_3$ thin films on $Pt/Ti/SiO_2/Si(100)$ substrate with different excess precursor solutions (0~30%) by using sol-gel process. For preparation of NKN precursor solutions, sodium acetate, potassium acetate, niobium pentaethoxide, 2-methoxyethanol and acetylacetone were used as starting chemicals, solvent and chelating agent, respectively. To obtain NKN thin films, the precursor solutions were spin-coated on Pt substrate at the rate of 2500 rpm for 20s. We have also investigated the effects of excess A site ion ratios (Na and K), crystal structure, leakage current, ferroelectric and fatigue characteristics.

Dp-081 **Electric and Magnetic Anisotropy in Single Crystalline $TmAlB_4$** SUNG N. H., KIM J. Y., CHO B. K.(*School of Photonics Science and Technology, Dept. of Materials Science and Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea.*) The single crystallic compound, $TmAlB_4$, which has an orthorhombic crystallographic structure (space group *Pbam*), exhibits a large magnetic anisotropy with magnetic easy axis along the c-axis. The saturated magnetization along the c-axis at H = 5T was found to be $M_s = 7\mu_B$, which is similar to the effective magnetic moment of Hund's rule ground state for an isolated Tm^{3+} ion, while the magnetic moment perpendicular to the c-axis is only $0.16\mu_B$. The isothermal magnetization at T = 2K along the c-axis shows several metamagnetic transitions at H = 9.6kOe, 12kOe, 17.1kOe, 21.4kOe, 24.1kOe, and 26kOe. We also found a large anisotropy in electrical transport with the resistivity perpendicular to the c-axis($\rho_\perp$) being larger by an order of magnitude than that along the c-axis($\rho_\parallel$). In addition, field-dependent $\rho_\parallel(H)$ at T = 2K with the applied field along the c-axis exhibits noticeable magnetoresistance (MR) jumps exactly at the fields of the metamagnetic transitions in $M_\parallel(H)$, meanwhile the MR jumps do not appear in $\rho_\perp(H)$. This observation shows well the relation between magnetic and electric anisotropy. We will discuss in detail the electronic anisotropy and MR in conjunction with the magnetic properties.

Dp-082 **Impedance and Dielectric Properties of Ferroelectric $(Na,K)NbO_3$ Thin Films Fabricated by RF-Magnetron Sputtering** 이 해준, 강 선희, 김 일원, HUSSAIN Ali[1], 이 재신[1], 정 귀상[2], 진 병문[3](*울산대학교 물리학과. [1]울산대학교 첨단소재공학부. [2]울산대학교 전기전자정보시스템공학부. [3]동의대학교 물리학과.*) The $(Na,K)NbO_3$ ceramics have been studied extensively, because of their good piezoelectric and ferroelectric properties. Recently, $(Na,K)NbO_3$ ferroelectric thin films have been reported for applications in memory devices, due to their high remanent polarization and good fatigue endurance, but they display conduction behavior at high temperature due to the metal ions or space charges. So, we focused on the dielectric defects by its impedance spectroscopy. Impedance spectroscopy is a popular analytical tool in materials research development, as it involved a relatively simple electrical characterization and its results may often be correlated with complex microstructure of the material. The transport of charge by motion of the constituent carriers or ions is one of the most important characteristics of dielectric thin films. We have deposited the ferroelectric $Na_{0.5}K_{0.5}NbO_3$ (NKN) thin films on $Pt(111)/Ti/SiO_2/Si$ substrates by using a RF-magnetron sputtering method and investigated the ferroelectric and low frequency dielectric and impedance properties as functions of temperatures. Furthermore leakage current density – applied electric field (J-E) and time (J-t) characteristics have been studied in order to investigate the conduction behaviors of the NKN films.

Dp-083 **X-선 미세회절을 이용한 NiO film의 구조변화 분석** 정 진석, 김 영은, 서 승실, 고 영동, 김 동욱[1], 윤 화식[2](*숭실대학교 물리학과. [1]이화여자대학교 물리학과. [2]포항가속기연구소 빔라인부.*) X-선 미세회절을 사용하여ReRAM의 소자로 알려진 NiO film의 구조적 변화의 유무를 살펴보았다 X-선 미세회절은 방사광에서 나오는X-선을 1 micron 정도로 집속하여 시료의회절 image를 얻고, 이를 분석하여 구조에 대한 정보를 얻는 실험방법으로 작은 빔의 크기를 이용하여 국부적인 구조의 변화를 정확하게 측정할 수 있다. 1960년대부터 연구되어온 Resistance Random Access Memory(ReRAM) 소자는 일반적으로 금속산화물을 이용한 MIM(Metal-Insulator-Metal)구조로서 , 적당한 전기적 신호를 가하면 저항이 큰 전도가 되지 않는 상태(OFF state)에서 저항이 작은 전도가 가능한 상태(ON state)로 바뀌는 메모리 특성이 나타난다. 이러한 switching mechanism은 아직까지 명확하게 규명되지 않은 실정이다.NiO film의 경우 switching mechanism인 저항변화 특성이 있다고 알려졌는데, 이에 대한 이해를 위하여forming된 pad와 pristine pad의 구조적 변화를측정하였다. X-선 미세회절 실험은 포항가속기 연구소의 1B2 빔라인에서 이루어졌는데, 단색광 8.6keV에서 회절 image를 얻은 결과, 수많은 작은 grain들에 의해 회절된 Debye ring이 관측되었고, forming된 pad와 pristine pad의 회절된 ring들을 비교해 보니, 다른 line들은 변화가 없었지만 NiO에 해당하는 line이 달라짐을 볼 수 있었다. Forming된 pad에서는

NiO에 해당하는 line이 약한 intensity를 보이는 지역이 상대적으로 많았고, 완전히 사라진 지역도 있었다. 따라서 forming 과정을 통해 형성된 filament가 있는 곳에서 결정의 국부적인 비정질화가 이루어짐을 알 수 있다. 이것이 switching mechanism의 이해의 결정적 단서가 될 것으로 보인다.

Dp-084 **Physical Characterizations of Lead-free Piezoelectric (1-x)$K_{0.5}Na_{0.5}NbO_3$ – (x/5)$Na_yK_{3-y}Li_2Nb_5O_{15}$ Composite Ceramics** 전 병억, 김 샛별, 최 병춘, 문 병기, 정 중현(*부경대학교 물리학과 및 기초과학연구소*) The alkali niobates (K,Na)NbO_3 based systems have been explored as a candidate for substituting the lead-based ferroelectric and piezoelectric materials. The wider compositions of $ANbO_3$ (A = K, Li and Na) displayed phase coexisting i.e. perovskite (Pe), $LiNbO_3$ (LN) and tetragonal tungsten-bronze (TTB) structures in the compositions of K_2O-Li_2O-Na_2O-Nb_2O_5. The Pe structures seemed to show the distortions with pseudo-orthorhombic symmetry, while the TTB structure showed the tetragonal distortions with high ionic conductions. In this report, the physical properties of (1-x)$K_{0.5}Na_{0.5}NbO_3$ (KNN) – (x/5)$Na_yK_{3-y}Li_2Nb_5O_{15}$ (NKLN) composite ceramics were investigated. For the Na content of $0 \le y \le 0.4$, the LN phase was suppressed in the NKLN ceramics. It is considered that the NKLN ceramics were the two phase composite of Pe and TTB. We discussed the physical properties of the two phases composing ceramics, where the ferroelectric properties were modified by the secondary phase of the fast ionic conductions.

Dp-085 **Optical Spectroscopic Study on Multiferroic $MnWO_4$** CHOI Woo Seok, TANIGUCHI K.[1], MOON Soon Jae, SEO Sung Seok, KIM Sun Jung, LEE Yoon Sang[2], ARIMA T[1], NOH Tae Won(*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University. [1]Institute of Multidisciplinary Research for Advanced Materials, Tohoku University. [2]Department of Physics, Soongsil University.*) Multiferroic oxide materials have an intrinsic magnetoelectric coupling, which drew considerable interests both scientifically and technologically. Among multiferroic oxides, $MnWO_4$ is known to exhibit ferroelectricity between 7.6 K and 12.7 K, which is induced by its incommensurate elliptical spiral magnetic ordering [1]. In this study, we report optical spectroscopic investigations on $MnWO_4$. We grew single crystals of $MnWO_4$ using floating zone method. To examine the optical anisotropy originating from the monoclinic crystal structure, we measured reflectivity spectra of $MnWO_4$ with light polarizations along three crystallographic axes, and calculated the optical conductivity spectra through the Kramers-Kronig transformation for each axis. We discuss the anisotropic phonon structures and electronic structures with temperature and magnetic field dependence in relation to its multiferroic properties.[1] K. Taniguchi *et al.*, Phys. Rev. Lett. 97, 097203 (2006).

Dp-086 **Reduction of a Hilbert-Space Dimension in the Exact Diagonalization Method for the Dynamical Mean-Field Theory** KIM Hyeong-Do(*Pohang Accelerator Laboratory, Beamline Division.*) The exact diagonalization method has been widely used for the dynamical mean-field theory (DMFT) which is powerful tool to describe the electronic structure of a strongly correlated electron systems. But because of its exponentially increasing Hilbert-space dimension with the number of sites, its usage has been limited only to small number of sites. Here, I propose a systematic way to reduce the Hilbert-space dimension by treating perturbatively the hybridization between the impurity site and the conduction bath in the Anderson impurity model, which would be used in the DMFT calculation for a much complicated system.

Dp-087 **Study of NZFO_PZT composite structures using X-ray Microdiffraction** 안 석진, 박 정웅[1], 나 은혜, 구 양모[1], 장 현명(*포항공대 신소재공학과. [1]포항공대 철강대학원.*) Magentoelectric 효과란 외부 전기장에 따른 유도 자화 또는 외부 자기장에 따른 유도 전기 분극이 나타나는 현상을 말한다. 1894년 Curie에 의해 처음으로 언급된 이후, 1960년 Astrov가 단일상인 Cr_2O_3에서 처음으로 이러한 현상을 발견하고, 실험적으로 증명하였다. 이후 단일상에서의 Magentoelectric 효과대한 지속적인 연구가 진행되었으나, 예상보다 낮은 Magentoelectric effect, 그러한 현상을 보이는 재료에 대한 수의 부족, 낮은 상전이 온도에 따른, 상온에서의 응용의 어려움 등에 따라 70년대 초반 이후로 점차 연구가 감소되는 추세였다. 하지만 1970년대 중반 2가지 상의 복합체에서 높은 magentoelectric 효과를 보이는 것이 발견된 이후, 단일 상뿐만 아니라 복합 재료들에 대한 관심이 점차 증가 되었다. 특히 최근 10년 사이에 magentoelectric 특성을 가지고 있는 단일상의 물질뿐만 아니라 복합체에 대한 연구도 활발히 진행되어왔고, Harshe 등은 multilayer 복합체에서 기존의 bulk composite에서의 여러 가지 제약사항을 극복하고, 보다 향상된 magentoelectric 효과가 있다는 것을 발표했다. 복합체는 자성상과 압전상으로 구성되어 있으며, 외부 자기장으로 인해 자성상에서 자기 변형(magnetostriction)이 유도되며, strain이 기계적으로 결합을 하고 있는 압전상으로 전달되면서 압전(piezoelectric) 효과에 의해 전기장에 형성되게 된다. 본 연구에서는 기존에 알려진 강한 magnetoelectric 효과를 가지고 있는 산화물 강자성물질과 강유전체를 물리 화학적으로 결합시킨 후, 외부 전기장 인가에 따른 압전상에서의 strain 발생이 자성상에 미치는 영향을 in-situ x-ray microdiffraction을 이용하여 정량적으로 관찰하고, 그 결과를 도출해 내는데 목적을 가지고 있다.

Dp-088 **Crystal structural studies of Ionic Conductor CuI: synchrotron and neutron diffraction experiments** PARK Junghwan, LEE SangHyun, PARK Je-Geun, AHN D. C.[1], ADIPRANOTO Dyah S[2], KAMIYAMA T.[2](*SKKU, Physics Dept.. [1]POSTECH, PAL.. [2]KEK, IMSS.*) Copper iodide CuI is one of the archetypal ionic conductors, which has been heavily used in industry. It has been known to have three phases for many years. At low temperatures, it has a so-called γ-phase, which is zinc-blend type structure with the F-43m symmetry. Upon heating, it forms into another structure known as a β-phase before transforming into an α-phase with the fluorite-type structure of the Fm-3m symmetry at higher temperatures. Although CuI has been known for a long time, our latest works using a total neutron scattering technique have discovered that there may be disorder at the Cu sites at room

temperature. In order to extend the neutron works, we have recently investigated the crystal structure of CuI from 300 to 10 K using a high resolution powder diffractometer beamline, 8C2 of PAL, which has a resolution of $\Delta d/d \sim 10^{-5}$. For the analysis of the data, we employed the usual Rietveld method using both Fullprof and Rietan to obtain the temperature dependence of the structural information. We have also implemented a recently developed MEM technique to obtain a charge density map with higher resolutions and reliabilities. Based on our results, we will discuss two different models of CuI: one with non-split Cu site and another with split Cu sites.

Dp-089 **Dielectric Behaviors and Ferroelectric Properties of lead-free La doped $(Na_{0.5}Bi_{0.5})TiO_3$ (NBT) ferroelectric ceramics**
김 샛별, 김 유성, 김 진수, 최 병춘, 정 중현(*부경대학교, 물리학과.*) Lead-free La doped NBT (NBLT) ferroelectric ceramics was prepared by using a solid-state reaction method. Single-phases with ABO_3 perovskite structure are conformed by using a X-ray diffraction. The Curie temperature Tc varied and the dielectric constant peak broadened with increasing La doping. In the ferroelectric P-E hysteresis loops measurements, the remanent polarization (Pr) slightly decreased by La doping, in addition, the coercive electric field (Ec) decreased remarkably which indicates that the domains begin to switch the polarity at low field. In this work, for the La doping on NBT, the doping effects on dielectric and ferroelectric properties were investigated by the dielectric constant, ferroelectric P-E hysteresis and ac electrical conductivity.

Dp-090 **Impedance Analysis of $Ba_{1-x}Eu_xTiO_3$ Fine Ceramic**
전 병억, 김 은지, 최 병춘, 문 병기, 정 중현(*부경대학교 물리학과 및 기초과학연구소*) Ferroelectric $Ba_{1-x}Eu_xTiO_3$ (x=0 - 0.4; BET) fine ceramics were prepared by the sol-gel driven method. The grain size and morphology of $Ba_{1-x}Eu_xTiO_3$ fine ceramics were investigated by the scanning electron microscopy and X-ray diffraction. The BET fine ceramics displayed the ferroelectric D-E hysteresis at room temperature. The ferroelectric phase transitions were examined with the dielectric behaviors with varying the Eu substitution. The ferroelectric phase transition temperature of $BaTiO_3$ was lowered by the incorporation of Eu ions. The anomalous dielectric relaxation of BET fine ceramics were observed at the temperature range up to 600 °C. It is considered that Eu ions substitute Ba site rather than Ti site due to the ionic radii of Ba^{2+} is larger than that of Eu^{2+} and/or Eu^{3+}. Nevertheless, the probability of Eu ion substitute Ti sites was not excluded when Eu was replaced for Ba with higher concentrations in BET fine ceramics. In this regards, the electrical properties of intrinsic BET phase separating from the grain boundary were elucidated by using the impedance analysis with the Maxwell-Wagner type composite model.

Dp-091 **Stress dependence of growth mode change of epitaxial layered cobaltite g-$Na_{0.7}CoO_2$**
손 종역, 조 진형[1], 김 형준(*포항공과대학교, 신소재공학과.* [1]*부산대학교, 물리학과.*) We report stress dependence of growth characteristics of epitaxial gamma-$Na_{0.7}CoO_2$ films on various substrates deposited by pulsed laser deposition method. On the sapphire substrate, the gamma-$Na_{0.7}CoO_2$ thin film exhibits spiral surface growth with multi-terraces and highly crystallized texture. For the gamma-$Na_{0.7}CoO_2$ thin film grown on the (111) $SrTiO_3$ substrate, the nano-islands of ~ 30 nm diameter on the hexagonal grains are observed. These islands indicate that the growth mode changes from step-flow growth mode to Stranski-Krastanow (SK) growth mode. On the (111) MgO substrate, the large grains formed by excess adatoms covering an aperture between hexagonal grains are observed. These experimental demonstrations and controllability could provide opportunities of strain effects of Na_xCoO_2, physical properties of thin films, and growth dynamics of heterogeneous epitaxial thin films.

Dp-092 **Optical characterization of thermally oxidized Ni films**
SEO Y.K., LEE D.J., LEE Y.S., CHOI W.S.[1], PARK C.[2], KIM D.W[3](*Soongsil University, Department of Physics.* [1]*Seoul National University, Department of Physics.* [2]*Hanyang University.* [3]*Ewha Woman's University.*) While the thermal oxidation technique for oxide thin film fabrication has some advantages, such as, its simple process and high controllability of stoichiometry, the change of the electronic properties of thin films with oxidation have been not studied in details. Using various optical characterization techniques we investigated the electronic properties of the thermally oxidized Ni films which have recently attracted much attention due to their good resistive switching behaviors. It was found that the optical responses of the oxidized Ni films exhibit the systematic changes with oxidation degree. While the optical characteristics of doped Mott insulator were detected, the possibility of the phase coexistence could not be ruled out. These findings are discussed in relation to the electric properties of the films.

Dp-093 **Electronic Structure Changes in Novel J_{eff}=1/2 System: Ruddlesden-Popper Series $Sr_{n+1}Ir_nO_{3n+1}$ (n=1, 2, and ∞)**
MOON Soon Jae, JIN H.[1], LEE J. S., CHOI W. S., LEE Y. S.[2], YU J.[1], DURAIRAJ V.[3], CAO G.[3], SUMI A.[4], FUNAKUBO H.[4], NOH T. W.(*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [1]*CSCMR &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [2]*Department of Physics, Soongsil University, Seoul 156-743, Korea.* [3]*Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506, USA.* [4]*Deparment of Innovative and Engineered Materials, Tokyo Institue of Technology, Yokohama 226-8502, Japan.*) We investigated the electronic structures of Ruddlesden-Popper series $Sr_{n+1}Ir_nO_{3n+1}$ (n=1, 2, and ∞) compounds using optical spectroscopy and first-principles calculation. Optical conductivity spectra of $Sr_{n+1}Ir_nO_{3n+1}$ showed a unique change of electronic structure from insulator (n=1 and 2) to metal (n=∞) which was found to be controlled by U/W where U and W are on-site Coulomb interactoin and bandwidth, respectively. Based on the comparison of optical conductivity spectra and the results of first-principles calculation, we found that $Sr_{n+1}Ir_nO_{3n+1}$ system

should be classified as weakly correlated narrow band system and this unique state can be realized by the cooperation between *U* and SO coupling.

Dp-094 **Theoretical Study of Electronic Structures in $Ca_{2-x}Sr_xRuO_4$ with the Dynamical Mean-field Theory** OH Hyungju, CHOI Hyoung Joon(*Department of Physics and IPAP, Yonsei University.*) The phase diagram of $Ca_{2-x}Sr_xRuO_4$ shows a variety of different structural, magnetic, and electronic phases. It is reported that a phase transition occurs at the critical value of $x=x_c=0.5$, separating a correlated metallic phase ($x<x_c$) from the paramagnetic metal ($x>x_c$). In that region, there are strong correlations but no symmetry breaking so that LDA and LDA+U are inapplicable. In the present work, we study the electronic structures of $Ca_{1.5}Sr_{0.5}RuO_4$ using the dynamical mean-field theory (DMFT). In the DMFT, the impurity Hamiltonian is expressed in terms of *d* orbitals in Ru^{4+} and bath electrons, and it is solved with non-crossing approximation (NCA). The spectral function of the *d* electrons in the Ru^{4+} sites is analyzed to understand the effects of the correlation on the electronic structures of the system. This work was supported by the KRF (KRF-2007-314-C00075), the KOSEF Grant No. R01-2007-000-20922-0, and KISTI Supercomputing Center (KSC-2007-S00-1011).

Dp-095 **LDA+U study of atomic forces in NiO** PARK Se-Young, CHOI Hyoung Joon(*Department of Physics and IPAP, Yonsei University.*) Using a recently-developed LDA+U method for atomic forces, we study optical phonon frequencies in NiO. To calculate optical phonon frequencies, we implement the atomic force formula in the LDA+U formalism based on pseudo-atomic orbital (PAO) basis method. The atomic force formula is tested with NiO by comparing calculated atomic forces with the derivatives of the total energy with respect to atomic positions. We find that the derivatives and calculated forces are almost identical for both nickel and oxygen atoms, supporting the validity of our implementation. The obtained optical phonon frequencies are compared with previous theoretical results and measurements. This work was supported by the KRF (KRF-2007-314-C00075), the KOSEF Grant No. R01-2007-000-20922-0, and KISTI Supercomputing Center (KSC-2007-S00-1011).

Dp-096 **Optical study on the electronic structure of $SrHfO_3$ ($5d^0$) in comparison with $SrTiO_3$ ($3d^0$) and $SrZrO_3$ ($4d^0$)** LEE D. J., SEO Y. K, LEE Y. S, MOON S.J[1](*Soongsil University, Department of physics.* [1]*Seoul National University, Department of physics.*) We investigated the electronic structure of pseudo-cubic perovskite $SrHfO_3$, one of high-K gate dielectric candidate, by using optical spectroscopy. A high density of polycrystalline samples were synthesized by the solid state reaction method. The reflectivity spectra were measured in a wide photon energy region of 5 meV – 20 eV, and the optical conductivity spectra were calculated through the Kramers-Kronig transformation. The optical conductivity spectra revealed that the bandgap of $SrHfO_3$ is about 6.1 eV, and the charge transfer excitation is located at about 7 eV. The crystal field splitting energy between Hf 5d t2g and eg bands is estimated to be 5 eV, and the Sr 5s bands appears to be strongly mixed with the Hf 5d eg bands. These electronic properties of $SrHfO_3$ are compared with those of $SrTiO_3$ and $SrZrO_3$ in terms of the d-orbital characters for transition metals.

Dp-097 **Electronic Structure of Delafossite $PdCoO_2$ Observed by Angle Resolved Photoemission Spectroscopy** 노 한진, 정 진환, 정 진원, 김 성백[1], 김 형도[2], 김 주영[3], 조 병기[3](*전남대학교 물리학과.* [1]*포항공과대학교 물리학과.* [2]*포항가속기.* [3]*광주과학기술원 신소재공학과.*) The delafossite $PdCoO_2$ shows very peculiar physical properties. Though it forms a quasi-2 dimensional oxide and is expected to be a correlated system, its in-plane conductivity is very high, showing better conductivity than that of Pd metal at room temperature. To investigate the origin of the property, we have measured the electronic structure of the delafossite $PdCoO_2$ by angle resolved photoemission spectroscopy (ARPES). Different from the calculated band structure by the local density approximation method, three sheets of Fermi surface were observed by our ARPES measurements. Comparison of our results with the reported band calculation results will be presented.

Dp-098 **Reentrant Behavior in Orientational Ordering of Asymmetric Quadrupolar Quantum Rotors** 신 현덕, 권 용경(*건국대학교 물리학과.*) Due to competition between large rotational kinetic energy and highly-anisotropic intermolecular interaction, quantum solids of molecular hydrogen exhibit complex orientational order-disorder phase diagrams over a wide range of temperatures and pressures. Solids of asymmetric HD molecules whose nuclei are distinguishable, do not show orientational ordering at low pressures where almost all molecules are in the spherically-symmetric *J=0* rotational ground state because of the large rotational constant of ~ 64.3 K. At high pressures, however, higher rotational levels are mixed into the ground state due to the strong anisotropic intermolecular interactions and solid HD experiences the orientational ordering at low temperatures. At intermediate pressures, significant occupation of the nonzero rotational levels of HD occurs only when temperature is higher than a certain value. These results in peculiar reentrant shape in its pressure-temperature phase diagram. Since most of the anisotropic interaction between the hydrogen molecules can be accounted for by electric quadrupole-quadrupole interaction, we here consider a system of asymmetric quadrupolar rotors localized at face-centered cubic lattice sites. Using the path-integral Monte Carlo method which enables us to make a full quantum treatment of the rotational dynamics of the rotors, we find reentrant shape in their orientational order-disorder phase transition as observed experimentally in solid HD. For quantitative agreement with the experiments the fourth-order propagator is introduced for the high-temperature density matrices in the path-integral formalism.

Dp-099 **X-ray absorption study of electro-forming effect in**

epitaxial $SrZrO_3$ films doped with various Cr concentrations. OH S.-J., PARK W.G., CHO Su-Yeon(*CSCMR, Department of Physics and Astronomy.*) In order to make clear the electro-forming process in resistance random access memory (RRAM), Cr doped $SrZrO_3$ films (0, 0.1, 0.2, 0.3 and 0.5%) were deposited by Pulsed Laser Deposition(PLD) and investigated by using X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS). Focusing on behavior of Cr ion, we deduced the chemical state change on the surface during electro-forming process. Also as increasing Cr concentration, we try to find how Cr ion can influence to the chemical state change in electro-forming process. We found that Cr ions on the surface play an important role to creat new states below Fermi energy where electrons can act as a carrier.

Dp-100 **Ferroelectric and dielectric properties of (Na,K)NbO_3 thin films** 김 일원, 안 창원[1], 홍 경수[1], 김 현규[1], 정 의덕[1], 이 해준, 이 선영(*울산대학교, 물리학과.* [1]*한국기초과학지원연구원, 하이테크부품소재연구지원센터.*) The $Na_{0.5}K_{0.5}NbO_3$ (NKN) thin films were successfully deposited on Pt/Ti/SiO_2/Si(100) substrate using chemical solution deposition. To compensate the alkaline metals loss during thermal annealing, 0 ~ 30 mol% excess amount of Na and K compositions were added to the NKN precursor solutions. The NKN thin films fabricated from stoichiometric precursor solution display high leakage current and leaky P-E hysteresis loops because of high volatility of sodium and potassium. Appropriate excess of Na and K to NKN precursor solution was found to be effective for single-phase perovskite thin films with enhanced leakage current properties. The 20 mol% excess of Na and K was determined to be an optimized amount for good ferroelectric P-E hysteresis loops with remanent polarization ($2P_r$) ~ 20 $\mu C/cm^2$ and coercive field (E_c) ~ 30 kV/cm at an applied electric field of 200 kV/cm. Moreover, this optimized NKN capacitor did not exhibit any significant fatigue up to 1×10^{10} switching cycles at a frequency of 1 MHz.

Dp-101 **강유전 박막에서의 스위칭 속도** 송 태권, 조 종호(*창원대학교, 나노신소재공학부.*) 최근 강유전체 박막의 강유전 스위칭에 대한 연구에서, 상부 전극이 있는 상태에서도 압전력 현미경(PFM, Piezoelectric Force Microscope)를 이용하여 아주 미세한 스위칭 특성을 연구하는 방법이 보고되고 있다. 이 방법은 기존에 상부 전극 없이 PFM을 이용하여 측정하는 방법에 비하여 일정한 전기장이 가해지는 조건이 이루어지기 때문에 기존의 스위칭 이론과의 관련성을 연구할 수 있는 방법을 제시하고 있다. 강유전 스위칭 이론들은 주로 강유전 스위칭 속도가 일정하다는 전제로 이루어졌으나 실제 실험에서는 강유전 분극의 크기에 따라 스위칭 속도가 달라진다. 강유전 도메인의 크기에 따른 강유전 스위칭 속도의 변화를 도메인 형성에 대한 열역학적 에너지와 수정된 Landau-Khalatnikov 방정식을 이용하여 계산하여 실험결과와 잘 일치하는 것을 알 수 있었다. 강유전 도메인의 모양은 실험 결과를 바탕으로 실린더 모양으로 가정하였고 이와 관련된 정전기적에너지와 도메인 벽의 에너지를 고려하였다. 그 결과 강유전 스위칭 속도가 도메인의 반경에 반비례하는 것을 알 수 있었으며 계산된 스위칭 속도의 크기가 실험결과와 잘 일치하는 것을 알 수 있었다. 이 결과로부터 PFM을 이용한 강유전 스위칭 연구가 이론적인 배경과 잘 맞으며 유효한 방법임을 알 수 있었다.

Dp-102 **비납계 압전재료 (K,Na)NbO_3의 A-위치 비화학양론 영향** 송 태권, 이 성찬, 여 홍구, 조 종호, 성 연수, 김 명호(*창원대학교, 나노신소재공학부.*) 비납계 압전 재료 후보 물질인 $(K_{0.5}Na_{0.5})NbO_3$ 세라믹의 A-위치 부족 및 과잉 효과에 대하여 살펴보았다. A위치에 해당되는 알칼리 금속 K나 Na의 경우 원료물질이 습기를 잘 흡수하여 정확한 화학양론을 조절하기 힘들다. K와 Na의 동시 부족 혹은 과잉 세라믹 시료를 고상반응법을 이용하여 제조하여 구조분석, 상온에서의 강유전 이력곡선, 압전 특성, 누설 전류 특성, 온도에 따른 유전상수를 측정하여 분석하였다. 상온에서의 압전 특성이, 1 몰% 과잉일 때 가장 좋은 특성을 보였다. 이러한 특성의 향상은 상온에서의 정방정/사방정 다형 상전이(PPT, Polymorphic Phase Transition)와 밀접하게 관련되어 있음을 알 수 있었다. 그리고 온도에 따른 유전 특성이 분극 처리 과정과 아주 밀접히 관련되어 있음을 관찰하였다. 그런데 PPT를 이용한 압전 특성의 향상은 압전 특성의 온도 의존성에 문제가 발생할 수 있다. 그러므로 압전 특성을 향상과 온도 안정성을 확보하기 위한 방법에 대하여 논의한다.

Dp-103 **집속 이온 빔 방법을 이용한 YBCO 나노 브릿지의 제작과 특성 연구** HONG Sung Hak, CHANG Jung Won, LEE Soon-Gul(*Korea University.*) 본 실험에서는 YBCO 나노 브릿지를 집속 이온빔 방법 (Focused Ion Beam)으로 제작하고, 그 특성에 관해 연구하였다. 상기 실험에 사용된 YBCO 박막은 150~300nm 두께로 펄스 레이저 증착법을 이용하여 제작하였으며, 포토리지스트 마스크와 Ar 이온 밀링 식각법을 사용하여 3~4μm 선폭으로 가공하였다. 나노 브릿지는 집속 이온빔 방법을 통해 다양한 형태의 두께, 너비, 길이 등으로 가공하였으며, Ga+ 빔으로 YBCO 패턴의 중앙에 제작하였다. 이때 사용된 빔의 가속에너지는 30eV, 빔전류는 30pA 내지 10pA 였다. 제작된 나노 브릿지의 전류-전압 특성과, 온도 변화에 따른임계전류의 변화 및 표준상태 저항 등을 측정하였으며, 일관성 없는 다양한 임계 특성을 보였다. S-I-S 접합의 특성 혹은 S-N-S 접합의 특성을 나타내는 것이 있으며, 또 어떤 것은 박막의 특성을 보이기도 하였다. 이러한 나노 브릿지의 다양한 특성들은 박막의 형상(Morphology), 특히 자연 결정 경계면에 의해 크게 달라지는 것으로 보인다.

Dp-104 **Role of Non-parquet diagrams in the Parquet graph Resummation Method for Two-dimensional Vortex Liquids** PARK Hyunjoon, YEO Joonhyun(*건국대학교 물리학과.*) We study the role of the non-parquet diagrams in a nonperturbative approach called the parquet graph resummation method for studying correlations in a two-dimensional vortex liquid. As an analytic approach, the parquet graph resummation method captures the growing crystalline order in the vortex liquid as the temperature decreases. For its systematic improvement, it is important to understand the effects of the non-parquet diagrams, which are neglected in a usual approximation. The contribution of the non-parquet diagrams can be summarized into the non-parquet vertex function that appears in the lowest Landau level formalism of the Ginzburg-Landau theory of a superconductor in a magnetic field.

We find that, as the temperature decreases, the non-parquet vertex develops minima at positions of the reciprocal lattice vectors of a triangular lattice where peaks grow in the structure factor of a vortex liquid. By solving the parquet equations for various forms of the non-parquet vertex, we analyze the effects of the minima in the non-parquet vertex on the positions and the sizes of the peaks in the structure factor.

Dp-105 **Fabricating MgB_2 Thin Films On a Various Buffer Layer by Using HPCVD System.** PARK Se-Won, SEONG WonKyung, JUNG Soon-Gil, KANG WonNam(*Department of Physics, Sungkyunkwan University.*) We have fabricated MgB_2 thin films by using the hybrid physical-chemical vapor deposition (HPCVD) method on Al_2O_3 (0001) substrates with a various buffered layer. Firstly, we have deposited Ni, Ti, and SiC on Al_2O_3 substrates for the growth of buffered layer by using pulsed laser ablation. The deposition time of buffered layers was 1, 2, 5, 10 min, respectively. And then the MgB_2 thin films have grown by the HPCVD system at 460℃ for 10min. The pure Mg pieces (99.999%) and the diborane gas (5% B2H6 in H2) have been used as the Mg and the boron sources. The as-grown MgB_2 thin films showed superconducting transition temperatures of about 39–40 K with a sharp transition width, ~ 0.2–0.4 K. The superconducting transition temperatures of these samples were obtained from the resistivity measurements as a function of temperature by four-probe method.

Dp-106 **Non-Hermitian vortex systems with two-dimensional quasiperiodic structures** 조 영권, 김 기홍(*아주대, 에너지시스템학부.*) We study the effect of a constant imaginary vector potential on two-dimensional superconducting vortex systems with quasiperiodically arranged pinning centers. Due to the imaginary vector potential, our Hamiltonian becomes non-Hermitian and its energy eigenvalues are complex-valued in general. We investigate the superconducting transition, the energy spectrum and the energy eigenfunctions for the 2D quasiperiodic vortex systems. In the one-dimensional quasiperiodic case, we have found the bubble-like energy spectrum which shows the Cantor set structure depending on the strength of the non-Hermitian field. In particular, we have confirmed the existence of a localization transition in the presence of the Rudin-Shapiro quasiperiodic potential. We generalize these results to 2D and compare the results with 2D random cases and with 1D quasiperiodic cases.

Dp-107 **Study of critical temperature distribution in YBa2Cu3O7 coated conductor using low temperature scanning laser microscopy (LTSLM)** KIM MaengJun, PARK sangkook, RI hyeongcheol(*경북대학교 물리학과.*) Low temperature scanning laser microscopy (LTSLM) can be used for a two-dimensional display of various sample responses arising from the localized excitation. As shown in many experiments, LTSLM becomes particularly interesting when applied to superconductors. By using the YBa2Cu3O7 coated conductor, we have measured the distribution of the critical temperature. We suspected the shorter once exposed laser beam time constant , the better signal to noise ratio we can get with eliminating whole substrate heating effect. We modified laser beam configuration by adopting maximum 3kHz modulated laser beam which is produced by mechanical opto chopper as needed .

Dp-108 **Study of magnetic field profiles in striated YBa2Cu3O7 coated conductor using scanning Hall probe microscopy** LEE sangbong, RI hyeongcheol(*경북대학교 물리학과.*) A scanning Hall probe microscope has been used to map the distribution of magnetic flux in YBa2Cu3O7 coated conductor's strips carrying transport of magnetization currents at 77K. Both shielded and trapped field were studied as a function of applied field and transport current. The results of Hall probe magnetic measurements were used in the inverse calculation to obtain the current distribution across the filaments.

Dp-109 **Growth of superconducting $Bi_2Sr_2Ca_2Cu_3O_{10+x}$ (Bi-2223) single crystal whiskers** SAINI Shrikant, KIM Sang-Jae(*Dept. of Mechatronics Engineering, Cheju National University, Jeju 690-756, Korea.*) We are reporting at first electric properties of $Bi_2Sr_2Ca_2Cu_3O_{10+x}$ (Bi-2223) single crystal whiskers. We prepared $Bi_2Sr_2Ca_2Cu_3O_{10+x}$ (Bi-2223) single crystal whiskers from precursor of $Bi_2Sr_2Ca_2Cu_{2.5}Te_{0.5}O_x$ using solid state reaction method. Te is used to enhance the growth of whiskers. We used 99.9 % pure powder of Bi_2O_3, $SrCO_3$, $CaCO_3$, CuO and TeO_2 to prepare our precursor. We mixed them and calcinated in air at 760 degree for two times and at 820 degree for one time. The calcinated powder pressed into a pellet. The precursor pellet heated at 880 degree for 100 hours and rapidly quenched. Before the process we heated the pellet at 890 degree for 15 minutes then cools in 30 minutes down to 880 degree. During the process we used oxygen atmosphere with constant flow of 150 ml/min and found micro-scale whiskers on the surface of pellet. We considered important processing parameters to grow high quality whiskers as annealing temperature, Te doping and the addition ratio of Ca and Cu. We measured resistance (R) - temperature (T) characteristic and found critical transition temperature (T_c) at 101 K, with the transition width of 6 K. The R-T characteristic also shows metallic dependence of temperature above T_c. The sharp and single phase transition in R-T curve indicates the growth of high crystalline whiskers. Critical current density in current (I) - voltage (V) characteristic is $1.5x10^3$ A/cm^2 at 100 K. We will report the growth conditions for growing high crystalline whiskers with single phase transition and *c*-axis transport properties in Bi-2223 whisker.

Dp-110 **Relationship Between Superfluid Density At Zero Temperature And T_c Of $Bi_2Sr_{2-x}La_xCuO_{6+d}$ (0.4 <x <0.76) And $Bi_2Sr_{1.6}La_{0.4}Cu_{1-y}Zn_yO_{6+d}$ (0.0 <y<0.015)** KIM G. C., PARK Insuk, KIM Y. C.(*Department of Physics, Pusan National University, Busan 609-735, Korea.*) We have studied the relationship between superfluid density at zero temperature, $rho_s(0)$, and superconducting transition temperature, T_c, for the underdoped $Bi_2Sr_{2-x}La_xCuO_{6+d}$ and nearly optimally-doped $Bi_2Sr_{1.6}La_{0.4}Cu_{1-y}Zn_yO_{6+d}$, using iso-

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thermal reversible magnetization. In our study, we found that $rho_s(0)$ in $Bi_2Sr_{2-x}La_xCuO_{6+d}$ and $Bi_2Sr_{1.6}La_{0.4}Cu_{1-y}Zn_yO_{6+d}$ are proportional to T_c^2, which is nearly in agreement with the relation suggested from the quantum criticality.

Dp-111 **서브 마이크로미터 패턴 Nb 박막의 임계특성**
KIM Yun Won, LEE Soon-Gul, CHOI Jae-Hyuk[1], KAHNG Yung Ho[1](*Korea University, Jochiwon, Chungnam 339-800, Republic of Korea.* [1]*Quantum Physical Metrology Center, Division of Physical Metrology, KRISS, Daejeon 305-340, Korea.*) 본 연구에서는 서브마이크로미터 패턴된 Nb 박막의 임계특성에 대하여 연구하였다 Nb 박막은 Si 기판 위에 e-beam lithography 방법으로 선폭 50nm 에서 5000nm 범위의 Nb bridge 를 패턴 작업하고, DC 마그네트론 스퍼터링 방법을 사용하여 각각 선폭에 대해 두께 5nm 에서 150nm 범위의 Nb 박막을 제작하였다. 제작된 박막은 전기적 특성인 임계온도(T_c), 임계전류 밀도(J_c)를 측정 하였다. 주어진 한 두께에 대한 임계온도(T_c)는 박막의 선폭이 두꺼워 질수록 급격하게 증가하다가 임계 선폭 이상에서는 일정한 값을 보였다. 임계온도(T_c) 가 일정해 지는 임계 선폭 이상에서는 선폭이 증가할수록 임계온도(T_c)는 감소하였다. : 임계온도(T_c)가 일정해지는 선폭은 두께가 20nm일때는 2000nm 였고, 두께가 150nm 일 때는 500nm였다. 박막의 두께가 50nm 인 경우의 일정해진 임계온도(T_c)는 Nb 벌크의 임계온도(T_c)와 비슷한 값을 보였다. 임계전류밀도(J_c)의 경우 어느 한 두께에 대하여 선폭이 두꺼워 질수록 급격하게 증가 하였으며, 최고 값에 도달한 이후 다시 감소하였다. 임계전류밀도의 최고 값은 박막의 두께가 두꺼워 질수록 감소 하였고, 두께 50nm 이상 선폭 200nm 에서 일정한 값을 가졌다. 가장 큰 임계전류밀도(J_c)는 두께 100nm 에서 확인할 수 있었다. 실험결과는 박막의 magnetic field penetration 과 edge profile 의해 설명되며, 이 결과는 서브마이크론 라인을 기본으로 하는 초전도 전자 소자의 분석과 디자인에 유용할 것이다.

Dp-112 **Distribution of Switching Currents in Intrinsic Josephson Junctions of $Bi_2Sr_2CaCu_2O_{8+x}$** 이 길호, 박 정환[1], 김 정구[1], 이 후종(*포항공과대학교 물리학과.* [1]*서울대학교 물리학과.*) Macroscopic quantum phenomena are expected in a current-biased Josephson junction. According to the Stewart's resistively and capacitively shunted junction (RCSJ) model, the dynamics of Josephson junctions can be described by the motion of a phase particle in a tilted washboard potential. The tunneling of a phase particle from the washboard potential was successfully observed in Josephson junctions consisting of conventional low-critical-temperature superconductors. This macroscopic quantum tunneling (MQT) phenomena were also observed in high-T_c superconducting Bi-2212 intrinsic Josephson junctions consisting of electrodes with the *d*-wave symmetry. Apparently the presence of the dissipative quasiparticle excitation near the zero-gap nodes in the momentum space does not fully suppress the phase-coherent quantum-tunneling phenomena in the intrinsic Josephson junctions. In this study, we measured the distribution of switching current in $Bi_2Sr_2CaCu_2O_{8+x}$ intrinsic Josephson junctions (IJJs) down to 90 mK to examine the existence of the crossover from the thermal activation of the phase particle over the washboard potential barrier to the MQT through the barrier. In our observation, the distribution of switching current gets narrower with lowering temperature down to about 1 K and then is saturated at further lower temperature. Saturated distributions fit to MQT theory well with same fitting parameters of thermal activation region.

Dp-113 **Electronic Structure Study of Cu Doped 2H-TiSe2 by Angle-Resolved Photoemission Spectroscopy** 노 한진, 정 진원, 정 진환, 김 성백[1], 김 형도[2], 김 주영[3], 조 병기[3](*전남대학교 물리학과.* [1]*포항공과대학교 물리학과.* [2]*포항가속기.* [3]*광주과학기술원 신소재공학과.*) Recently the Cu-doped 2H-TiSe2 has been paid much attention to because it shows superconductivity when Cu is doped or intercalated into the layered structure. To reveal the role of the Cu atoms, we synthesized single crystals of TiSe2 with various range of Cu concentration, and have performed angle-resolved photoemission spectroscopy (ARPES) experiments. The measured ARPES data reveal that the system undergoes a phase transition, which has been believed to be induced by charge density wave (CDW), at around 200 K. As Cu is doped into the system, electron pocket appears around gamma point and the transition-induced peak in ARPES fades out. A discussion about the role of the intercalated Cu atoms will be presented.

Dp-114 **Josephson Vortex Dynamics in Out-of-plane Magnetic-Field Components** JIN YONG-DUK, KI DONG-KEUN, LEE HU-JONG(*Postech, Dept of Physics.*) Static and dynamic phases of pancake and Josephson vortices formed in cuprate high-Tc superconductors have been studied extensively. Especially, the dynamic phase of Josephson vortices shows a variety of characteristics such as a resonance with discrete plasma modes or the dynamic phase separation due to the inductive interlayer coupling and interaction of Josephson vortices with Josephson plasma waves. In contrast to the in-depth studies carried out for the resonance between the Josephson vortices and the discrete plasma modes, both theoretical and experimental [1,2,3], the dynamic phase separation has been suggested only theoretically [3] without enough experimental confirmation.In this study, we investigated c-axis tunneling current-voltage characteristics of stacks of Bi2Sr2CaCu2O8+x intrinsic Josephson junctions in varied magnetic fields applied slightly tilted from the in-plane direction, which resulted in the coexistence of Josephson and pancake vortices. The tilt angle was varied within 1 degree in both positive and negative directions from the in-plane position. Above 2 T, in addition to the quasiparticle branches, a new set of branches referred to as the flux-flow branches (FFBs) appear. The FFBs possess a few characteristics; 1) FFBs reveal themselves in a high-enough in-plane magnetic field, indicating that they are caused by the Josephson vortex dynamics. 2) The number of FFBs almost coincides with the number of junctions. 3) FFBs are suppressed with increasing magnetic field in a tesla range. 4) FFBs become more prominent as more pancake vortices are introduced by tilting the field angle. 5) Features of FFBs are weakened with increasing temperature and completely disappear above 35 K. All of these features can be explained in terms of the dynamic

phase separation model along with the in-plane dissipation due to pancake vortex motion taken into account. [1] R. Kleiner, Phys. Rev. B 50, 6919 (1994).[2] M. Machida, T. Koyama, A. Tanaka, and M. Tachiki, Physica C 330, 85 (2000).[3] M.-H. Bae and H.-J. Lee, Phys. Rev. B. 75, 214502 (2007).[4] A. E. Koshelev and I. S. Aranson, Phys. Rev. Lett. 85, 3938 (2000); A. E. Koshelev and I. S. Aranson, Phys. Rev. B 64, 174508 (2001).

Dp-115 **S/F 다층막 구조에서 Py 자성층의 자구 안정에 따른 초전도 전이온도와 자기저항의 변화** 황 태종, 김 동호(*영남대학교 물리학과.*) F/S/F 구조와 AF/F/S/F 구조의 초전도 전이온도와 자기저항 변화를 자성층의 자구 안정과 관련지어 조사하였다. 두 구조의시편은 D.C. magnetron sputtering 증착법으로 제작하였고, 스트립 형태로 패턴된 편은 길이방향으로 자화 용이축이 정렬되게 진공중에서 자기장을 인가하면서 열처리하였다 두 자성층이 서로 반대 방향으로 정렬된 반평행 상태에서 두 구조의 자기저항의 변화를 비교하였으며, 반평행 상태에 해당하는 자기장하에서 두 구조의 초전도 전이온도의 변화를 조사하였다두 자성층의 자화가 평행 상태와 반평행 상태일 때를 비교하면, 평행 상태에서 F/S/F 구조는초전도 전이온도의 증가를 나타내나 AF/F/S/F 구조는 반평행 상태에서 초전도 전이온도의 증가를 보였다. 자기저항의 변화와 초전도 전이온도의 변화를 두자성층에서 발생되는 자구벽의 생성, 소멸 그리고 자성층의 안정과 관련지어 설명하였다.

Dp-116 **Possible Observation of a Spin-triplet Supercurrent in Superconductor/Ferromagnet Hybrid Structure** KI Dong-Keun, LEE Hu-Jong[1](*POSTECH, Department of Physics.* [1]*POSTECH, Department of Physics and National Center for Nanomaterials Technology.*) Since a spin-singlet superconductor (SC) and a ferromagnet (FM) have ground states with conflicting spin configurations, the superconducting order in a FM in proximity contact with a SC is bound to be suppressed. However, a rather long-range proximity effect has been observed in a metallic FM of a SC/FM junction. Recently, the possible formation of long-range spin-triplet pairing at the SC/FM interface has also been claimed. In this study, we examined the superconducting proximity effect in a specific Nb/Py/AlO_X/Co/AlO_X/Py/Nb geometry where the magnetizations of permalloys (Py's) and Co are not collinear. In this non-collinear magnetization configuration, the m=0 spin-triplet superconducting order induced in one side of Nb/Py interface becomes long-ranged over the 20-nm-thick Co and connected to the m=1 spin-triplet superconducting order in the other side of Nb/Co interface. We observed the existence of the supercurrent through the above-structured junction, which strongly suggest the induction of a spin-triplet superconductivity at an interface between a spin-singlet superconductor and a ferromagnet. We also observed Fraunhofer-like interference behavior of the supercurrent in a planar directional external magnetic field. All these strongly suggest the direct confirmation of the triplet superconductivity at a SC/FM interface.

Dp-117 **Multi-layer deposition of high-Ic YBCO coated conductors by reel-to–reel PLD method** KO R.K., KIM H.S., HA H.S, SONG K.J., HA D.W., OH S.S., SOHN M.H., PARK C.[1], MOON S.H.[2](*Korea Electrotechnology Research Institute.* [1]*Seoul National University.* [2]*Superconductor, Nano and Advanced Materials Corporation.*) High temperature superconductors (HTS) offer a great promise for electrical power applications, most of which require flexible, long lengths of HTS coated conductors capable of carrying high currents in presence of magnetic fields.PLD technique is one of the most popular and versatile process for the deposition of oxide superconducting films. In this study, we summarized fabrication of YBCO coated conductor continuously by reel-to-reel PLD method on IBAD_MgO template and characterized in KERI. $LaMnO_3$/CeO_2 and $LaMnO_3$ were also deposited by PLD on IBAD_MgO template as cap layer respectively. We obtained 200A/cm_width over high Ic YBCO coated conductors. The results will be presented together with the detailed manufacturing processing.This research was supported by a grant from Center for Applied Superconductivity Technology of the 21st Century Frontier R&D Program funded by the Ministry of Science and Technology, Republic of Korea.

Dp-118 **Anisotropy of Current Density In Low Angle Bi-crystal YBCO Under Oblique Magnetic Fields.** 정 예현, 유 재은, 고 락길[1], 염 도준(*KAIST, 물리학과.* [1]*KERI 초전도재료그룹.*) Critical current density, Jc, of YBCO thin film was measured under various oblique magnetic fieldat 77K. The angle varied from 90° to -90° with respect to ab-plane. YBCO thin film was deposited on bi-cryatal STO substrates using Pulsed Laser Deposition in KERI. Then the Ag stabilizer was sputtered on YBCO film. The thickness and size of thin film were about 400nm and 5mm x 10 mm. The film crystallinity, composition ratio and morphology were examined by XRD, EDS, SEM. The angle of misorientations were 5°, 7° and 12°. The angle vs Jc reveal the angular dependence of bi-crystal YBCO having single josephson junction which is analogous to single grain boundary of coated conductor(CC). We try to explain transport property and mechanism of CC having multi-grain network from bi-crystal data numerically.

Dp-119 **Mechanical Characteristics of Single dsDNA Elasticity Studied by Atomic Force Microscopy** NGUYEN T. H., KIM Y. U.[1], CHOI S. S.[2](*Department of Physics and Nanoscience, Sun Moon University, Asan, Korea.* [1]*Department of Biology, Sun Moon University, Asan, Korea.* [2]*Department of Physics and Nano-Science, Sun Moon University, Asan, Korea.*) The physical and structural properties of single double-stranded deoxyribonucleic acid (dsDNA) molecules (2.9 kb) are investigated by atomic force microscopy (AFM). The DNA sample is prepared on the gold substrate treated by alkythiol linkers which can attach the 5' end of DNA for the investigation. In order to examine the elasticity and the structure transformation of a single DNA moplecule, the force versus distance (F-D) curves between AFM tip which is treated by biotin molecules and DNA are measured in DI water. As the functionalized is brought closed to the DNA end, the biotin molecule on the tip will

bind with 3' end of DNA covalently. During retracting the tip away from the surface, this binding allows dsDNA being stretched. This retraction part of the force curve gives information about structural characteristics of the dsDNA molecules. The transition of the twisted (B-form) to the untwisted (S-form) molecule is obtained right after the tip jump out of the surface. The next zigzag signal where the force increases abruptly is attributed to the melting transition from double stranded to single stranded DNA. The curve between final melted and the ruptured points is attributed to the stretching of single stranded DNA. However, we observed only about 20% F-D curves which contain the detailed mentioned structures, and the remained experiments shown the forces increase regularly in the area between the snap-out point and the final rupture point. This is due to the dsDNA stretching which is used for analyzing Young's modulus and persistence length of the dsDNA. The obtained results are agreeable with other published data. The mechanism of dsDNA structural transition and the elasticity properties will be described in detail.

Dp-120 **Physical Properties of Saccharomyces Cerevisiae Studied by Atomic Force Microscopy** BUI V.C., KIM Y.U.[1], KIM D.W., CHOI S.S.(*Sunmoon University, Department of Physics and Nanoscience.* [1]*Sunmoon University, Department of Biology.*) We have investigated the mechanical properties of the surrounding cell walls of the wild type and mutant type of the Saccharomyces cerevisiae yeasts by using atomic force microscopy (AFM). The yeast cells were mechanically trapped in the porous membranes for the measurements. In order to examine the elasticity of these biological samples, the force versus distance curves between an AFM tip and the yeast cells as well as between an AFM tip and the glass substrate were measured in DI water. The difference between the slops of the force curves measured on hard glass substrate and on soft yeast samples showed the deformation of the yeast cells, i.e., how much the AFM tip indented the yeast. The slops in approach parts of the force curves were then converted into force versus indentation curves which would be fitted with Hertz-Sneddon model for the calculation of the elasticity. Analysis of the curves indicates that the Young's modulus value of the wild type yeast is greater than that of the mutant type yeast. The detailed explanation for Young's modulus calculation based on the force curves will be discussed.

Dp-121 **Study of Optical Torque acted on Irregularly Shaped Micro-size Objects with Form Birefringence using an Optical Tweezers** HA Chungil, KIM Kipom[1], PAK Hyuk Kyu(*Department of physics, Pusan National University, Busan, 609-735, Korea.* [1]*Materials Department, University of California, Santa Barbara, CA 93106, USA.*) In recent years, optical tweezers based on laser-intensity optical gradient force has been used as an attractive tool for trapping and manipulating micro-size objects in a three dimensional space. Here, we demonstrate how optical force, in association with the polarization of the light, can give rise to rotate irregularly shaped micro-size biological objects, such as bacteria and red blood cells, with the property of form birefringence (not chemical birefringence) trapped by optical tweezers. We present a simple discussion to explain the observed rotational motion of the irregularly shaped micro-size biological objects. Form birefringence determined by the object's geometrical form and the relative index of refraction between the object and the background fluid, interact with the polarization of the 1064nm laser beam, resulting in the optical torque exerted on biological objects without any optical damage.

Dp-122 **A Study of the Phase Transitions and Proton Dynamics of the Superprotonic Conductor $Cs_5H_3(SO_4)_4{\cdot}0.5H_2O$ Single Crystal with ^1H and ^{133}Cs Nuclear Magnetic Resonance** 임 애란(*전주대학교, 과학교육과.*) The phase transitions and proton dynamics of $Cs_5H_3(SO_4)_4{\cdot}0.5H_2O$ single crystals were studied by measuring the NMR line shape, the spin-lattice relaxation time, T_1, and the spin-spin relaxation time, T_2, of the ^1H and ^{133}Cs nuclei. The "acid" protons and the "water" protons in $Cs_5H_3(SO_4)_4{\cdot}0.5H_2O$ were distinguished. The loss of water protons was observed above T_{C1}, whereas the content of water protons was found to recover above T_{C2}. Therefore, the water protons play a special role in the stability of the superprotonic phase at high temperatures. The mechanism of fast proton conduction was found to consist of hydrogen-bond proton transfer involving the breakage of the weak part of the hydrogen bond and the formation of a new hydrogen bond. Thus these structural phase transitions probably involve significant reorientation of the SO_4 tetrahedra and dynamical disorder of the hydrogen bonds between them.

Dp-123 **A Study of the Electric Quadrupole Raman Processes of the Proton Conducting $KHSeO_4$ and $KDSeO_4$ Single Crystals using ^1H, ^2H and ^{39}K NMR** 임 애란, 윤 춘섭[1](*전주대학교, 과학교육과.* [1]*한국과학기술원, 물리학과.*) The spin-lattice relaxation time, T_1, and the spin-spin relaxation time, T_2, of the ^1H, ^2H, and ^{39}K nuclei in $KHSeO_4$ and $KDSeO_4$ crystals were determined in the temperature range 160–420 K. The T_1 of the ^{39}K nuclei in the two crystals were found to decrease with increasing temperature, and the spin-lattice relaxation rate, T_1^{-1}, for ^{39}K is proportional to T^k. In the case of $KHSeO_4$, T_1^{-1} for the ^{39}K nuclei was found to have a very strong temperature dependence, i.e., it is proportional to T^7. The temperature dependence of the ^{39}K relaxation rate in $KDSeO_4$ is in accordance with a Raman process, as T_1^{-1} α T^2. Thus, for the ^{39}K nuclei in the two crystals, Raman processes with k=2 and 7 is due to the coupling of electric quadrupole moments to the thermal fluctuations of the local electric field gradients.

Dp-124 **Phase Transition Mechanisms of $[N(C_2H_5)_4]_2BCl_4$ and $[N(CH_3)_4]_2BCl_4$ (B=^{63}Cu and ^{67}Zn) Single Crystals Studied by Proton NMR** 임 애란, 임 계영[1](*전주대학교, 과학교육과.* [1]*한국기술교육대학교, 지식기반에너지대학원.*) The proton line widths and spin–lattice relaxation rates in $[N(C_2H_5)_4]_2BCl_4$ (hereafter called $[TEA]_2BCl_4$, where B=^{63}Cu and ^{67}Zn) and $[N(CH_3)_4]_2BCl_4$ (hereafter called $[TMA]_2BCl_4$) single crystals were investigated in

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the temperature range 150–430 K. Our experimental results showed that the relaxation rates of $[TEA]_2CuCl_4$ and $[TMA]_2CuCl_4$ differ from those of $[TEA]_2ZnCl_4$ and $[TMA]_2ZnCl_4$. In the case of $[TEA]_2ZnCl_4$ and $[TMA]_2ZnCl_4$, the maximum of the spin–lattice relaxation rate is attributed to the molecular motions of ethyl and methyl groups in the respective $[TEA]^+$ and $[TMA]^+$ ions. The NMR line widths indicate that the ethyl groups in the $[TEA]_2BCl_4$ compounds have an additional degree of freedom compared to the methyl groups in the $[TMA]_2BCl_4$ compounds. The differences in the ^1H spin–lattice relaxation rates among the members of the series may be due to differences in the electronic structures of the metal ions, in particular the structure of the *d* electrons, which screen the nuclear charge from the motion of the outer electrons. Also, the ^1H spin–lattice relaxation behavior in the Cu-based compound is driven by fluctuations of the dipolar magnetic field from the Cu^{2+} ion, and is dominated by Cu spin fluctuations.

Dp-125 **A Study of the Phase Transitions and Structural Chemistry of $CsH_3(SO_4)_2$ and $Cs_3H(SO_4)_2$ Single Crystals using ^1H and ^{133}Cs NMR** 임 애란, 봉 필훈, 김 선하[1](*전주대학교, 과학교육과.* [1]*한국기초과학지원연구원*) The ^1H and ^{133}Cs spin-lattice relaxation rates of $CsH_3(SO_4)_2$ and $Cs_3H(SO_4)_2$ single crystals grown using the slow- evaporation method were measured using FT nuclear magnetic resonance (NMR) near the temperatures of new phase transitions identified by differential scanning calorimetry (DSC) measurements. DSC disclosed successive phase transition temperatures 320 K (T_{C1}), 420 K (T_{C2}), and 496 K (T_{C3}). The spin-lattice relaxation time, T_1, of ^1H in $CsH_3(SO_4)_2$ crystals below T_{C3} exhibited a maximum, indicating distinct molecular motion according to the Bloembergen–Purcell–Pound (BPP) theory. The crystal in the high-temperature phase of T_{C2} exhibited the characteristics of a liquid-like fast ionic conductor. Although the results for ^1H relaxation provide no evidence of the phase transition at T_{C1}, the ^{133}Cs relaxation changed abruptly at T_{C1} and T_{C2}. This means that the T_1 values for the ^1H and ^{133}Cs nuclei depend on their local environments. Furthermore, the change in the splitting of the Cs resonance line at T_{C1} and T_{C2} is associated with the change in local symmetry at the Cs site. In conclusion, the new phase transition of a $CsH_3(SO_4)_2$ crystal is accompanied by slight rotations of sulfate atoms and by a slight distortion of the lattice in the neighborhood of the Cs^+ ions. These results are compared with those obtained for other $Cs_3H(SO_4)_2$ crystals, that have similar hydrogen-bonding structures.

Dp-126 **A Nuclear Magnetic Resonance Study of the Ferroelastic Phase Transitions of $K_3Na(CrO_4)_2$ and $K_3Na(SeO_4)_2$ Single Crystals** 임 애란, 한 희정(*전주대학교, 과학교육과.*) Nuclear magnetic resonance (NMR) measurements were carried out for $K_3Na(CrO_4)_2$ and $K_3Na(SeO_4)_2$ crystals over a range of temperatures. Two and three groups were observed in the ^{23}Na spectra of $K_3Na(CrO_4)_2$ and $K_3Na(SeO_4)_2$ crystals, respectively, which were found to become one group at the ferroelastic phase transition temperature, T_{C1}; these transitions to one resonance line from two and three resonance lines are associated with the crystals' ferroelastic phase transitions. The changes in the spin-lattice relaxation times, T_1, for the ^{23}Na and ^{39}K nuclei in two crystals indicate that there is a structural phase transition from the trigonal phase to the monoclinic phase in these crystals at T_{C1}. Further, our results for the shifts in the resonance frequencies for the ^{39}K central resonance lines show that these ferroelastic phase transitions are accompanied by shifts of the two crystallographically independent K^+ cations, and mainly affect the environment of K(2), which is the most loosely bound cation in the crystal structures. We conclude that shifts of the oxygen atoms in the chromate and selenate groups around the Na and K atoms also play important roles in these phase transitions. Therefore, the ferroelastic phase transitions in $K_3Na(CrO_4)_2$ and $K_3Na(SeO_4)_2$ crystals at T_{C1}=239 K and T_{C1}=334 K, respectively, are accompanied by slight changes in the respective geometries of the CrO_4 and SeO_4 tetrahedra around the Na and K atoms.

Dp-127 **X-ray Reactive Hydrogels** CHANG Soeun, WEON Byung Mook, YEOM Junseok, HAHN Sei Kwang, JE Jung Ho(*POSTECH, Dep. Mater. Sci. &Eng..*) Phase transition triggered by external perturbation is quite important in diverse fields ranging from physics to chemistry, biomedicine, and materials science. We present the first evidence of X-ray-reactive transitions in hyaluronic acid-based hydrogels. The transition is triggered by a brief irradiation with hard X-rays (10-60 keV) and is attributed to the breakdown of crosslinking bonds by X-ray irradiation. Real-time synchrotron X-ray imaging provides direct and rheological evidence of a rapid gel-to-sol transition. X-ray irradiation offers the important advantage of high penetration, making it applicable to thick objects, opening up new and interesting technological opportunities.

Dp-128 **Direct Manipulation of Water Droplet Template for Microlens** WON Kyu Hwang, WEON Byung Mook, JE Jung Ho(*POSTECH, X-ray Imaging Center, Dept. Mater. Sci. &Eng..*) Water droplet template is an interesting soft mold for a potential protocol of polymer microlens in optoelectronics but its curvature control remains a challenge. We report a new approach to curvature control by manipulating water droplet size and position through a micropipette using real-time observation with synchrotron X-ray imaging. The real-time observation demonstrates evidence for a direct control of meniscus shape of polymer microlens. This approach may be used for a feasible, versatile protocol of water-assisted microstructure fabrication.

Dp-129 **Optoelectrical Properties of Hybrid Single Poly (3-methylthiophene) Nanowire with Au Nanoparticles** 김 기현, 박 동혁, 김 미숙, 배 상원, 김 미경, 주 진수(*고려대학교 물리학과.*) Poly (3-methylthiophene) (P3MT) 나노선이 전기화학 중합방법을 이용하여 Al_2O_3 template 안에서 합성되었다. 합성된 P3MT 나노선의 직경은 100~200 nm이며, Al_2O_3 template는 HF 혹은 NaOH 용액을 이용하여 제거하였다. 직경 3~5 nm의 Au 나노입자를 합성하여 P3MT 나노선에 흡착시켰다. P3MT 나노선에 Au 나노입자

가 흡착된 하이브리드P3MT/Au 나노선 한 가닥에top contact 방식으로 4-단자 전극을 제작하였다. 4-단자 전극 사이의 간격은 약 1 μm이며, 전자빔 리소그래피 (e-beam lithography)를 이용하여 제작하였다. P3MT 나노선과 P3MT/Au 하이브리드 나노선의 직류 전기전도도를 각각 측정하였으며, 직류 전기전도도의 온도 의존성 실험을 통하여 전하전달 특성을 분석하였다. 또한 P3MT 나노선과 P3MT/Au 하이브리드 나노선에300~600 nm의 파장을 가지는 빛을 조사하여 빛에 의한 전기적 특성 변화를 연구하였다.

Dp-130 **Synthesis and characterization of Poly sodium 4-styrenesulfonate (PSS) graphite oxide** 정 혜경, JIN Mei Hua[1], 이 윤표[1], 라 은주[1], 배 정준[1], 장 진호[1], 안 계혁[2], 박 종윤, 이 영희[3](*성균관 대학교 물리 학과CNNC.* [1]*성균관 대학교 물리 학과(BK21).* [2]*전주기계산업리서치센터.* [3]*성균관 대학교 물리 학과(BK21) CNNC.*) Poly sodium 4-styrenesulfonate (PSS) intercalated graphite oxide (GO) were synthesized and characterized by XRD, FTIR, XPS, SEM, and TGA. We have found that PSS was inserted between layers of GO and oriented in plane parallel to planes of GO as a single layer. However, there is no evidence of strong chemical bonding between PSS and GO from FTIR and XPS. Dielectric constant and capacitance of the composites in inorganic electrolyte were investigated and will be present.

Dp-131 **Slow Relaxation of Persistent Photoconductivity and Memory Effect in Organic Thin Film Transistors Using Soluble Star-shaped Molecule** 조 미연, 한 윤덕, 박 동혁, 김 경환[1], 최 동훈[1], 주 진수(*고려대학교, 물리학과.* [1]*고려대학교, 화학과.*) 용해되는 star-shaped 분자인 4(HPBT)-benzene을 이용한 유기 박막 트랜지스터를 제작하고, 전기 및 광 반응 특성을 연구하였다. 4(HPBT)-benzene을 이용한 광 트랜지스터는 낮은 세기의 광(6.8 ~ 30 μW/cm^2)에서도 높은 광 반응도를 보였고, 이러한 민감한 광 반응 특성을 사용하여 낮은 세기의 광과 낮은 게이트 전압을 이용하여 ~4×10^{4}의 높은 점멸비를 얻을 수 있었다. 광에 의해 유도된 전하들은 시간에 대한 매우 느린 완화시간을 보이게 되는데, 그 변화율은 처음에는 빠르게, 그리고 시간이 감에 따라 점차적으로 느려지는 형태의 stretched-exponential form (Kohlrausch's 법칙)을 따르게 된다. 드레인 전압과 게이트 전압을 변화시키면서 광에 의해 유도된 전하들의 완화시간의 변화를 살펴보고, 이러한 느린 완화시간을 보이는 지속적인 광 전도도를 이용하여 전기 및 광 유도 메모리 효과를 구현하였다.

Dp-132 **The Electrical Properties and Morphologies of the PVDF-TrFE Films on the Silicon by the Surface Treatment** LEE Gwang Geun, JEON Ho Seung, PARK ByungEun(*University of Seoul.*) PVDF (polyvinylidene fluoride) and its copolymer with TrFE (trifluorethylene) are representative ferroelectric polymers. Their ferroelectricity, piezoelectricity and pyroelectricity have been intensively studied for application in no-volatile memory in organic electronic devices. It was well known that, by adding a relatively small amount of TrFE to VDF, the PVDF-TrFE copolymer is able to acquire directly β-phase without additory processes such as heat-treatment, poling or mechanical drawing. On the silicon, however, it is difficult to obtain the β-phase of the PVDF-TrFE thin films by a sol-gel method. In this paper, we attempted to make the β-phase of the PVDF-TrFE on the silicon by the surface treatment. We made a comparative study of piranha, HMDS and no treatment of the silicon. According to the surface treatment, the electrical properties and morphologies of the PVDF-TrFE films on the silicon showed the different properties.

Dp-133 **White organic light emitting devices with blue and yellow emitting layers with effects of doping** 박 효영, 이 영구[1], 이 순일[2], 고 근하[2](*아주대학교, 에너지시스템 학부.* [1]*아주대학교, 영상표시전공.* [2]*아주대학교, 에너지시스템학부.*) We fabricated white organic light-emitting devices with deep-blue and yellow light-emitting layers (EMLs). A deep-blue EML was MADN doped with BD(blue dopant), and a yellow EML was either TBRb single doped or TBRb and Alq3 co-doped NPB. MADN, BD, and TBRb are 2-methyl-9,10-di(2-napthyl)-anthracene, bis-biphenyl-4-yl-[4-(2-[1,1';4',1'']terphenyl-4-yl-vinyl)-phenyl]-amine, and, 2,8-di(t-butyl)-5, 11-di[4-(t-butyl)phenyl]-6, 12-diphenylnaphthacene, respectively. Thickness of each EML and BD-doping concentration were systematically varied to optimize performance of two-EML white organic light-emitting devices (OLEDs) with a standard multilayer structure. Alq3 co-gest is expected to assist efficient transfer of energy from NPB host to yellow light-emitting TBRb dopants.

Dp-134 **Size effects in organic nanocrystals 3-methyl-4-methoxy-4'-nitrostilbene** RIM Min Ho, YOON Choon Sup, SEO Jung In[1], LEE Yoon Sup[1](*Dept. of Physics, KAIST.* [1]*Dept. of Chemistry, KAIST.*) The size effect in semiconductor and metal nanocrystals has been studied extensively and is now well understood. However, the size effect presented in the organic nanoparticles differs fundamentally from the quantum confinement effect observed in semiconductor and metal nanoparticles and the origin of the effect remains unknown. High quality nanocrystals of 3-methyl-4-methoxy-4'-nitrostilbene (MMONS) were fabricated using the reprecipitation method in conjunction with sonification. The quantum chemical calculation based on TDDFT method indicates that the configuration of hydrogen bonding and pi-electron stacking in MMONS crystals are the major factors to determine the characteristic absorption spectra of the MMONS nanocrystals, which affects the exciton confinement in the nano structure.

Dp-135 **Charge Storage Properties Of Nickel Disilicide Nanocrystals Embedded In Silicon Dioxide** JANG Yoo-Sung, YOON Jong-Hwan(*강원대학교, 물리학과.*) Nonvolatile memory (NVM) devices employing nanocrystal floating gates offer many advantages over conventional structures, and there are additional advantages in using metallic nanocrystals instead of semiconducting nanocrystals. In this study we report the direct growth of crystalline nickel disilicide ($NiSi_2$) nanocrystals (NCs) in silicon-rich silicon oxide (SiO_x) layers. The formation of a well-defined $NiSi_2$ NC monolayer was also demonstrated by depositing an ultra-thin Ni layer between two SiO_x layers. The latter structure is shown to exhibit char-

acteristic capacitance-voltage hysteresis suitable for memory applications. The large memory window of about 12V is observed for the silicon oxide layer of 10 nm thick containing $NiSi_2$ NCs.

Dp-136 **X-ray Microdiffraction Set-up for Nano Structures**
박 정웅, 안 석진, 구 양모, 천 정환[1], 김 동언[1](*포항공과대학교 신소재공학과.* [1]*포항공과대학교 물리학과.*) In nano science, for the past decades, the key issues have been moved from how to make well-defined nano structures to how to make the well established various applications such as light emitting diode, solar cell1, gas storage and so on. As one can notice from recent great success of protein related macro-molecule crystallography, the knowledge of the atomic arrangements in the crystalline compounds is a key point for the understanding and the enhancing of the chemical and physical properties. However, recent emerging functional materials have atomic order limited to the nanoscale and their atomic structures are often different from bulk's one. In addition, we often could not get the sufficient size for single-crystal diffraction from many newly synthesized materials.More and more new solids synthesize currently, as above mentioned, their structure remains still unknown. The synchrotron x-ray microdiffraction experiment that could solve the structure of very small single crystal. To determine atomic arrangements in nanostructure quantitatively and with high precision, I proposed synchrotron x-ray microdiffraction technique that X-ray diffraction with focused x-ray beam which is the size of 1 μm. The x-ray microdiffraction experiments was carried out to determine atomic structure of Cr-doped GaN nanowire (0.6 um x 0.6 um x 15 um). The synchrotron radiation from the 1B2 microprobe beam line at the Pohang Light Source (PLS) was used for the reflection Laue experiment. Developments of this technique would help to understand and enhance of new complex functional material which is hard to synthesize. In principle, if one can synthesize even only single powder, then one can determine its structure with accuracy of single-crystal diffraction by using x-ray microdiffraction.

Dp-137 **PLD법으로 증착한 투명 전도성 산화물 Al-doped ZnO 박막 위에 성장한 ZnO 나노결정** 이 수연, 채 종아[1], 배 종성[1], 윤 장희[1], 원 미숙[1], 김 종필[1](*한국기초과학지원연구원 부산센터 나노표면기술연구팀 부산대학 화학과.* [1]*한국기초과학지원연구원 부산센터 나노기술표면연구팀*) ZnO는 3.3 eV의 큰 직접전이 띠 간격 그리고 상온에서60 meV의 큰 엑시톤 결합에너지의 소재로서 광전자 응용을 위하여 많은 연구자들의 연구가 집중되고 있다. Al, Ga, 그리고 In 등을 첨가한 ZnO 소재는 높은 광 투과도, 전도성 등의 특성 때문에 태양전지, 평판 디스플레이, 그리고 OLED의 투명전극 제작을 위한 소재로서 각광받고 있다. 특히 Al을 첨가한 ZnO는 투명전도성 산화물(transparent conductive oxide : TCO) 전극으로서 널리 알려져 있다. 직접전이 에너지띠, 반도체로서 ZnO는 나노소자 제조와 여러가지 나노구조 합성을 위하여 최근 연구가 활발히 진행되고 있다. 지금까지, 많은 연구자들은 나노크기의 전자 그리고 광소자 등의 가능성 때문에 일차원ZnO 나노소재에 연구가 집중 되었다. 그리고 catalyic growth, thermal evaporation, chemical vapor deposition, electrochemical 그리고 solvothermal 등의 다양한 방법들이 ZnO nanorod 혹은 nanowire를 합성하기 위하여 제안되었다. 본 연구는 먼저 PLD 방법으로 SiO_2/Si 그리고 Al_2O_3 기판 위에 Al-doped (2 wt %) ZnO을 상온에서 증착하였다. 기판의 부정합을 최소화를 꾀하여 반도체 나노 결정성장에 널리 이용되고 있는solvothermal 방법으로 Al-doped (2 wt %) ZnO 박막 위에 ZnO 나노 결정(nanorod 그리고 nanowire)을 성장하였다. ZnO 나노결정의구조, 형상, 화학성분, PL 등을 분석하였다. This work was supported by grant the SMEs Technology Innovation Program (S1028273)

Dp-138 **Coherent Phonon Oscillations Eexcited by the E_{11} Ttransition in Micelle-Suspended Single-Walled Carbon Nanotubes**
안 재금, 임 용식, 엄 인태[1], 박 소현[1], 주 태하[1], 이 기주[2](*건국대.* [1]*포항공대.* [2]*충남대.*) We report the observation of coherent phonon oscillations(CP) of radial breathing modes(RBMs) resonantly-excited by the lowest optical transition E_{11} transition in isolated single-walled carbon nanotube(SWNTs) in suspension. Time-resolved degenerate pump-probe measurements were performed on HipCo SWNTs at room temperature using a Lock-In amplifier detection scheme and a home-built tunable OPO with a transform-limited 70 fs pulse-width and 1 MHz repetition rate, covering from 1125 nm to 1320 nm wavelength. In contrast to resonant Raman scattering, CP oscillations show the contributions from the excited-state stimulated emission(ESE) with a fast dephasing time of ~500fs and from the ground-state stimulated emission(GSE) with a slow dephasing time of ~5ps in sequence. In GSE, we also observe RBMs of semiconducting SWNTs show strong intensity for the (*n-m*) mod 3 = +1 family comparable to the (*n-m*) mod 3 = -1 family, which is in striking contrast to the E_{22} transition. We will discuss the difference between CP measurement and other cw spectroscopies to demonstrate several advantages of CP measurement for chirality assignments.

Dp-139 **Measurement of a charge qubit in an electronic Fabry-Perot interferometer** PATHAK PRADYUMNA, 강 기천 (*Department of Physics, Chonnam National University.*) We present an interferometry model of a very high sensitivity charge detector in the integer quantum Hall regime. Our model is an electronic analog of Fabry-Perot interferometer with edge channel. For small transmission through the point contacts the sensitivity of the interferometer is very high. We report the possibility of tuning the interferometer for quantum limited measurement for $R_1$2, where R_1 (R_2) is reflection probability of first (second) quantum point contact. For $R_1>R_2$, quantum limited measurement is not possible in our scheme. We also find the possibilities of nearly quantum limited measurement for $R_1=R_2$, except at resonance. On resonance, because of abrupt change in phase and minimum sensitivity, dephasing is maximum but measurement rate vanishes [1]. [1] *G. L. Khym, Y. Lee, and K. Kang, J. Phys. Jpn. 75, 063707 (2006)* .

Dp-140 **Fabrication of air-stable n-type carbon nanotube(CNT) field effect transistor(FET) with low work function metal electrodes** 김 효숙, 전 은경, 김 주진, 이 정오[1](*전북대학교 물리학과.* [1]*한국화학연구원*) In the field of CNT-based devices, the fabrication of high-performance and air-stable n-type transistors is

one of the greatest challenges. To achieve this objective, electron doping in the SWNT channel has been tried using alkali metals such as potassium or amine-rich polymers. On the other hand, low work function metals such as Ca or Al have been employed to lower the Schottky barrier for electron transport at the contact. However, most of the fabricated devices were unstable in the ambient air due to the easy oxidization of electrode materials or n-doped channel. In the present study, we successfully fabricated a high performance n-type CNT-FETs with low work-function metal electrodes. Although the fabricated devices shows a slight decrease of electron concentration due to the oxygen channel doping effect in the ambient air, the n-type characteristics and device performance kept high stability in air condition. We will report the electrical characteristics in air/vacuum condition and fabrication procedures of air-stable n-type CNT-FET.

Dp-141 **탄소나노튜브 첨가에 따른 무기EL 형광체 스펙트럼의 변화** 전 소연, 유 세기(*한국외국어대학교 전자물리학과*) 후막형 무기 electroluminescence(EL) 구조에 탄소나노튜브(CNT)를 넣은 것과 그렇지 않은 두가지 경우에 대한 EL과 photoluminescence(PL)의 특성을 비교 분석하였다. 평균 직경이 약 30 um인 녹색 EL 형광체 powder를 스크린 프린팅 방법으로 SiO2 절연층이 입혀진 ITO 전극면 위에 도포하였다. 형광체 중에 CNT의 함양을 0, 0.5, 1 wt%로 조절하였으며, 형광체 위에 Ag 전극을 도포하여, 무기 EL 구조를 완성하였다. 이 세 종류의 시료는 PL에서는 변화가 별로 없었으나, EL에서는 CNT의 함양에 따른 luminescence의 변화를 나타냈다. 이 EL 곡선을 Gauss 함수의 합으로 fitting하였으며, 이를 CNT 함량에 따라 분석하였다. 포스터에서 스펙트럼에 대한 자세한 분석에 대하여 다룰 예정이다. 이 연구는 2007년 정부(교육인적자원부)의 재원으로 한국학술진흥재단의 지원을 받아 수행된 연구임(KRF-2007-313-C00299).

Dp-142 **수직자기장하에 있는 양자 우물에서 광검출 자기포논 공명** 이 상철, 양 강효[1], 김 두철[1], 김 석환[2], 안 형수[3](*제주대학교 기초과학연구소. [1]제주대학교 물리학과. [2]안동대학교 물리학과. [3]한국해양대학교 반도체물리전공*) 양자 선형응답이론을 토대로 수직 자기장하에 있는 포물선형과 사각형 구속퍼텐셜을 가지는 양자우물의 Voigt 배치와 광성포논 산란에 대하여 광자기 전도도와 이완함수를 해석적으로 구하여 광검출 자기포논 공명 조건을 얻었다. 다양한 광자진동수에 대하여 구속퍼텐셜 진동수, 양자우물 두께, 자기장 세기의 함수로 공명정점의 쪼개짐과 이동과 같은 광검출 자기포논 공명의 선모양에 대해서 토의하였다.

Dp-143 **Structural and Optical Properties of $(GaP)_n/(InP)_n$ Short-Period Superlattices** 노 희석, 임 정란[1], 송 진동[2], 최 원준[2], 이 용탁[3](*전북대학교, 물리학과. [1]한국기초과학지원연구원 전주센터. [2]한국과학기술연구원. [3]광주과학기술원, 정보통신공학과.*) $(GaP)_n/(InP)_n$ 짧은 주기 초격자 구조의 성장 과정에서 형성되는 측면성분변조와 연관된 구조적, 광학적 특성 변화를 투과전자현미경, 원자힘현미경, 라만 산란 등을 이용하여 연구하였다. 시료의 성장온도의 변화 및 단원자층의 수 n의 변화에 따라 나타나는 측면성분변조의 유형을 관찰하였다. 특히 성장온도나 단원자층의 수를 변화시킴에 따라서, 규칙적인 방향성을 지닌 측면성분변조의 형성뿐만 아니라 보다 복잡한 패턴의 측면성분변조가 형성될 수 있음을 각각의 시료의 측면에서 얻어진 투과전자현미경 영상을 통해 알 수 있었다. 이러한 다양한 유형의 측면성분변조는 시료의 표면 지형을 변화시키는데, 이에 대한 연구는 광학적 비등방성을 지니는 광전자 소자 응용 분야에 유용한 정보를 준다. 원자힘현미경을 이용한 표면지형 분석 결과, 일정한 형태의 측면성분변조의 형성에 의한 표면 지형과 복잡한 형태의 측면성분변조의 형성에 의한 표면 지형 사이의 현격한 차이를 알 수 있었다. 복잡한 패턴의 측면성분변조가 형성된 경우 라만 산란의 입방 대칭성이 현저하게 줄어듦을 편광선택규칙을 적용하여 규명하였다.* 이 논문은 2006년 정부(교육인적자원부)의 재원으로 한국학술진흥재단의 지원을 받아 수행된 연구임(KRF-2006-005-J00302). 한국과학기술연구원에서의 연구는 기관고유사업(SPINTRONICS)의 지원을 받아 수행되었음.

Dp-144 **자기조립식으로 제조된 PS-PMMA 박막의 도메인 구조** KIM YongSeok, SEO YoungSoo, SEO YongHo(*Sejong University, nanotechnology and advanced material engineering.*) 원자현미경(AFM), 수평방향 힘 현미경(LFM), 그리고 힘의 spectroscopy를 이용하여 섞이지 않는 polystyrene/ poly(methyl methacrylate) (PS/PMMA) 박막의 도메인 구조를 연구하였다. 잘 알려져 있듯이, PMMA 박막위에 이슬방울 모양의 PS 돌출부가 AFM으로 확인되엇으나, LFM을 이용하여 자세히 관찰해 본 결과, PS 방울 위에 원형의 더 작은 구조물(subdomain)이 있는 것을 확인 할 수 있었다. PMMA 영역의 마찰력과 잡아당기는 힘 (pull-off force)의 세기를 비교해 본 결과, 이 작은 도메인은 PMMA와 같은 물리적 성질을 띠는 것으로 확인되었다.

Dp-145 **Electrical properties of Pt contacted n-type ZnO nanowire** 정 두원, 오 황유, 김 주진(*전북대학교 물리학과*) To investigate contact barrier at the interface between metal electrode and a single ZnO nanowire, FETs were fabricated with ZnO nanowires grown by CVD method. The devices made of Ni or Ti/Au electrodes show a practically symmetric and ohmic-like behavior, whereas ones made of Pt electrodes reveals a slightly non-linear behavior in the I-V characteristics at room temperature. Pt metal is known to have high work function on a very clean substrate surface. The respective work functions are 5.15 eV for Ni and 5.65 eV for Pt. In the case of n-type ZnO film, Pt metal has often been employed to fabricate Schottky diode due to the formation of high barrier height about 0.5 eV. However, relatively low schottky barrier height has been observed in ZnO nanowire/Pt contacts, suggesting that the Fermi level pining position of ZnO nanowire would be different from that of ZnO film. We will present the systematic change of barrier heights in ZnO nanowire/metal contacts and the change of corresponding gate response curves.

Dp-146 **The effect of dispersants in dispersing carbon nanotubes for flexible transparent conducting film** PARK Hyeon ki, KIM Ki kang, KIM Soo Min[1], GENG Hong Zhang[1], LEE Young Hee(*성균관대학교 물리학과. [1]성균관대학교 나노과학 기술 학과.*) Carbon nanotubes (CNTs) were dispersed by using different dispersants in aqueous solution; anionic sodium dodecylbenzene sulfo-

nate (NaDDBS), non-ionic triton X-100 (TX-100), and cationic cetyltrimethylammonium bromide (CTAB). The flexible transparent conducting films (TCFs) were prepared by using the prepared CNT solution with spray method. The TCFs were then immersed in acidic solution (HNO_3) for some time. The variation of the sheet resistance by acid treatment depend on the interaction energy between dispersant and CNTs. The interaction nature was characterized by UV-Vis-NIR, Raman spectrum, electrophoretic light scattering and scanning electron microscopy.

Dp-147 **Appearance of Adsorption Resistant Behaviors of Au Nanoparticles with Decreasing Particle Size** 김 효상, 신 선영, 엄 상훈, 한 진희, 황 한나[1], 김 봉수[1], 정 진욱, 김 영독[2], 황 찬국[1](*포항공대물리학과.* [1]*포항공대 포항가속기연구소.* [2]*성균관대학교 화학과.*) Size-dependent variation of electronic and adsorption properties of Au nanoparticles formed on native Si oxide surfaces have been investigated using synchrotron radiation photoemission spectroscopy (SRPES) and ultraviolet photoelectron spectroscopy (UPS). Adsorption reactivity of oxygen and butanethiol initially increases with decreasing particle size. Below certain particle sizes, however, Au nanoparticles becomes gradually resistant toward the adsorption of both reagents. The average particle sizes for the maximum adsorption reactivity are found to be 2.5 and 0.8 nm for oxygen and butanethiol, respectively. This observation is in sharp contrast to previous study on Au_{55} clusters, which showed a non-monotonous size-dependence in chemical activity with a pronounced inertness for a certain particle size. We find evidence of the formation of Au silicide which may be a source of the chemical inertness for small Au nanoparticles. We further observe a possibility of metal-insulator transition (MIT) with reducing particle size, which does not go parallel to the chemical transitions.

Dp-148 **Crystal Structure and Luminescence Properties of Tb^{3+} Doped $YAlO_3$ and $GdAlO_3$ Nano-phosphors** 문 병기, 박 진영, 정 홍채, 정 중현, 정 종원, 최 병춘, 김 중환[1], 최 혜영[1], GANJI Seeta Rama Raju(*부경대학교 물리학과.* [1]*동의대학교 물리학과.*) Aluminum perovskite($LnAlO_3$)는 희토류산화물-알루미나 계의 3개의 결정구조인 garnet(Ln_3Al_5O12), perovskite($LnAlO_3$), monoclinic($Ln_4Al_2O_9$) 중 하나이다. Aluminum perovskite에는 hexagonal, cubic, orthorhombic의 세가지 결정구조가 있으며, 그 중에서 orthorhombic가 안정한 결정상으로 알려져 있다. 본 연구에서는 Tb^{3+} 을 첨가한 $YAlO_3$와 $GdAlO_3$ 나노분말을 합성하였으며, 결정구조에 따른 Tb_{3+}의 형광특성을 연구하였다. 합성한 $YAlO_3$의 결정구조는 cubic과 orthorhombic이며, $GdAlO_3$의 결정구조는 hexagonal과 orthorhombic 이다. 각각은 Tb_{3+}의 $^5D_4$ - $^7F_6$ 천이에 의한 형광을 방출하였으며, 형광여기스펙트럼은 모체의 결정구조에 따라 크게 달라졌다. $YAlO_3$와 $GdAlO_3$의 결정구조에 따른 PL, PLE, EL, relaxation dynamics를 비교하여 설명한다. Aluminum garnet 형광체는 녹색 형광을 보이며 광학 분야에서 폭넓게 연구되어 왔다. Tb^{3+} 가 첨가된 Aluminum perovskite 형광체 역시 응용 분야에서 기대되고 있다. Aluminum perovskite 형광체를 solvothermal reaction method로 합성하였고 800 °C와 1200 °C에서 열처리하여 결정화 시켰다. 800 °C에서 열처리한 $YAlO_3$ (YAP) and $GdAlO_3$ (GAP)는 각각 cubic phase 와 hexagonal phase를 가졌다. 1200 °C 에서 열처리 한 YAP는 cubic phase를 가지며 부분적으로 $Y_4Al_2O_9$ (YAM)이 존재했고, GAP는 orthorhombic phase를 가지며 부분적으로 cubic phase가 존재했다. YAP와 GAP는 표면이 둥글고, 입자 크기는 열처리 온도에 크게 관계 없이 각각 50, 52nm를 나타냈다. 형광에 있어서, YAP: Tb^{3+} 은 227, 270, 325nm의 세 개의 여기 밴드를 가지고, GAP: Tb^{3+} 역시 세 개의 여기 밴드를 가지는데, 227nm의 여기 밴드에서 열처리 온도에 대해 차이를 나타냈다. FT-IR의 결과로부터 800 °C와 1200 °C의 GAP에서 차이를 볼 수 있는데 800 °C에서의 GAP이 cubic phase를 가지지만 일부 amorphous 상태도 같이 존재함을 볼 수 있다. 형광 스펙트럼에서는 YAP와 GAP 모두 270nm에서 여기되어 545nm($^5D_4$-$^7F_6$)의 주 발광 peak을 나타냈다.

Dp-149 **Ce을 첨가한 aluminum garnet nanocystal의 성장과 형광특성** 문 병기, 정 홍채, 박 진영, 정 중현, 양 현경, 최 병춘, 김 중환[1], 최 혜영[1], GANJI Seeta Rama Raju[2](*부경대학교, 물리학과.* [1]*동의대학교, 물리학과.* [2]*부경대학교 물리학과.*) Yttrium aluminum garnet($Y_3Al_5O_{12}$, YAG)은 다양한 solid-state lasers의 호스트물질로 잘 알려져 있으며, Ce^{3+}을 첨가한 YAG는 백색 LED의 황색형광체로 사용되고 있다. YAG:Ce 황색형광체를 이용한 백색 LED는 색온도가 높고 색지수가 낮으며 이를 보완할 수 있는 새로운 황색 형광체의 개발이 요구되고 있다. 본 연구에서는 Ce을 첨가한 aluminum garnet nanocystal을 solvothermal 방법으로 성장하였다. rare earth acetylacetonate와 aluminum alkoxide를 전구체로 하였으며, 330°C 의 알코올 용액에서 garnet nanocystal을 성장하였다. 성장한 garnet nanocystal은 $Y_3Al_5O_{12}$, $Gd_3Al_5O_{12}$, $Sm_3Al_5O_{12}$, $Tb_3Al_5O_{12}$ 등이며, 각각의 격자상수는 12.02, 12.12, 12.09, 12.10 Å이고, 별 모양의 입체적 형상이었다. 이 중에서 $Gd_3Al_5O_{12}$:Ce, $Sm_3Al_5O_{12}$:Ce은 아직까지 보고되지 않은 새로운 물질이다. 형광 피크의 파장은 각각 $Y_3Al_5O_{12}$:Ce가 535nm, $Tb_3Al_5O_{12}$:Ce는 541.5nm, $Sm_3Al_5O_{12}$:Ce는 542.5nm, $Gd_3Al_5O_{12}$:Ce는 544.5nm 이었다.

Dp-150 **Growth Behavior of Carbon Nanotubes Forest Dependent on the Pressure** LEE IL HA, HAN GANG HEE[1], KIM EUN SUNG[1], LEE YOUNG HEE[2](*SKKU Advanced Institute of Nanotechnology (SAINT), BK21 Physics division, Sungkyunkwan university.* [1]*Department of physics, BK21 Physics division, Sungkyunkwan university.* [2]*Department of physics, BK21 Physics division, SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan university.*) Carbon nanotubes (CNT) forest has been successfully grown on FeCo/Al deposited Si substrate. The large-capacity thermal chemical vapor deposition (TCVD) of a quartz tube with the diameter of 25 cm and the length of 150 cm was used for nanotube growth. The mixture of C_2H_4, H_2, and Ar were introduced into chamber during the growth. We have checked the gas ratio, temperature and pressure then observed by scanning electron microscopy (SEM) and raman spectroscopy. In the relatively low pressure, nanotube alignment was improved because of the decrease of the C_2H_4 partial pressure. In this report, we have tried to compare two cases to make sure the cause of nanotube alignment. One is the decrease of C_2H_4 gas in the same pressure. Another is the change of

total pressure with the same gas ratio.

Dp-151 **Growth of long single-walled carbon nanotube (SWCNTs) arrays on a Si substrate using lamina flow** CHAE Seung Jin, JANG Jin Ho[1], LEE Il Ha, LEE Young Hee[2](*SKKU Advanced Institute of Nanotechnology (SAINT). [1]Department of Physics. [2]Department of Physics, SKKU Advanced Institute of Nanotechnology (SAINT), Center for Nanotubes and Nanostructured Composites (CNNC).*) Horizontally aligned single-walled carbon nanotubes (SWCNTs) were synthesized using laminar flow in the thermal chemical vapor deposition (CVD). Fe catalyst from $FeCl_3$ in ethanol has been used to produce long single-walled carbon nanotubes (SWCNTs) array. The catalysts were prepared on the Si substrates using dipping or stamping. In order to achieve the goal of small diameter SWCNTs and control the number of SWCNTs, we controlled concentration of catalyst. The mixture of CH_4, H_2, and Ar were introduced into chamber at 1000 °C during the growth. The extremely low flow rate of CH_4 (8 sccm) was one of the important factors. The length of synthesized SWCNTs was about 1cm. This was confirmed by scanning electron microscopy (SEM), raman spectroscopy, and atomic force microscopy (AFM).

Dp-152 **Selective growth of ZnO nanowires using patterned ZnO seed layers for device application** SHIN Seongmo, PARK J., JEONG H., KIM D.-W.[1](*Hanyang Univ., Dept. of Appl. Physics. [1]Ewha Womans Univ., Dept. of Physics.*) Growth of zinc oxide (ZnO) nanowires (NWs) has been intensively studied to investigate physical properties of the low-dimensional structures. In spite of the fascinating properties of the NWs, difficulty in site-controlled growth has hindered us from fabricating integrated NW-based devices. ZnO NWs were grown on ZnO thin film seed layers, without any metal catalyst, by vapor phase deposition. It was found that the NW growth could be suppressed on some growth barrier layers, such as SiO_2 thin films. Patterned ZnO NW arrays were prepared using conventional photolithography and dry etching techniques.

Dp-153 **Photoluminescence Imaging of ELOG-GaN Structures** 송 지선, 노 희석, 정 문석[1], 주 진우[2], 이 인환[2](*전북대학교, 물리학과. [1]고등광기술연구소. [2]전북대학교, 신소재공학부.*) Epitaxial lateral overgrowth (ELOG) 방법을 이용하여 성장시킨 GaN 박막에 대한 발광 이미징 결과를 보고한다.GaN buffer 층 위에 SiO_2 띠를 일정한 간격으로 구성한 후 그 위에ELOG-GaN 층을 성장시켰다. 광섬유를 이용하여 시료에 자외선 레이저 빛을 근접장에서 쪼여 준 후, 시료로부터 방출 된 발광 반응을 광학현미경을 이용하여 수집하였다. 발광 스펙트럼을 통해 띠 간격 에너지와 근접한 370 nm 영역에서의 발광 반응을 확인하였고, 결함 등의 요인에 의한 선폭이 넓은 가시광선 영역에서의 발광 반응을 얻었다. 시료로부터 얻어진 발광 이미징 결과에 의하면ELOG-GaN 층으로부터의 발광 반응이 매우 강하게 나타났다. 반면, ELOG 성장층이 아닌 영역에서의 발광 반응은 매우 약하게 나타났다. 이는 ELOG-GaN 박막 층의 결정성 등이 매우 우수함을 나타낸다* 이 논문은 2006년 정부(교육인적자원부)의 재원으로 한국학술진흥재단의 지원을 받아 수행된 연구임(KRF-2006-005-J00302).

Dp-154 **Electronic transport properties of individual Silicon Nanowire and their junction structure studied by electrostatic force microscopy** 권 혁상, 이 윤희(*고려대학교 물리학과.*) CVD 법으로 성장시킨 실리콘 나노와이어의 좌우 전극으로서Ni을 패턴 정의하고 후면 게이트를 정의하여 삼전극형 실리콘 나노와이어(Si-NW) 전자 소자구조를 제작하였다. 먼저 길이가 약 2-5um 이고 직경이 10-30nm인 한 가닥의 as-grown Si-NWs의 한쪽 끝에서 부터 끝나는 지점까지의 연속적인 포텐셜 변화를 EFM(Electrostatic Force Microscopy)으로 관찰하고 난 다음, 국소 전기장의 인가 방향에 따른 나노와이어의 용량성 및 충방전 현상을 고찰하였다. 또한 실리콘 나노와이어전극 접합 특성을 조사하기 위하여 전도성 팁을 사용한 전류 분포와 표면 퍼텐셜 분포를 관찰하여 실리콘나노선의수송특성 기구를 이해하여보았다.

Dp-155 **탄소나노튜브 기반 나노소자의 비접촉식 전압분포 측정연구** 박 지용, 정 희성, 김 용선, 권 향명(*아주대학교 에너지시스템학부 응용물리학과*) 탄소나노튜브(CNT)와 같은 나노소재를 이용한 나노소자에 대한 연구가 활발히 이루어지고 있지만, 그 동작특성에 대한 이해는 아직 부한 실정이다.이를 극복하기 위해서는 나노스케일에서 나노소자의 전기적 특성을 측정할 수 있는 방법이 필수적이며, 본 연구에서는 그 하나의 방법으로 원자힘현미경(AFM)을 이용한 나노스케일 비접촉식 전압분포측정법을 이용하였다. 열화학기상증착법으로 CNT를 성장시킨 후 금속 전극을 형성하여 CNT소자를 제작한 후, AFM을 이용한 측정법의 하나인 교류형식의 정전기력현미경법 (AC-EFM)을 이용하여 제작한 CNT소자에서의 전압분포를 형상화하였으며, 교정을 통하여 CNT자체의 전압분포와 CNT-전극 접합부의 전압강하정도를 정량적으로 계산하였다.

Dp-156 **The fabrication of highly sensitive ZnO nanowire gas sensor through step edge decoration** 손 종역, 임 성준, 조 진형[1], 성 우경[2], 김 형준(*포항공과대학교, 신소재공학과. [1]부산대학교, 물리학과. [2]반도체부품연구원*) We fabricated ZnO nanodot arrays with 5 and 10 nm diameters and well aligned ZnO nanowires on sapphire terraces by step edge decoration technique. ZnO nanostructures of nanodots and nanowires were well localized at step edges of terraces on sapphire substrate. ZnO nanowires showed parallel arrangement with uniform interval, which facilitates simple sensors fabrication process. High sensitivity ethanol sensor could be fabricated by using well aligned ZnO nanowires with remarkably high surface/volume ratio of about 58.6 μm^{-1}, which produced significant change of about 1000 % in electrical resistance even for the low ethanol concentration of 0.2 ppm.

Dp-157 **Dependence of Domain Wall Velocity on the Pinning Potential** RYU Jisu, LEE Hyun-woo(*POSTECH, Department of Physics.*) Domain Wall Motion in a magnetic nanowire can be induced by the injection of a spin-polarized current along the wire. Because of the extrinsic pinning effect, only the current larger than the threshold current can generate the domain wall motion. We investigate the domain wall motion in a nanowire where identical pinning sites are uniformly distributed. First, we calculate the final velocities of the domain wall for various densities

of pinning with the current larger than the threshold current. We, then, compute the fluctuation of final velocities for various numbers of pinning sites with fixed pinning strengths and the current. When the pinning strengths are weak, the fluctuations are in the order of 1%, and they decrease as the injected currents increase. When the pinning strengths are intermediate or strong, however, the fluctuations are in the order of 10% and they decrease to the order of 1% under the current almost 3 times larger than the threshold current. Second, we found that the motion of domain wall is more sensitive to the initial condition of the wall in the intermediate pinning strength regime than in the weak or strong pinning strength regime.

Dp-158 **Edge States Of Zizag Bilayer Graphite Nanoribbons** RHIM Jun Won, MOON Kyungsun(*연세대학교, 물리학과*) Electronic structures of the zigzag bilayer graphite nanoribbons (Z-BGNR) with various ribbon width N are studied within the tight binding approximation. Neglecting the small inter-layer hopping parameter gamma_4, there exist two fixed Fermi points k^* independent of the ribbon width with the peculiar energy dispersion near k^* as $E(k) \sim (k-k^*)^N$. By investigating the edge states of the Z-BGNR analytically, we notice that the trigonal warping of the bilayer graphene sheets is reflected on in the edge state structure of the Z-BGNR. Interestingly, the existence of the edge states seem to agree with the condition imposed by the Berry phase argument.[1] The edge magnetism of the Z-BGNR is also examined by solving the half-filled Hubbard Hamiltonian for the ribbon with a Hartree-Fock approximation. It is more favorable, at realistic U values, to have a spin configuration which is anti-ferromagnetic between the upper and lower layers at one edge of the ribbon. Contrary to the monolayer Z-GNR, the half-metallicity is not expected at the Z-BGNR. [1] Shinsei Ryu and Yasuhiro Hatsugai, Phys. Rev. Lett. 89, 077002 (2002).

Dp-159 **Sputter를 이용해 증착된 Zr-rich ZrO_2 박막의 메모리 특성 연구** 오 광택, 강 성웅, 최 진식, 황 인록, 전 상호, 김 상훈, 홍 사환, 이 진호, 최 정애, 김 연수, VADIM Yalishev, 박 배호(*건국대학교 물리학과*) 기존의flash memory는 누설 전류로 인한 높은 전력소비의 문제와 구조적 한계로 인한 정보 집적도 문제의 한계가 대두되고 있다. 이러한 기존 flash memory의 한계점을 극복하기 위한 대안으로 대두되는 것이 NFGM (Nano Floating Gate Memory)이다.NFGM은 기존의 floating gate를 bar형의 구조에서 nano crystal 형태로 변화시킴으로서누설전류 문제의 해결책을 찾았으며 정보 집적 능력의 비약적인 향상되었다. 무엇보다도 NFGM은 기존의 flash memory의 제작 공정을 변화 시킬 필요 없이 약간의 수정만으로도 개선된 효과를 가지고 올 수 있다는 큰 장점이 있다.본 연구에서는high-k 물질인 Zr을 사용하였으며 sputter 방법을 이용하여 온도의 변화를 주어 Zr-rich ZrO_2증착하였고, C-V, I-V data를 통하여 전기적 특성을 분석하였으며, XRD, AFM, SEM, TEM등을 NFGM의 구조를 통하여 확인 하였다.본 연구를 통하여 floating gate memory 소자로서 Zr-rich ZrO_2 박막의 응용가능성을 확인 하였고 박막이 200℃에서 가장 좋은 메모리특성을 보여주는 것을 확인 하였다. 또한, annealing 을 통하여서 누설 전류 문제를 크게 극복할 수 있음을 알 수 있었다. 이러한 실험 결과를 바탕으로 Zr-rich ZrO_2 박막이 메모리로서 사용 가능하며 ZrO_2 대체 유전 박막의 성장조건을 조절하여 성장된ZrO_2 박막 내부에 Zr 나노 결정을 in situ로 형성하는 단일공정을 개발 하였다.

Dp-160 **Carbon nanotube fibers spun from ultra-long vertically-aligned carbon nanotube films synthesized by aerosol-assisted thermal CVD** BYEON heejun(*아주대학교 에너지시스템학부*) A few millimeter long vertically aligned carbon nanotubes (VA-CNTs) were synthesized via aerosol-assisted thermal CVD. An aerosol nebulizer was used to generate floating catalysts from ferrocene solution in ethanol. Since both catalysts and hydrocarbon precursors were supplied in gas phase, we were able to control size and number density of catalyst cluster, which gave us the potential to grow ultra-long VA-CNTs easily over large-area substrates and to control VA-CNTs' properties such as density, length, and degree of alignment. We are going to report the spinning of CNT fibers using these VA-CNT films, and the effects of CNT-film properties on spinning and the quality of CNT fibers.

Dp-161 **Synthesis and Field Emission Properties of Vertically Aligned Carbon Nanotubes using Floating Catalyst Method** KIM Sang Yong, LEE Soonil, KOH Ken Ha(*Ajou University, Division of Energy Systems Research.*) Vertical aligned carbon nanotubes (VA-CNTs) were synthesized on silicon wafer sputtered aluminum thin film with 10 nm thickness by floating catalyst method. Ferrocene used as catalyst was dissolved in alcohol, which is also supplied to grow CNTs with feedstock gas controlled by mass flow controller. As prepared precursor was supplied into a quartz tube furnace by using conventional syringe. The grown VA-CNTs were characterized by scanning electron microscopy (SEM), thermogravimetric analysis (TGA) and Raman spectroscopy. Also we measure field emission property of VA-CNT film on patterned Si substrate. This stretegy is of great advantage to economic cost, human being safety and control of experiment parameter than previous techniques. Therefore this method may be suitable for commercial mass production.

Dp-162 **Nickel Oxide nano-particle의 전기적 특성 분석** 황 인록, 최 진식, 전 상호, 김 상훈, 홍 사환, 최 정애, 오 광택, 강 성웅, VADIM SH. Yalishev, 박 배호, 구 자용[1](*건국대학교 물리학과.* [1]*한국표준과학연구원*) 전도성 전이 산화물인NiO는 최근 차세대 비휘발성 메모리의 하나인 Resistance Random Access Memory (RRAM) 용으로 많은 연구가 진행되어 왔다. 현재까지 다양한 산화물 박막을 이용하여 저항변화 현상을 관찰하였으나 아직 명확하게 전도성 전이 특성의 메커니즘의 규명이 이루어지지 않았다. 전도성 전이 특성의 메커니즘을 분석하기 위한다양한 방법중 나노 크기에서의 전도성 전이 현상을 분석하고자 한다. 다양한 Nickel nano-paricle을 제작하여 X-ray diffraction (XRD)를 통하여 Nickel paricle의 구조적인 성장을 분석하였으며 scanning electron microscopy (SEM), atomic force microscopy (AFM)을 이용하여 표면 분석을 하였다. 또한 conducting atomic force microscopy (C-AFM) 방법을 이용하여 국소적인 전류 분포를 통한nano size의 전류분포 특성을 분석하였다. nsno size의 전류 분포 특성의

분석을 통하여 박막에서의 저항변화 현상과 미시적인 크기에서의 저항변화 현상에 따른 특성을 비교 분석하고자 하였다.

Dp-163 **음극형광법을 이용한 ZnO 나노막대의 광·전 특성 연구** 오 영무, 이 경문[1], 정 희성, 안 영환, 이 순일, 박 지용(*아주대학교 에너지시스템 학부 응용물리전공 [1]아주대학교 물리학과.*) 본 연구에서는 높은 공간해상도를 가지는 음극형광법을 이용하여 ZnO 나노막대의 광·전특성을 조사하였다. 동일 ZnO 나노막대의 광·전특성의 측정을 위하여 화학기상증착법으로 합성된 직경 30~80nm의 ZnO 나노막대에 반도체 공정을 통하여 전극을 형성하였다. 이와 같이 제작된 ZnO 나노막대 소자가 n형 반도체 특성을 나타내는 것을 전기수송측정법을 통하여 확인하였으며, Au, Ti 등 사용한 전극물질의 변화에 따른 I-V 특성을 조사하여 ZnO 나노막대와 금속전극 사이의 접합특성을 연구하였다. 또한 전자현미경에서 음극형광법(Cathodoluminescence)을 이용하여 개별 소자 내의 ZnO 나노막대의 발광특성을 조사하고 나노막대의 전기적특성 (도핑농도, 전극과의 접합특성 등)과의 상관관계를 조사하였다.

Dp-164 **Current Hysteresis of Carbon Nanotube Random Network at Low Temperature** CHOI Wonsuk, KIM Duk Young, KIM Un Jeong[1], KIM Eunseong(*Center for Supersolid &Quantum Matter Research and Department of Physics, KAIST. [1]Samsung Advanced Institute of Technology.*) We have studied current hysteretic behavior of single walled carbon nanotube (SWCN) random network film filed effect transistors (FETs). SWCNs were fabricated by water plasma enhanced chemical vapor deposition (PECVD) which produces very high population of semiconducting SWCN. Very dense SWCN random network thin film FETs fabricated by PECVD are reported to have an excellent on/off switching ratio close to 10^{-5}. Hysteresis in the electrical characteristics ordinarily observed in SWCN network film FETs is not understood yet. The hysteretic phenomenon is often attributed to water molecules acting as charge trapping sites [1] or surfactants used as dispersion solutions changing the characteristic properties of substrates [2]. We measured current hysteresis of SWCN film FETs while varying the gate voltage at different temperature ranging from 10K to 300K. We will discuss the temperature dependence of these hysteretic behaviors. 1. Woong Kim, Ali Javey, Ophir Vermesh, Qian Wang, Yiming Li, and Hongjie Dai, *Nano Lett.* 3, 193 (2003)2. Shaoning Yuan, Qing Zhang, Daisuke Shimamoto, Hiroyuki Muramatsu, Takuya Hayashi, Yoong Ahm Kim, and Morinobu Endo, *Appl. Phys. Lett.* 91, 143118 (2007)

Dp-165 **Synthesis of Millimeter-Thick Carbon Nanotube Arrays by Oxygen-Assisted MPCVD** 김 유석, 송 우석, 이 승엽, 최 원철, 박 종윤(*나노튜브 및 나노복합구조 연구센터BK21 물리연구단, 성균관대학교, 수원 440-776.*) 탄소나노튜브(carbon nanotubes, CNTs)는 강철 보다 10 - 100배 견고할 뿐만 아니라 영률(Young's modulus)과 탄성률(elastic modulus)은 각각 1.8 TPa, 1.3 TPa에 달하는 매우 우수한 역학적, 기계적 강도를 지니고 있다. 이러한 특성을 이용한 나노섬유, 고분자-탄소나노튜브의 고기능 복합체 (composites), 나노소자, DNA 검출을 위한 나노전극 등 많은 분야로의 활용을 위한 연구가 진행되고 있다. 또한 mm 이상의 길이로 수직 성장된 탄소나노튜브의 합성은 길이 대 직경의 비가 비약적으로 증가하여 앞서 언급한 분야로의 활용이 더욱 유리하며, 그 중에서도 대량 생산, 나노섬유 및 나노복합체로서의 활용에 극히 유용하다. 최근에는 열 화학기상증착(thermal chemical vapor deposition, TCVD)법을 이용하여 합성된 탄소나노튜브의 길이를 증가시키기 위해 성장 과정 중 탄화수소(hydrocarbon) 외에 물, 알코올 등을 주입하여 활성화된 촉매금속의 반응시간을 증가시키는 방법들이 보고된 바 있다. [1-3]본 연구에서는 Si 기판 위에 금속 촉매인 Fe을 증착한 후 마이크로웨이브 플라즈마 화학기상증착(microwave plasma CVD)법을 이용하여 탄소나노튜브를 합성하였다. 탄소공급원인 메탄(CH4)가스와 함께 물 또는 미량의 산소를 주입하여 탄소나노튜브를 성장 시켰으며, 열처리 과정을 통해 합성된 탄소나노튜브의 순도를 향상시켰다. 실험결과, 3시간 만에 3 mm 이상의 길이를 지니며 기판에 수직 정렬된 얇은 다중벽 탄소나노튜브(thin multi-walled CNTs)를 합성할 수 있었다. 이러한 결과는 적절한 양의 산소 공급으로 인한 비정질 탄소(amorphous carbon)의 산화반응에 의해 촉매의 활성화 시간이 증가된 것이라 예상된다. 따라서 같은 시간에 물과 산소를 공급해주지 않은 경우에 비해 성장률 및 길이가 증가된 것을 확인할 수 있었다. 성장된 탄소나노튜브의 표면 형상과 내부 구조를 주사전자 현미경(scanning electron microscopy, SEM)과 투과전자현미경(transmission electron microscopy, TEM)을 통해 측정하였고, 결정성의 향상 및 순도를 라만 분광법(Raman spectroscopy)과 열분석(thermogravimetric analysis, TGA)을 통해 분석하였다.
[참고문헌]1. R. Saito et al, "Physical Properties of Carbon Nanotubes" Imperial College, London (1998)2. Guofang Zhong et al, J. Phys. Chem. B, 111, 1907-1910 (2007)3. Kenji Hata et al., Science, 306, 1362-1364 (2004)

Dp-166 **Electrical and optical characterization of SnO2 nano-particles in polyimide insulator** LEE Dong Uk, KIM Seon Pil, LEE Tae Hee, KIM Eun Kyu, KIM Young-Ho[1] (*Quantum-Function Spinics Lab. and Department of Physics, Hanyang University. [1]Department of Materials Science and Engineering, Hanyang University.*) A few studies have been reported about the formation of metal or metal oxide nano-particles embedded in an organic layer for applications as optoelectrics device. Especially, SnO_2 is an *n*-type semiconductor having wide bandgap energy, deep work function and well known for its potential for applications in dye based solar cells and photoconductor devices.In this study, 5-nm-thick Sn film was deposited on the *p*-type Si with 5 nm thickness of SiO_2 tunnel layer and glass substrates by using a thermal evaporator. The polyamic acid (PAA) was spin coated on the deposited Sn film. The polyamic acid (PAA) precursor used in this study was prepared by dissolving biphenyltetracarboxylic dianhydride-phenylene diamine (BPDA-PDA) commercial PAA (PI2610D) in N-methyl-2-pyrrolidon (NMP). The PAA/Sn layer was held to react with the metal layer at room temperature for 24 hours. Then the PI/Sn layer was cured at 400 °C for 1 hr in N_2 atmosphere after drying at 135 °C for 30 min through rapid thermal annealing. After curing process at the temperatures of 400 °C for 1 hr, the nano-particles appear to have irregular spherical shapes with

average diameters of approximately 15 nm. The SnO_2 nano-particles embedded in polyimide was fabricated and its electrical and optical properties were investigated by using Boonton 7200 1-MHz capacitance-voltage meter and VARIAN Carry 300 UV-Vis spectrophotometer. Also, the transmission electron microscopy measurement was performed to investigate the morphology of the SnO_2 nano-particles embedded in polyimide matrix.

Dp-167 **Synthesis of nano particles with diformities shape by hydrolysis of metal** 엄 영랑, 이 희민, 이 창규(*한국원자력연구원.*) The hydrolysis reaction of nano metallic powders such as Al, Fe, Cu and Zn were carried out, and those tendency and mechanism were investigated by transmission electron microscopy (TEM) and x-ray diffraction (XRD). The nature of the surface oxidation on Al, Fe, Zn and Cu reacted in distilled water. The deformities shapes of oxidized materials were nano-fiber, nano-rod, and nano-cube.The oxygen passivatied layer is one of main motivations of deformities phase of oxide materials such as bohemite (AlOOH), goetite(FeOOH), zincia (ZnO) and cuprite (Cu_2O).

Dp-168 **Deposition of Pt nanoparticles on oxidizing agent treated multiwalled carbon nanotubes** KIM Tae Hyung, KIM Sung Jin[1], PARK Min Ho[2], LEE Young Hee(*aBK21 Physics Division, Department of Physics, Center for Nanotubes and Nanostructured Composites, Sungkyunkwan Advanced Institute of Nanotechnology, Sungkyunkwan University, Suwon 440-746, Republic of Korea.. [1]aBK21 Physics Division , Center for Nanotubes and Nanostructured Composites, Sungkyunkwan Advanced Institute of Nanotechnology, Sungkyunkwan University, Suwon 440-746, Republic of Korea.. [2]Department of Advanced Materials Engineering, Sungkyunkwan University, Suwon 440-746, Republic of Korea..*) The multiwalled carbon nanotubes(MWCNTs) were treated mixture of $HNO_3/NaClO_3$ solution with microwave oven. Defect induced MWCNTs were mixed with H_2PtCl_6 used as Pt precursor. The results show that the Pt loading amount was rapidly increased at 2 min microwave treatment. The Pt deposited quantity on MWCNTs were characterized by Thermogravimetric analysis(TGA). Oxidizing agents treated MWCNTs shows the changing D/G ratio in Raman spectroscopy. The MWCNTs defect site and Pt nanoparticle size were confirmed in terms of transmission electro microscope(TEM).

Dp-169 **탄소나노튜브 첨가에 따른 복합나노섬유의 기계적·광학적 특성 변화** 이 미현, 홍 준용, 김 태민, 최 원철, 박 종윤(*나노튜브 및 나노복합구조 연구센터성균관대학교BK21 물리연구단*) 나노섬유는 지름이 수십에서 수백 나노미터(1나노미터=10억분의1m)에 불과한 초극세 물질로 비표면적이 매우 크고[1], 제작이 간편하여, 사용되어지는 고분자의 종류에 따라 에너지·환경·의료 관련 분야에서 전극소재·필터재·피복재·인공 피부등 다양한 분야에서의 활용이 가능하여 전 세계적으로 연구개발이 활발하게 이루어지고 있다. 그러나 그 자체만으로 응용하기에는 그 기계적·전기적 특성의 한계 때문에 응용의 다양성에 제약을 받고 있다. 그러나 그 자체만으로 응용하기에는 그 기계적·열적·전기적 특성을 가진 탄소나노튜브를 첨가한 복합나노섬유에 의해 그 응용영역의 한계를 넓혀가고 있다[2] 본 연구에서는 전도성 고분자인 polyacrylonitrile (PAN)에 multi-walled carbon nanotubes (MWCNTs)를 첨가한 복합나노섬유를 이중노즐을 사용한 전기방사법(electro-spinning method)으로 제조하였다. 전도성 고분자인PAN계 고분자는전기방사법으로나노섬유를제조하기에 가장 용이한 고분자로 알려져 있다[2] CNTs 첨가농도에 따른 제조된 복합나노섬유의 형상변화와 섬유내의CNTs 배열상태를 각각 주사전자 현미경(scanning electron microscope: SEM)과 투과전자현미경(transmission electron microscope: TEM)을 이용하여 관찰하였다. 또한, 복합나노섬유의 광학 특성 변화를CNTs 첨가농도에 따라서FT-IR 과 Raman spectroscopy등을 이용하여 조사하였으며, 나노섬유의 tensile strength의 측정을 통해 CNTs 함량에 따른 기계적 특성 변화를 분석하였다.[참고 문헌] 1. C. Kim and K. S. Yang. Appl. Phys. Lett. 83, 1216 (2003). 2. J. Yu et al. Carbon 45 (2007) 618.623 3. E. H. Ra, Chem. Phys. Lett. 413, 188 (2005).

Dp-170 **Electrospun carbon nanofiber/carbon nanotube paper; Application to supercapacitor** RA Eun Ju, KIM Tae Hyung, LEE Young Hee(*BK21 Physics Division, Institute of Basic Science, Center for Nanotubes and Nanostructured Composites, Sungkyunkwan University, Suwoan 440-746, Korea.*) The electrospinning process has been used successfully to fabricate the polyacrylonitrile (PAN)-based nanofiber paper and the multiwalled carbon nanotubes (MWCNTs)-embedded PAN-based nanofiber paper. The diameters of nanofibers decreased with increasing CNT concentration. We found large anisotropic electrical conductivity, i.e., the electrical conductivity of the carbonized nanofiber paper along the spinning direction was about three times larger than that normal to the spinning direction, in good contrast with observations that the carbonized PAN-based nanofiber paper without CNTs did not reveal anisotropy in electrical conductivity. This proves that CNTs in PAN-based nanofiber were preferentially aligned along the nanofiber axis, in excellent agreements with transmission electron microscopy observations.For supercapacitor activated carbon nanofiber papers prepared by CO_2 activation methods were characterized using N_2 and CO_2 adsorption and X-ray photoemission spectroscopy. We observed elctrochemical electrochemical properties of activated carbon nanofiber papers with aqueous electrolytes and organic electrolyte.

Dp-171 **Synthesis of Thin Graphite Layers by Remote RF Plasma-Enhanced CVD** KIM Eun Sung, KIM Ki Kang, LEE Il Ha[1], HAN Gang Hee, LEE Young Hee[2](*BK 21 Physics Division, Department of Physics, Sungkyunkwan University. [1]BK 21 Physics Division, Department of Nanoscience and Nanotechnology, SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University. [2]BK 21 Physics Division, Department of Physics, Department of Nanoscience and Nanotechnology, SKKU Advanced Institute of Nanotechnology (SAINT), Center for Nanotubes and Nanostructured Composites (CNNC), Sungkyunkwan University.*) We have synthesized thin graphite layers using remote RF plasma-enhanced chemical vapor deposition (PE-CVD) with gas mixture of H_2 and C_2H_4.

For the synthesis, Ni(111) and poly-Ni substrates were used. There was reduction process by H_2 gas to remove native oxide layer before growth process. We have changed plasma power and stage height between plasma and substrate. Graphite layers were characterized by high-resolution transmission electron microscopy (HRTEM), Raman analysis, field-emission scanning electron microscope (FESEM), and X-ray diffractometer (XRD).

Dp-172 **Nanoscale Flow Sensors Using Partially-Suspended, Individual Carbon Nanotube Transistors** 손 병희, 박 지용, 이 순일, 안 영환(*아주대학교, 에너지시스템학부*) Field effective transistors based on single-walled carbon nanotubes (CNTs) have been found to be extremely sensitive to its environment. Recently it has been demonstrated that individual, single-walled nanotube transistors can be used for a sensitive nanoscale probe for fluidic transport. Here we report that partially suspended CNT devices can serve as extremely sensitive nanoscale flow sensors. Partially suspended CNT devices were fabricated by a conventional e-beam lithography followed by chemical etching of supporting oxide layers. The length of the individual CNT devices was about 3 μm, while the suspended part of CNTs was 1 μm long. The CNT devices were then integrated into microfuidic channels (200 μm height and 400 μm wide) and electrolytically gated by an additional electrode submerged in the solution. We have found that the conductance of the suspended CNT devices changes dramatically once we induce the flow of the liquid (DI-water) using a syringe pump. The flow direction was perpendicular to the CNT axis. The device conductance increases by more than 10 μS for a typical flow rate of 10 μl/min. The change of the conductance was steeper for a higher flow rate. The suspended CNT shows enhanced sensitivity, about 20 times higher than the supported CNT devices. In addition, the electrolyte gate measurements ensure the change in the electrochemical potential surrounding CNTs during the flow of the liquid. We also found that both the suspended and the supported CNT devices were characterized by a fast rise time and a relatively slow decay. The detailed quantitative results will be presented together with the discussion about the sensing mechanisms.

Dp-173 **Maintaining conductivity of p-doped CNT-TCF to thermal treatment** BAE Jung Jun, YOON Seon Mi[1], KIM Ki Kang, LEE Young Hee(*BK21 Physics Division, Department of Physics, Center for Nanotubes and Nanostructured Composites,Sungkyunkwan Advanced Institute of Nanotechnology, Sungkyunkwan University, Suwon 440-746, Korea.* [1]*Display DeVice &Processing Lab and Analytical Engineering Center, Samsung AdVanced Institute of Technology, Post Office Box 111, Suwon 440-600, Korea.*) To improve the conductivity of single-walled carbon nanotube-transparent conducting films (SWCNT-TCFs), many researchers studied the doping effect on SWCNTs. Especially, the p/n-doping on the SWCNTs increase the conductivity of SWCNT-TCFs. However, in the nature, n-doping on the SWCNTs is difficult due to the stability of dopants in the air. We introduced two types of p-type dopants: ionic type, complex type. In the first case, the complex type dopant of $NH(SO_2CF_3)_2$ reduced the sheet resistance (R_s) of SWCNT-TCFs and maintained the R_s after heat treatment. On the other hand, ionic type dopant of H_2SO_4 could reduce the R_s, but the R_s were increased after heat treatment. This phenomena is related the interaction energy between SWCNT and dopant, and thermal stability of dopant. These were characterized by Raman spectroscopy and sheet resistance measurement.

Dp-174 **Electron transport property of ZnO nanowire field effect transistor in electrolyte environment** 박 재구, 박 지용, 이 순일, 안 영환(*아주대학교, 에너지시스템학부*) The ability to work in the electrolyte environment and the excellent gate coupling is crucial for the electrical sensing of biological molecules using nanowire devices. We report the electron transport property of ZnO nanowire field effect transistors in electrolyte environment. ZnO NWs are synthesized by chemical vapor deposition technique. A mixture of ZnO and graphite powder is placed in the quartz tube for two hours at high temperature in the flow of nitrogen gases. The diameters of the ZnO NWs were about 50 nm. The NWs were then deposited on a 200 nm thick, thermal oxide layer on a heavily doped silicon substrate that is used as back gate electrode. E-beam lithography techniques followed by gold metal evaporation and liftoff were used to define source and drain electrodes for the electrical contact of the ZnO nanowires. We have performed the electrolyte gate measurements for ZnO NWs placed in a DI-water solution and compare them with back gate measurements. Platinum wire is used to apply electrochemical potential relative to the device. The electrolyte gate response of the ZnO nanowires shows a clear n-type behavior and the transconductance of the devices are generally 50 times higher than that of the back gate measurements. To our surprise the recorded transconductance shows as high as 20 microsiemens per volt for some devices. This proves that electrolyte technique is an effective tool for gating ZnO NWs and hence they could work as sensitive biological sensors. The dependence of the transconductance on the NW diameters and the ionic concentrations will be presented.

Dp-175 **Energy-selective Photocurrent Imaging in Individual ZnO Nanowire Transistors** 박 재구, 이 상민, 이 순일, 안 영환(*아주대학교, 에너지시스템학부*) ZnO nanowires have been proposed as sensitive, UV-selective, nanoscale light detectors. Here we present scanning photocurrent microscopy with individual ZnO nanowire field-effect transistors to investigate detailed spatial information on electronic band structures especially near metal contacts. In the combined optical scanning microscope and transport measurement, a diffraction-limited laser beam is scanned to illuminate the ZnO devices while the device conductance is recorded as a function of the position of the laser spot. In particular we use the light sources with wide tuning range for the selective excitations of different energy levels of ZnO nanowire, including the defect levels. The light-induced current signals from the ZnO devices are characterized by the localized current spots found near the source and the drain electrodes for both visible and UV illuminations. The

observed polarity of the photocurrents validates the formation of n-type band-bending near the metal electrodes at zero gate-bias. The behavior of the spatially-resolved photocurrent at different gate bias will be discussed for various excitation conditions.

Dp-176 **The separation of semiconducting SWCNTs from the metallic SWCNTs using P3HT** KIM Soo Min, KIM Ki Kang[1], PARK Hyeon Ki[1], BAE Jung Jun[1], LEE Young Hee[1](*Department of Nanoscience and Nanotechnology, Sungkyunkwan University*. [1]*Department of physics, Sungkyunkwan University*.) The coexistence of metallic single-walled carbon nanotube (m-SWCNTs) and semiconducting singlewalled carbon nanotubes (s-SWCNTs) in commercially available samples has been a bottleneck for many fundamental researchers and applications. We designed a series of oligomers, which were based on the monomer 3-hexylthiophene for the separation of s-SWCNTs from m-SWCNTs in organic solvent. With increasing the numbers of head groups and the head-to-tail ratios of the hexyl group in the oligomers, semiconducting SWCNTs were more interacted with the oligomers. And the regioregularity of the oligomers is also important for the separation. Raman spectra and UV-Vis-NIR was used for characterizing the separation of semiconducting SWCNTs from metallic SWCNTs.

Dp-177 **Polarized micro-Raman spectroscopy of graphene** 윤 두희, 문 혜림, 정 현식, 손 영우[1](*서강대학교, 물리학과*. [1]*건국대학교, 물리학과*.) Graphene은 탄소원자들의 sp^2결합에 의한 벌집 모양의 2차원 구조이며, 이는 D^4_{6h} hexagonal space group에 속한다. Graphene에서의 Raman 스펙트럼을 살펴보면 E_{2g} symmetry에 의한 G 피크(~1584 cm^{-1})와 A'_1 symmetry에 의한 D 모드의 Double Resonance Raman scattering (DRR)에 의한 2 포논에 해당하는 2D 피크 (~2684 cm^{-1})가 관찰된다. 그리고 graphene 층의 개수에 따라 Raman 스펙트럼의 변화가 관찰되며 이를 이용하여graphene 층의 개수를 알아내는 데 마이크로 Raman 분광이 유용하게 이용되고 있으며 최근에는 graphene의 도핑에 따른 Raman 스펙트럼의 변화가 관측되었다고 보고된 바 있다. 원자현미경(Atomic Force Microscopy)과 마이크로 Raman 이미징 기술을 이용하여 정확히 단층 graphene 영역을 구별하고, 이렇게 구별된 단층graphene 영역에서 편광 Raman 분광 실험을 이용하여graphene 구조에 대한 광학적 특성을 연구하였다. G 피크는 입사 레이저의 편광방향 및 Raman 산란 빛의 편광 각도에 따른 변화가 없는 것이 관찰 되었고 이는 Raman 텐서를 이용한 E_{2g} 모드의 계산 결과와 일치한다. 하지만 DRR에 의한 2D peak는 Raman 산란 빛의 편광 방향에 따른 변화가 관찰되었다.

Dp-178 **마이크로 Raman 분광법을 이용한 graphene의 두께 측정 연구** 문 혜림, 윤 두희, 정 현식, 최 진식[1], 박 배호[1](*서강대학교, 물리학과*. [1]*건국대학교, 물리학과*.) Graphene은 탄소원자가 sp^2결합에 의한 2차원 벌집구조를 가지는 물질이다. 그 한 층의 두께가 약 3.4Å정도이며 순수한 2차원 구조가 존재할 수 있다는 증거가 되었다. Electric field effect와 전자의 이동도가 매우 우수하여(실험적으로 약 20,000 cm^2/Vs로 측정되었다.) 고효율의 트랜지스터 소자로 응용될 물질로 관심 받고 있으며, 상온에서의 Quantum Hall effect도 측정되어 양자소자의 응용 가능성도 보이고 있다. Graphene의 layer 수가 증가함에 따라 Raman 스펙트럼이 달라지는데, 이때 layer 수에 따른 스펙트럼의 변화로 layer 수를 알아내는 연구를 수행하였다. Graphene 시료는 흑연과 테이프를 이용하여 300 nm의 SiO_2가 증착된 Si 기판위에 제작하였다. 광학현미경(Optical microscope)을 이용하면 SiO_2와 graphene layer 사이의 간섭으로 인하여 색과 명암비가 달라지는 것을 관찰할 수 있는데, 이를 이용하여graphene의 두께를 추정할 수 있다. 하지만 이는 시스템의 환경에 따라서 색이 조금씩 틀리며 추정할 수 있는 오차의 범위도 상당히 크다. 때문에 Raman 스펙트럼이나 원자현미경(Atomic Force Microscopy)으로 측정하지 않고는 layer 개수를 정확히 판단하기 어렵다. 따라서 광학현미경을 사용하여1~20 layer 정도의 graphene으로 추정되는 것들을 찾은 후, Ar^+ 레이저(514.5 nm)를 사용하여Raman 스펙트럼을 측정하였다. 또한 원자현미경으로 실질적 두께를 측정하여 각 부분에 대하여 원자현미경 측정 결과와 Raman 스펙트럼을 비교 분석하여 Raman 스펙트럼만으로 graphene의 layer 개수를 측정할 수 있도록 연구하였다.

Dp-179 **CVD 방법으로 증착한 탄소나노튜브의 촉매 및 gas 유량에 따른 성장성 연구** 심 인보, 양 준영, 김 동휘, 윤 경환, 이 종찬, 최 동혁(*국민대학교 물리학과*.) 본 연구에서는 열화학기상증착법(Chemical Vapor Deposition: CVD)으로 탄소나노튜브(Carbon Nano Tube: CNT)를 증착하였으며, 촉매 및 CH_4 gas의 유량에 따른 CNT 성장의 영향에 대하여 연구하였다. 직경이 작고 균일한 Single Wall CNT를 성장시키기 위하여, 증착에 사용된 촉매로써, Fe와 Mo의 메탈염과 particle size 가 약 4 nm인 Al_2O_3 파우더를 사용하였다. SEM(Scanning Electron Microscope) 측정을 통하여 성장된CNT의 이미지 분석 결과, Fe와 Mo의 몰비가 10 : 1 일 경우 직진성이 좋으며 평균 직경이 약9 nm로 균일한 CNT가 성장됨을 확인할 수 있었다. 또한 CH_4 gas 유량을 변화시킴에 따라 성장되는CNT의 직경을 제어할 수 있음을 확인할 수 있었다.

Dp-180 **마이크로웨이브 처리법을 통하여 유리 기판위에 제작된 탄소나노튜브 방출원의 전계방출 특성** 권 영택, 유 동헌, 이 승엽, 최 원철, 박 종윤(*나노튜브 및 나노복합구조 연구센터(CNNC), 성균관대학교 BK21 물리연구단*) 탄소나노튜브(carbon nanotubes ; CNTs)는 나노과학기술분야에서 각광을 받고 있는 재료 중의 하나이다. 특히 LCD의 Back Light Unit (BLU) 의 광원과 Field emission display (FED) 에 사용되는 전계 방출원의 재료로서 활발한 연구가 진행되고 있다. 탄소나노튜브 방출원을 제작하는 방법으로는 직접 성장법, 스크린 인쇄법 및 스프레이 법 등이 있다. 직접 성장법은 높은 탄소나노튜브의 성장 온도와 대면적화의 어려움이 있으며 스크린 인쇄법은 기판에 잔류한 일부 유기물에 의한 outgassing 으로 디스플레이 소자의 진공도를 떨어뜨려 방출원인 탄소나노튜브의 동작 안정성을 악화시키는 단점이 있다. 본 연구에서사용한스프레이 법은 유기물에 의한 outgassing 은 거의 없지만 기판과의 점착력(adhesion)이 나쁜 단점이 있다. 이러한 단점은 전도성 합금을 증착함으로써 해결할 수 있었으며 마이크로웨이브 처리법을 사용함으로서 실리콘 기판에 방출원을 제작하는 것보다 상대적으로 낮은 온도에서 유리 기판의 변형을 최소화 하면서 전도성 합금과 탄소나노튜브의 점착력을 높일 수 있었다.전기 전도성이 우수한 합금을 증착한 유리 기판위에 1,2-dichloroethane(DCE) 용액에 잘 분산된 얇은 다중벽 탄소나노튜브(thin multi-walled CNTs)를 스프레이 법을 이용하여 균일한 두께

를 이루도록 증착하였다. 위의 기판을 마이크로웨이브를 사용하여 처리한 후 adhesive taping 과정을 통해 탄소나노튜브를 수직으로 정렬함과 동시에 적절한 밀도를 갖도록 하였다. 탄소나노튜브와 전도성 합금 필름의 표면형상(morphology)의 변화를 주사전자현미경(Scanning Electron Microscopy, SEM)을 사용하여 관찰하였으며 그에 따른 전계방출 특성의 변화와 전계방출의 안정성을 연구하였다.

Dp-181 **Control of Nanopore Morphology in Porous Anodic Alumina** BU Sang Don, CHOI Yong Chan, KIM Jongok, YANG Sun A(*전북대학교, 물리학과.*) We report a controlled fabrication of nanopore structures inside porous anodic alumina prepared by an anodization method. The nanopore structures were controlled by choosing appropriate anodizing conditions and subsequent pore widening treatment. The morphology of nanopores was characterized by field emission scanning electron microscopy. The ordered pore arrangement was strongly dependent on the anodizing voltage and time, and the highly ordered array with an average domain size of about 5 μm^2 was attained after anodization for 36 h at anodizing voltage of 40 V in a 0.3 M oxalic acid solution. Nanopores with diameter of 10 to 120 nm and length of 300 nm to 100 m were also fabricated by controlling anodizing voltage, time and time of pore widening treatment. In addition, various shaped nanopore structures, such as step-shaped and Y-branched nanochannels, were achieved by employing a pore-widening treatment in the middle of anodization and reducing the anodizing voltage by a factor of 1/(root 2), respectively.

Dp-182 **HREELS Investigation of Na Nanocluster on Si Surface** 신 선영, 황 춘규, 엄 상훈, 김 남동, 김 효상, 정 진욱(*Postech.*) A well-ordered array of nanoclusters on single crystalline solid surfaces may have a variety of potential application in nanoelectric devices, ultra-high density data storage, and nanocatalysis. It has been reported that identical-size nanoclusters of various species including Al, Ga, In, Tl, Na, Pb, Mn, Sn and Cu are self-assembled on Si(111) surface. In this work, we have studied structural and vibrational properties of Na nanoclusters formed on the Si(111)-7x7 surface at room temperature mainly using high-resolution electron-energy-loss spectroscopy. We observe three characteristic loss peaks unique to the Na nanoclusters as Na coverage q varies. The spectral change of these peaks suggest that the S1 dangling bond band is gradually filled up to open a band gap with increasing q up to 1.1 eV when two initial loss peaks are completely disappeared. We interpret the spectral behavior of these loss peaks in comparison with earlier photoemission [1] and STM study [2]. [1] J. R. Ahn et al., Phys. Rev. B 72, 113309 (2005)[2] K. Wu et al., Phys. Rev. Lett. 91, 126101 (2003)

Dp-183 **Growth Condition Dependent Characteristics of Pulsed Laser Ablated $ZnGa_2O_{4-x}S_x$:Mn^{2+} Thin Film Phosphors Grown on MgO(100) Substrate** 배 종성, 박 상신, 김 종필, 박 성균[1], 최 병춘[2], 문 병기[2], 정 중현[2], 이 성수[3](*나노표면기술연구팀 한국기초과학지원연구원.[1]물리학과, 부산대학교.[2]물리학과, 부경대학교.[3]전자재료공학과, 신라대학교.*) Mn-doped $ZnGa_2O_{4-x}S_x$ thin film phosphors have been grown using a pulsed laser deposition technique at varying growth conditions. The structural characterization carried out on a series of $ZnGa_2O_{4-x}S_x$:Mn^{2+} films grown on MgO(100) substrates using Zn-rich ceramic targets. Oxygen pressures were varied from 50 to 200 mTorr and substrate temperatures were varied from 500 to 700 °C. Epitaxial films were certainly obtained on MgO (100) substrates under certain deposition conditions due to the low lattice mismatch. The data reveals a (400) $ZnGa_2O_4$ diffraction peak, indicating {h00} plane lies parallel to the substrate. As can be seen from XRD, X-ray photoelectron spectroscopy (XPS) measurement, significant Zn loss was observed in the $ZnGa_2O_{4-x}S_x$:Mn^{2+} films deposited using a Zn-rich $ZnGa_2O_{4-x}S_x$:Mn^{2+} ceramic targets due to the relatively high vapor pressure of Zn. Measurements of photoluminescence (PL) properties of $ZnGa_2O_{4-x}S_x$:Mn^{2+} thin films have indicated that MgO (100) is one of the most promised substrates for the growth of high quality $ZnGa_2O_{4-x}S_x$:Mn^{2+} thin films. In particular, the incorporation of Sulfur into $ZnGa_2O_4$ lattice could induce a remarkable increase of PL. The highest green emission intensity was observed with $ZnGa_2O_{3.95}S_{0.05}$: Mn^{2+} films, whose brightness was increased by a factor of 3.5 in comparison with that of $ZnGa_2O_4$:Mn^{2+} films. This phosphor may promise for application to the flat panel displays. (This work was supported by KBSI grant N27078 to PI initial)

Dp-184 **SRPES study of Alkaili Metal Adsorption on 1,4-Cyclooctadiene/Si(100)2x1 Surface** KIM Seok-Hwan, PARK Ho-Young[1], JEON Chul-Ho[1], AHN Jong-Ryeol[1], PARK Chong-Yun[1], AN Ki-Seok(*한국화학연구원 소자나노재료연구센터.[1]성균관대 물리학과.*) The chemical reaction of Na with 1,4-cyclooctadiene (OD)overlayer on Si(100)2x1 surface have been studied using synchrotron radiation photoemission spectroscopy in order to investigate the possibility of organic molecule-metal multilayered structure on semiconductor surface using unsaturated functional group of molecule. As well known, the ethylene-like overlayer can be induced by OD adsorption on the Si(100)2x1 surface at RT without breaking Si dimer. At low coverage of Na adsorption on the OD/Si(100)2x1 surface, large binding energy shift of C 1s core level spectrum was induced and,interestingly, the metallic Na overlayer beyond the RT saturation at higher coverage. In this study, from work function changes, Si 2p, C 1s, and Na 2p core level shifts, and valence band spectra, the chemical reaction of Na with ethylene-like OD overlayer on the Si(100)2x1 surface are discussed.

Dp-185 **배선 소재용 전기도금 구리 및 구리-코발트 합금 박막의 물성** 황 주하, 손 동수, 류 영호, 안 성복, 김 은경, 홍 기민(*충남대학교 물리학과.*) 반도체 소자 내부의 금속배선공정에 대한 최근 동향은 새로운 배선소재와 공정에 대한 연구이다. 저저항 배선소재 개발을 위해 본 연구에서는 구리 박막과 구리코발트 합금박막을 전기도금 방법으로 제작하였다. 구리 전해액 조성변화에 따른 표면 거칠기 변화를 AFM(Atomic Force Microscopy)로 관찰하였고 비저항 변화를 관찰하였다. 또한 전기도금 용액에 가해지는 유기 첨가제의 특성을 순환전압전류

법(Cyclic Voltammetry)을 통해 조사하였다. 유기 첨가제를 도금용 구리 전해액에 미량 첨가해 전기도금한 결과 표면 거칠기가 37.1 ㎚에서 5.6 ㎚로 감소하였고 유기 첨가제의 농도변화에 따른 비저항 역시 3.13 μΩ㎝에서 1.50 μΩ㎝로 감소함을 관찰하였다. 유기 첨가제를 미량 첨가한 구리-코발트 전해액으로 제작한 합금박막의 경우 전류밀도 변화에 따른 두께변화를 FESEM (Field Emission Scanning Electron Microscopy)을 통해 측정 하였고 전류밀도 변화에 의한 조성비 변화를 EPMA (Electron Probe X-ray Micro Analysis)를 통해 측정 하였다.

Dp-186 **The Structure Analysis of NO gas on MgO (100) Powder Surface** KIM Euikwoun, LEE Jeonggil, LEE Sangwha, SHIN Hyemin, KIM Jae-yong, LEE HyunHwi[1], LEE DongRyul[1] (*Hanyang University, Department of Physics.* [1]*Pohang Accelerator Laboratory, Pohang.*) Recently, the studies of gas adsorption on metal oxides have been studied because they are useful to investigate the fine structure of the surface. We focused on nitric oxides (NOs) on MgO surface aims at finding the surface structure of adsorbed gas. The meso- sized MgO(100) powder were prepared by rf-power induction method. NO adsorption isotherm on MgO data were measured by using a computer-controlled isotherm apparatus below the triple point (108.9K). The structure of NO gas adsorption was investigated by X-ray diffraction at High Flux Materials Science Beamline (PAL-5A) of the Pohang Accelerator Laboratory. X-ray diffraction data was collected by using two dimensional image detector plate (MAR 345). The adsorption isotherm data demonstrated that NO molecules form two atomic layers on a clean MgO surface. The diffraction data showed NO diffraction peak near the Q value of 2.12 $Å^{-1}$ at 90K. The investigation of the NO peak location revealed that the NO molecules forms 1 x 1 commensurated structure on the MgO (100) surface.

Dp-187 **Growth Mechanism of the ALM Molecular Line on Si(001)** CHOI Jin-Ho, CHO Jun-hyung(*Department of Physics, Hanyang University.*) A recent STM study of Hossain et al.[1] not only reported that allyl mercaptan(ALM) lines grow in perpendicular to dimer row direction through chain reaction, but also suggested the growth mechanism. Using ab-initio density functional theory calculations, we investigate the adsorption kinetics of ALM molecule on the Si(001) surface. We calculate the energy profile for the reaction pathway proposed by Hossain et. al, but it is unlikely because of the existence of a high activation energy along the reaction pathway where H-diffusion process was involved. In the present work, we propose a new reaction pathway with lower energy barriers, thereby providing an explanation for the observed data. [1] Md. Z. Hossain, H. S. Kato, and M. Kawai, J. Am. Chem. Soc. 127, 15030 (2005)

Dp-188 **STM을 이용한 Si(111)7×7 표면과 Si(111)√3×√3-Ag위에서의 C70분자 흡착연구** 심 형준, 우 정석, 이 근섭(*인하대학교 물리학과*) C_{70}분자를 Si(111)7×7표면과 Si(111)√3×√3-Ag 표면에 여러 덮임율로 각각 흡착하였으며, 성질이 다른 두 표면으로부터 명백히 다른 C_{70}분자의 흡착양상을 STM을 이용하여 관찰하였다. Si(111)7×7 표면의 경우, 낮은 덮임율에서 상온 흡착된 C_{70} 분자들이 표면에 무작위(randomly)로 분포하고, 덮임율을 증가시켜 상온 증착을 한 후 표면을 post annealing하면 C_{70}분자들이 서로 반데르발스 힘이 작용되어 결합을 이루면서 국지적으로 정돈된 육각형(hexagonal)배열 구조를 형성하게 된다 반면, C_{70}분자는 Si(111)√3×√3-Ag 표면의 테라스 위에서 자유로이 이동하여 표면 C_{70} 상호작용이 상대적으로 강한 테라스의 가장자리 혹은 defect site에 우선 흡착한다. 덮임률을 증가함에 따라 테라스 경계에서부터 여러 가지 육각형 배열 구조의 C_{70}섬(island)로 성장해 나온다. C_{70}섬의 분자들의 배열 방향과 C_{70}-C_{70}거리를 측정하여 C_{70}섬의 흡착 구조 모델들을 결정하였다.

Dp-189 **Initial growth mode study on YSZ films on Si (100) using x-ray photoelectron spectroscopy: Role of second nearest neighbors and interface charge effect** 박 상신, 배 종성, 정 의덕, 김 영철[1], 박 성균[1](*한국기초과학지원연구원 부산센터,* [1]*부산대학교 물리학과.*) 최근 Si 기판 위에 epitaxial한 산화물 박막을 만들기 위한 연구가 활발히 진행되고 있다. 하지만 Si 기판 위에 박막을 증착하게 되면 박막과 Si 기판과의 격자 불일치 성 정도가 클 뿐 아니라 Si이 박막위로 diffusion되는 문제점이 발생한다. 이러한 문제점을 해결하기 위한 대응책 중 한가지가 Yttrium-stabilized Zr_2O_3 (YSZ)를 buffer layer로 사용하는 것이다. Si기판 위에 YSZ를 buffer layer로 증착하게 되면 Si기판과 YSZ layer의 계면에서 chemical reaction이 활발하게 진행되며 이러한 reaction은 YSZ를 증착하는데 중요한 요소로 작용한다. 이번 연구에서는 실온에서 Pulsed-laser deposition system으로 Si 기판 위에 YSZ 박막을 증착한 후 700도에서 챔버내의 분위기를 바꾸어가며 후열처리를 하였고, x-ray photoelectron spectroscopy(XPS)를 이용하여 YSZ와 Si기판 사이의 계면에서 일어나는 Zr, Si, O 등의 chemical reaction에 대해 조사하였다. Si2p peak의 경우는 Si^o와 $Si4^+$로 분리되는 것을 확인할 수 있었다. 이 때 Si^o peak의 binding energy (BE)가 순수한 Si^o 보다 낮은 쪽으로 이동하게 되는데, 이것은 증착하는 동안 Si기판과 YSZ 박막의 사이에 positive charge가 축적되는 charging effect 때문인 것으로 알 수 있었다. [1]. 이 charging 현상은 후열처리과정을 통해서 사라졌다. Zr3d peak의 경우는 BE가 열처리 후 순수한 metal oxide Zr의 BE보다 0.32eV정도 높은 BE로 이동함을 알 수 있었는데, 이러한 BE의 이동은 second nearest neighbor element (Zr-O-Si bond)의 전자친화력이 Zr oxide (Zr-O-Zr bond) 보다 강하기 때문에 발생한 것으로 보인다. 위에 같은 다양한 결과를 통해 Si(100)기판 위에 high quality의 YSZ film을 성장시키기 위해서는 증착 시 기체분위기와 그 기체의 양이 중요한 변수로 작용한다는 것을 확인할 수 있었다. 본 과제는 기초과학지원연구원의 자체연구사업비 (N28075)에 의하여 진행되었음을 알립니다. [1] R. L. Opila, G. D. Wilk, M. A. Alam, R. B. van Dover, and B. W. Busch, Appl. Phys. Lett. 81, 1788 (2002)

Dp-190 **Off-Axis RF sputtering 방법으로 제작되어진 에피한 (0.2)Bi($Zn_{1/2}Ti_{1/2}$)O_3-(0.8)$PbTiO_3$ 박막의 성장과 구조 특성에 관한 연구** 권 대영, 김 봉주, 김 선화, TONG peng, 김 복기(*부산대학교 물리학과*) 우리는 (0.2)Bi($Zn_{1/2}Ti_{1/2}$)O_3-(0.8)$PbTiO_3$(BZT-PT) 강유전체 박막에 대하여 성장과 구조 특성에 관하여 연구를 하였다. BZT-PT 박막은 off-axis RF sputtering 방법으로 약 8.9 nm에서부터 60.8 nm 의 두께를 가지는 박막을 준

비 하였으며, lab xrd 및 포항 방사광 가속기를 이용하여 분석을 하였다. 높은 tetragonality 임에도 불구 하고, BZT-PT는 $SrTiO_3$(001) 기판위에 high-quality로 에피하게 성장을 하였음을 확인하였다. 박막의 두께와 거칠기는x-ray reflectivity를 통하여 관측을 하였으며, 구조 분석을 통해 박막의 두께에 따른strain relaxation 현상을 관측하였다. 또한 rocking curve 및 거칠기 변화의 분석을 통하여 strain relaxation의 원인을 규명하고자 한다.

Dp-191 **First-Principles Study of the Adsorption and Reaction of Acetone on Si(001)** LEE Jun-Ho, CHO Jun-Hyung (*Department of Physics, Hanyang University.*) The adsorption and reaction of acetone on the Si(001) surface are investigated by first-principles density-functional calculations within the generalized gradient approximation. We find that the carbonyl O atom initially bonds to the down Si atom of the buckled dimer forming a dative-bonding configuration. Subsequently, the dative-bonding configuration undergoes the C-H dissociation through the intradimer- or interdimer-transfer of the H atom, and the [2+2] cycloaddition reaction where the C-Si and O-Si bonds are formed. Here, the [2+2] cycloaddition structure remains stable, while the two C-H dissociation species proceed to the formation of the end-bridge(EB) structure where acetone adsorbs across the ends of two adjacent dimers in the same dimer row and the dimer-bridge(DB) structure where acetone adsorbs on top of a single dimer with both Si-O and Si-C bonds. We predict that as temperature increases, the less-stable [2+2] cycloaddition structure can be converted to the more-stable EB and DB structures. Based on our calculated energy profiles for the reaction pathways, we not only interpret the observed single dimer structure in terms of the [2+2] cycloaddition structure, but also provide an explanation for the observed conversion from the single dimer structure to the DB or EB structures.

Dp-192 **First-principles study of topological defects on clean Si(100) surface** KIM Min-Kook, CHOI Hyoung Joon (*Department of Physics and IPAP, Yonsei University.*) The effects of local structural defects on clean c(4×2) reconstructed Si(100) surface are studied, using an *ab-initio* pseudopotential density functional method. We used the local density approximation to the density functional theory with pseudo-atomic orbitals. The atomic structures of defects are optimized by minimizing the total energy. The increased total energy due to the defects is attributed to the energy difference between p(2×1) and c(4×2) reconstructed surface structures. It is also confirmed that there exists an energy barrier for creating the defects. We calculated the local density of states at several energy intervals for unoccupied states to investigate the effects of the defects on the surface electronic structures. This work was supported by the KRF (KRF-2007-314-C00075), the KOSEF Grant No. R01-2007-000-20922-0, and KISTI Supercomputing Center (KSC-2007-S00-1011).

Dp-193 **Simulation of STM images and ARPES spectra of graphene on Au and Ti surfaces** GOH JUNG SUK, CHOI HYOUNG JOON(*Department of Physics and IPAP, Yonsei University.*) We study graphene-metal contacts for two metals, Ti and Au, based on first-principle density functional method. We investigate the equilibrium distances, binding energies, and potential barriers in the graphene-metal systems, and simulate the scanning tunneling microscopy (STM) and angle-resolved photoemission spectroscopy (ARPES). Our simulated STM images show periodic patterns which are strongly related to vertical changes of carbon-atom positions. Electronic structures near the Dirac point are studied by the simulated ARPES spectra.
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Dp-194 **First-principles investigation for the Au-induced Si(111)5x2 reconstruction** 정 호진, 염 한웅(*원자선 원자막 연구단, 연세대학교*) The Si(111)5×2-Au surface, which occurs at 0.4-0.5 ML Au coverages, has been used as a prototypical model of the one-dimensional (1D) surface superstructures formed on semiconductors. A strong metallic band and its dimensionality change from 1D near the Ferm energy to 2D at higher binding energies were observed on this surface. In addition, our group recently reported two interesting observations; (i) a unique metal-insulator transition with systematic tuning of the surface band-gap via dopant (Si adatom) coverage control, and (ii) a soliton-like fluctuation of 1D dislocation confined by paired adatoms (these results will be published separately in Phys. Rev. Lett.). However, the origins of these fabulous behaviors have not been made clear, mainly because of the limited structural information of the surface. In this respect, we have perform a systematic investigation on the atomic and electronic structures of the Si(111)5×2-Au surface using a first-principles calculation method. We have extensively searched the atomic structure of the surface at different Au coverages of 0.4-0.5 ML. By the comparison of the surface energetics, we propose a new structural model with Au coverage of 0.5 ML, which is in sharp contrast with the previously suggested ones of 0.4 ML. The present structural model consists of Si-honeycomb-chain structure and two 1D atomic chains. One atomic chain is formed by Au atoms with ×1 periodicity, and the other one by alternating Au and Si atoms with ×2 periodicity. This model reproduces well the characteristic STM images and parts of the electronic bands. The details of the atomic and electronic structures of the surface as well as the comparison with the previous experimental and theoretical results will be presented.

Dp-195 **Electric Field Effects On Atomic And Electronic Structures Of Epitaxial Graphene On SiC: A First-Principles Study** LEE Hyungjun, SON Young-Woo[1], CHOI Hyoung Joon(*Department of Physics and IPAP, Yonsei University.* [1]*Department of Physics, Konkuk University.*) We have performed first-principles calculations of atomic and electronic structures of epitaxial graphene on SiC(0001) under applied electric fields. We employed *ab initio* pseudopotential density functional methods within the local density approximation. To incorporate a large number of atoms in the sys-

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tem, we expand the wave function with localized basis sets. Effects on energy gaps and midgap states at the Dirac point are analyzed by simulating angle-resolved photoemission spectra.

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Dp-196 **ZnO 박막의 전자구조연구** 오 세정, 박 원구, 이 승혁(*서울대학교 자연과학대학 물리천문학부*) LCD, PDP, 태양전지등의 수요와 관심이 늘어나면서 ZnO와 같은 투명전극 으로 사용할 있는 물질 재료들이 많은 관심 끌고 있다. ZnO의 경우 박막으로 증착시에 자연스럽게 n-type 전기전도성을 보여지는데 이것의 원인이 산소 빈자리 때문인지 결정구조 격자의 사이에 추가된 Zn 때문인지에 대해 많은 논쟁이 있다. Pulsed Laser Deposition(PLD)를 이용하여 ZnO 박막을 Si 기판에 조건을 변화시켜 증착하여 XRD로 박막이 제대로 된 구조로 쌓였는지 확인하고 XPS를 사용하여 Zn와 O의 구성비를 조사하고, XAS를 사용하여 전도전자띠를 분석한다.

Dp-197 **Anisotropy of the Photo-Induced Translation Diffusion of Liquid Crystal Molecules on the Azo-Polymer Surface** CHOI Hyunhee, WU J. W.(*Department of Physics and Division of Nano Sciences.*) It is already well known that the large amplitude surface relief gratings are optically fabricated by resonant visible exposure on the azobenzen containing polymer surface and there are many study to propose the model accounting for the dynamics of the surface relief grating formation. However, a real understanding of these phenomena is shown not to be fully accomplished. In this study, we coated the liquid crystal(LC) on the azobenzen polymer and manipulated the liquid crystal molecules interacting with azo moieties controlled by the 514 nm, laser beam with linear and circular polarizations. The resultant large birefringence of LCs allowed us to observe the azo moieties dynamic motions on the azo-containing polymer film by using the typical polarization microscope and a cross polarization set-up, and we are convinced that a worm-like motion model can describe the essential dynamic features of azo-moieties. These results may be used to manipulate molecules by intermediation of the optically controlled azo-moieties so that more advanced applications will be born.

Dp-198 **X-ray-Induced Rapid Control of ZnO Film Wettability** KWON Yong Bum, WEON Byung Mook, WON Kyu Hwang, JE Jung Ho(*POSTECH, X-ray Imaging Center, Dep. Mater. Sci. &Eng.*.) Wettability change by external perturbation is an important surface phenomenon throughout nature and technology. In particular, light-induced wettability control using UV or visible light remains a challenge for rapid transition despite its potential such as remote controllability and individual addressability. Here, we report a rapid, reversible transition by X-ray-induced wettability change of ZnO films. A brief irradiation of X-rays (10-60 keV) is appropriate to trigger a rapid, switchable transition between hydrophobicity and hydrophilicity. This rapid transition is attributed to fast dynamics of charging or discharging on ZnO films by X-ray-induced photoemission. This work shows a feasibility of X-ray-induced rapid wettability control for many potential applications.

Dp-199 **Comparison of elastic properties between the aspirin crystal and the glassy aspirin** KO Jae-Hyeon, LEE Kwang-Sei[1], IKE Yuji[2], KOJIMA Seiji[3](*Hallym University, Department of Physics.* [1]*Inje University, Department of Nano Systems Engineering.* [2]*University of Tsukuba, Graduate School of Pure and Applied Sciences, Japan.* [3]*University of Tsukuba, Institute of Materials Science, Japan.*) Brillouin spectra of aspirin crystal and amorphous aspirin in its glassy phase have been measured as a function of temperature. One longitudinal and one transverse acoustic modes were observed in the crystal phase of aspirin. The calculated elastic constants were much smaller than those of typical dielectrics, suggesting that the aspirin is a very soft material. The temperature dependence of these acoustic modes was dominated by usual lattice anharmonicity without any signature of structural phase transition in the investigated temperature range from the melting point down to 77 K. On the other hand, one longitudinal acoustic mode was observed in the glassy phase of aspirin, which was prepared by quenching the liquid aspirin. The temperature dependence of the Brillouin shift of this mode showed a clear change at about 240 K, indicating a transformation from glassy phase to supercooled liquid phase. The acoustic damping of the acoustic mode in the glassy phase was much larger than those of two acoustic modes in the crystal phase of aspirin. * This work was supported by the KoreaResearch Foundation Grant funded by the Korean Government (MOEHRD,Basic Research Promotion Fund) (KRF-2006-331-C00088).

Dp-200 **The resistance switching and transport properties of NiO thin films** KIM D.-W., PARK C.W.[1], CHAE S.C.[2](*이화여자대학교.* [1]*안산 한양대학교.* [2]*서울대학교.*) 우리는 Pt/Ti/SiO_2/Si과 Pt/Sapphire (0001)기판 위에 NiO thin films을 thermally 성장시키고 또한 NiO를 성장시킬 때의 oxidation temparature를 673K과 873K으로 하여 제작한 시료들에 대한 resistance switching과 transport properties를 연구하였다. Sapphire기판 위에 성장된 시료의 경우, Si기판 위에 성장된 시료의 경우보다 high resistance state의 resistance가 더 작음이 관찰되고 재현적인 switching이 힘들어 보인다. 또한 두 기판 위에 성장된 시료들의 high resistance state의 경우의 current-temperature 측정을 통한 $\ln(I)$-$1/k_BT$ plot으로 oxidation temperature가 크게 되면 activation energy 값이 더 크다는 것을 보여준다. 이러한 결과를 바탕으로 NiO thin films의 crystal structure와 defect concentration의 차이가 resistance switching과 transport properties에 영향을 끼침을 알 수 있다.

Dp-201 **Polarization switching behaviors in multiferroic $BiFeO_3$ films** KIM Tae Heon, ORTIZ Daniel[1], JO Ji Young, YANG Sang Mo, KIM Yong Su, PARK Seung-young[2], JO Younghun[2], JUNG Myung Hwa[2], EOM Chang Bum[1], NOH Tae Won(*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul, Korea.* [1]*Department of Materials Science and Engineering, University of Wisconsin-Madison, USA.* [2]*Quantum Materials*

Research Team, Korea Basic Science Institute, Daejeon, Korea.) Multiferroic materials, which show a magnetic ordering through an electric field and vice versa, have been considered as an important issue in view of applications for micro-scale devices as well as fundamental physics. Especially, multiferroic $BiFeO_3$ (BFO) is one of remarkable materials due to its large remnant polarization and weak ferromagnetic property at room temperature. However, because many researches in multiferroic BFO have been mainly focused on the probing of their ferroelectric properties, detailed studies for domain switching process in BFO films with complicated ferroelectric domain structures have been rare. Here, we will show polarization switching behavior of multiferroic (001), (101), (111)-oriented BFO films through a transport measurement and piezoresponse force microscopy (PFM). Each BFO film was epitaxially grown on $SrTiO_3$ (STO) (001), (101), (111) substrates with Pt/BFO(200nm)/$SrRuO_3$(100nm) heterostructure. We found that polarization switching behavior of respective BFO films is definitely different in a low field region less than a coercive field. Actually, a local field distribution for ferroelectric domain switching in (001) BFO films was narrower than that in (101), (111) BFO films. Also, from PFM images, we found that domain size in BFO films is much larger than that in conventional ferroelectric films. And, through this result, we could partially explain polarization switching behavior of BFO films.

Dp-202 **Sol-Gel 법으로 제작한 $Pb_5Ge_3O_{11}$(PGO) 박막의 유전특성** 정 창희, 이 호섭(*창원대학교 물리학과*) 자발분극의 방향이 c-축 방향으로만 존재하는 일축성 강유전체 $Pb_5Ge_3O_{11}$(PGO) 박막을 Pt(111)/Ti/SiO_2/Si(100)기판 위에 sol-gel 법으로 제작하였다. PGO 박막 시료 제작의 최적 열처리 조건은 한 층씩 코팅한 후 350 °C에서 5분간 전열처리(preheating)하고, 적당한 두께를 얻은 시료를 600 °C에서 1시간 30분 후열처리(annealing)하는 것이었다. 이러한 최적조건으로 얻어진 시료에 전극을 증착하여 P-E hysteresis loops와 Capacitance-applied Voltage 및 주파수에 따른 유전상수를 측정하였다. Non-perovekite 구조, 일축성 강유전체 PGO는 유전상수와 잔여 분극률이 작아서 강유전체를 이용한 메모리 연구분야에서 특히1T 메모리 응용에 적당하다고 볼 수 있다.

Dp-203 **Effects of strain and defect dipoles on occurrence of ferroelectricity in strontium titanate thin films** 김 용수, 문 순재, 최 우석, 장 영준, 김 태헌, 양 상모, 이 대수, 장 승엽, 김 지연[1], 유 재준[1], 최 진식[2], 박 배호[2], 윤 종걸[3], 정 진석[4](*ReCOE &FPRD, Department of Physics and Astronomy, Seoul Nat'l Univ.. [1]CSCMR &FPRD, Department of Physics and Astronomy, Seoul Nat'l Univ.. [2]Department of Physics, Konkuk Univ.. [3]Department of Physics, University of Suwon.. [4]Department of Physics and CAMDRC, Soongsil Univ..*) Strain- and defect dipole-induced ferroelectricity were investigated on the strontium titanate (STO) thin films. Incipient ferroelectric $SrTiO_3$ retains its paraelectric phase down to 0K. Namely, it doesn't go through ferroelectric transition due to strong competition between intrinsic factors, such as quantum fluctuation and/or the antiferrodistortion. Such a sharp equipoise could be easily broken by external processes, such as putting dopants, substituting isotope oxygen, and/or applying external stress. In spite of numerous reports on induced ferroelectric STO films, the direct evidences of ferroelectricity have been rear. In addition, the reported values of the Curie temperature enhancement were not so large. In this work, I observed room-temperature ferroelectricity on STO films on $SrTiO_3$ (001) substrates. I grew fully strained SRO/STO/SRO heterostructures on $SrTiO_3$ (001) substrates with varying deposition oxygen partial pressure (P_{O2}). Coherently grown STO films without in plane lattice relaxation have tetragonal structure even on $SrTiO_3$ substrate and tetragonality increase with decreasing P_{O2}. STO films, which were deposited at P_{O2} = 1 and 0.2 mTorr, have greater tetragonality than that of ferroelectric BTO. From piezoresponse force microscopy tests, we could observe the piezoelectric response and stable, read-and-writable, and reversible piezoresponse domain at room temperature. From electrical measurements, we observed *P-E* hysteresis loops, which are most convincing evidence of ferroelectricity, even on room-temperature. The maximum misfit strain, -4.3×10^{-3}, between STO films and $SrTiO_3$ substrate is just can raise the Curie temperature up to around 150K. Therefore, we purely cannot ascribe the observed room-temperature ferroelectricity of STO films only to biaxial strain. From electrical and stoichiometry measurement, we found that STO films have insulating characteristics and show decrease of relative ratio of Sr as decreasing P_{O2}. Therefore, we expect that the formation of defects, which have neutral charge state, during deposition. These defects dipole might be an additional contributor of ferroelectricity on STO films. In order to investigate the intriguing possibility, we fabricated tensilely stressed STO films on $GdScO_3$ (110) substrates. Surprisingly, we could observe the piezoresponse and *P-E* hysteresis loops along out-plane direction at room temperature. From these convincing experimental results, we could assert that defect dipole should be an important contributor of ferroelectricity in the STO thin films. From first principle calculations, it is revealed that Sr-O-O vacancy clusters create deep localized states in the band gap of STO without affecting its insulating property. Localized states were manifested by optical absorption spectra obtained from STO thin films deposited at the same condition of ferroelectric STO films. We found that the orientation of defect dipoles, to which room-temperature ferroelectricity of STO films was attributed, could be reversed by the migration of oxygen vacancy under external electric field. This work provides a possibility of exploiting oxygen vacancies and their complexes for inducing or modifying functional properties of oxides.

Dp-204 **Solid-State ^{195}Pt NMR Measurements of Pt Nanoparticles in a Membrane Electrode Assembly of Direct Methanol Fuel Cell** HAN Kee Sung, KIM Seong-Soo[1], MEAN B. J., KANG K. H, CHOI H. H., LEE Moohee, HAN Oc Hee[1], KWAK C. Y.(*Konkuk University, Department of Physics. [1]Korea Basic Science Institute, Daegu Center.*) The nano-sized Pt particles have drawn a great deal of scientific attention due to its important applications such as heterogeneous catalysts for fuel cells. The electronic

structure of the catalysts depends strongly on metal particle size, surface morphology, supporting materials and preparation history, etc., as well as catalytic activity. The electronic structure of Pt catalysts in a membrane electrode assembly (MEA) may altered because there are three phase boundaries around Pt particle surface due to addition of Nafion ionomer for proton conduction and MEA binding. To investigate Nafion additional effects on the electronic structure of Pt particles, we performed ^{195}Pt nuclear magnetic resonance (NMR) experiments at 8 T on the MEA of DMFC, which are made of 60% Pt/C (average particle size~3.4 nm) catalyst, with and without the Nafion in the temperature range of 10~80 K. The ^{195}Pt NMR spectrum obtained at 20 K shows a typical spectral shape but another signal arises next to surface peak position due to Nafion adsorption onto Pt particle surfaces in the Nafion-containing sample. The T_1T is constant for the Nafion-containing sample, which is a NMR fingerprint of metallic states. However, T_1T increases as temperature increases in the non-Nafion-containing sample. This result suggests that the abnormal behavior of T_1T may be caused by an interaction of the Pt catalysts with the carbon cloth and the addition of Nafion. This indicates that the electronic properties of Pt catalysts may significantly change depending on an environment around the catalysts.

Dp-205 **Simulations of B_1 Field Distribution in Toroidal Cavity Resonator for NMR Measurements** HAN Kee Sung, JUNG Ho Sang, LEE Moohee, HAN Oc Hee[1](*Konkuk University, Department of Physics.* [1]*Korea Basic Science Institute.*) The toroidal cavity resonator have already developed intuitively to investigate the catalytic properties of a direct methanol fuel cell under the real operating conditions by using nuclear magnetic resonance (NMR). However, the probe heads show relatively low NMR sensitivity, poor spectral resolution and spatial resolution due to its intrinsic constraints such as shape, structure and materials. So it is important to overcome the constraints to improve sensitivity and both resolutions. As a first step for this, we have simulated mapping of the B_1 field inside of the toroidal cavity resonator. In this presentation, our probe design ideas for the *in situ* NMR measurements of DMFCs will be introduced and the simulated B_1 field profile in the probe heads will be shown.

Dp-206 **Photoluminescence characterizations of Sm^{3+}-doped SrS phosphors** 하 명규, 정 의덕, 김 상민[1], 양 호순[1], 홍 경수(*한국기초과학지원연구원 하이테크부품소재연구지원센터* [1]*부산대학교 물리학과*) We synthesized trivalent samarium ions-doped strontium sulfide powders using sulfurizing flux method, where sodium carbonate is used as a fluxing agent. The obtained strontium sulfide phosphors have larger size resistant to the moisture. We characterized the synthesized powders using XRD patterns, and investigated the properties of strontium sulfide phosphors by measuring excitation and emission spectra in terms of the concentration of doped samarium ions. We found the solid solubility limit of samarium ions and the concentration quenching effects in synthesized strontium sulfide phosphor materials.

Dp-207 **Structural studies of metal hydrides $Ti_{0.32}Cr_{0.43}V_{0.25}H_x$** PARK Junghwan, KIM Youngsoo, PARK Je-Geun, CHO Sung-Wook[1](*SKKU, Physics Dept..* [1]*KIGAM.*) Recently, there has been much interest in hydrogen absorbing materials as the world is fast moving toward the future non-fossil oil-based economy. Although there have been some progresses on several areas of these vast activities, the current status of R &D is still at its infant state requiring much more basic researches. One of the key technological issues in the so-called hydrogen economy is to discover ideal hydrogen storage materials. Among several candidate materials, Ti-based transition metal alloys are particularly extensively studied. Especially, metal hydrides have attracted much attention due to their small volume, low equilibrium pressure and high safety. For example, Ti-Cr-V alloy has been investigated because of its high storage capacity of about 3.8 wt%. Here we report our recent works on related materials using both neutron and synchrotron diffraction techniques. We have studied $Ti_{0.32}Cr_{0.43}V_{0.25}H_x$ to understand the position and mechanism of hydrogen using neutron and synchrotron diffraction techniques. We have also employed a newly developed MEM technique in our analysis of the neutron and synchrotron diffraction results.

Dp-208 **Domain Wall Motion in Epitaxial $Pb(Zr,Ti)O_3$ Capacitors Investigated by Modified Piezoresponse Force Microscopy** YANG S. M., JO J. Y., KIM D. J., SUNG H., NOH T. W., LEE H. N.[1], YOON J. G.[2], SONG T. K.[3](*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [1]*Materials Science and Technology Division, Oak Ridge Nat'l Lab. Oak Ridge, USA.* [2]*Department of Physics, University of Suwon, Suwon, Gyunggi-do 445-743, Korea.* [3]*School of Nano and Advanced Materials Engineering, Changwon National University, Changwon, Gyeongnam 641-773, Korea.*) Polarization can be switched by external electric field, via nucleation and wall motion of domains with opposite polarity. Investigation of domain switching dynamics in ferroelectric capacitors can give us physical understanding of the elastic objects driven by an external force in disordered media as well as technological solution of the applications such as ferroelectric random access memories. Here, we report experimental results on domain wall motion in ferroelectric capacitors.We deposited epitaxial $PbZr_{0.2}Ti_{0.8}O_3/SrRuO_3$ thin films on SrTiO3 (001) substrates by pulsed laser deposition and prepared the Pt top electrode with 100μm diameter. In order to investigate domain wall motion in ferroelectric capacitors, we used modified piezoresponse force microscopy (PFM). We modified our PFM configuration by adopting a separate probe needle to provide a reliable electric contact to the top electrode. So, the PFM cantilever would work only as the scanning probe. Using our modified PFM, we obtained successive images of domain evolution reliably. We could obtain directly domain wall speed (v) from the PFM images and found that v decreases with increases in domain size.

Dp-209 **Controlling Switching Behaviors of Electric Polarization in Multiferroic $HoMnO_3$ Thin Films** LEE Daesu,

JOH Geon Woo[1], JANG Seung Yup, LEE Cheol Eui[1], NOH Tae Won(*ReCOE &FPRD, Department of Physics and Astronomy, Seoul National University, Seoul, Korea.* [1]*Spin Dynamics Lab, Department of Physics, Korea University, Seoul, Korea.*) There has been much effort to rebuild existing bulk materials into thin films. Especially in ferroelectrics, their physical properties have been tuned by various control parameters during film deposition. For example, it has been reported that the ferroelectricity can be enhanced using strain engineering. However, there have been few studies on controlling the polarization switching behavior itself, for instance, from ferroelectric (FE) switching to antiferroelectric (AFE)-like switching. We found that controlling the switching behaviors of electric polarization could be realized through a pulsed laser deposition (PLD) of $HoMnO_3$ thin films. As the oxygen partial pressure during the deposition was increased, the switching behaviors showed a continuous change from AFE-like double switching to biased FE switching. The defect-dipoles inside the films might induce this interesting phenomenon. The experimental and theoretical considerations on this will be presented. Our study suggests that the switching behavior of electric polarization itself can be tuned by parameters of PLD, esp., oxygen partial pressure.

Dp-210 **실리콘 기반 양자컴퓨터에서 큐빗 연산의 원리를 실증하기 위한 Si:P의 전자스핀공명 연구** 송 명훈, 정 현욱, 정 민기, 강 병기, 이 순칠(*한국과학기술원 물리학과*) 인(P)을 도핑한 실리콘(Si)은 불순물 농도에 따라 Metal-Insulator (n_c ~ 3 x $10^{18}/cm^3$) 전이를 보이는데, 부도체 영역에 해당하는 시스템이 고체상태 양자컴퓨터 소자의 후보로 최근 제안되었다. 불순물로 들어간 인의 핵스핀으로 큐빗을 구현하는 이 시스템은 대체로 DiVincenzo의 기준을 잘 만족한다. 실리콘 기반의 양자컴퓨터 모델에서 큐빗의 연산은 인의 핵스핀과 전자스핀간의 초미세상호작용의 세기를 외부의 전기장으로 조절하여 구현된다. 초미세상호작용의 전기적 조작은 단일 큐빗 연산에서는 큐빗 배열내에서 조작하고자 하는 큐빗만을 어드레싱할 수 있게 해주고, 큐빗간의 연산에서는 큐빗간의 상호작용의 세기를 조절할 수 있게 해 준다. 이러한 큐빗 연산의 원리를 실험적으로 증명하기 위해서 전기장을 Si:P 샘플에 인가한 체로 전자스핀공명(Electron Spin Resonance) 실험을 하였다. 전기장의 세기는 2~3V/um이고, 시료의 크기는 30mm x 5mm x 0.25mm, 불순물 농도는 부도체 영역에 속하는 6.88 x $10^{16}/cm^3$이다. 대부분의 도너 전자들이 인 핵 주위에 국지화되어있기 때문에, 전자스핀은 인 핵스핀과 강한 초미세상호작용을 한다. 전자스핀공명선은 스핀 1/2을 가진 인 핵스핀의 방향에 따라 두 개로 갈라지게 되고, 두 공명선 사이의 거리는 인 핵스핀과 전자스핀간의 초미세상호작용의 세기에 해당되는데, 자기장 단위로 42Gauss이다. 전기장에 의해서 초미세 상호작용의 세기가 감소하면 전자스핀공명선 사이의 거리도 좁아질 거라 예상되는데, 2~3V/um 전기장 하에서는 2Gauss 정도 이동한다.

Dp-211 **Fabrication of multiferroic $ErMnO_3$ thin films and reentrant spin glass behavior of the films** JANG Seung Yup, LEE Daesu, LEE Jung-Hyuk, JO Younghun[1], JUNG Myung-Hwa[1], NOH Tae Won(*ReCOE and FPRD, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea.* [1]*Quantum Material Research Team, Korea Basic Science Institute, Daejeon 305-333, Korea.*) Hexagonal $RMnO_3$ (R = Ho, Er, ... , and Lu) have been attractive materials to physicists not only for improper ferroelectricity but also for their complex magnetic structure. Moreover, recent studies demonstrate that ferroelectric and magnetic order parameters of hexagonal $RMnO_3$ are coupled in low temperature, and consequently induce magnetoelectric effects. We successfully fabricated $ErMnO_3$ thin films on YSZ (111) and Pt (111) / Al_2O_3 (0001) by a pulsed laser deposition technique. We measured high resolution x-ray diffraction (HRXRD) pattern to confirm the epitaxial growth. The $ErMnO_3$ films show ferroelectric hysterisis loop similar to other hexagonal $RMnO_3$ thin films. We also investigated the magnetic structure of the films and found that the films deposited at low oxygen partial pressures shows spin glass behavior in low temperature, which is unusual in bulk hexagonal $RMnO_3$. Moreover, the low temperature spin glass state has reentrant character. To clarify the origin of spin glass behavior, we checked the stoichiometry of our thin films. The electron probe x-ray micro analyzer (EPMA) measurements reveal that our films have Mn deficiency. The x-ray photoemission spectroscopy (XPS) measurements suggest that the films deposited at low oxygen partial pressures have relatively large amount of oxygen vacancies compared to the films deposited at high oxygen partial pressures. Our study reveals that Mn deficiency and oxygen vacancy in Mn-O polyhedra can increase the local disorder effect in magnetic ground state of $ErMnO_3$ and finally induce the reentrant spin glass behavior.

Dp-212 **Theoretical study of $CdLa_2S_4$ for a photo-catalyst** 박 찬현, 공 기정, 장 현주, 백 진욱, 문 상진(*한국화학연구원*) 빛을 받으면 촉매 반응을 일으키는 광촉매 물질은 에너지, 환경 등 다양한 분야에서 연구되고 있다. 특별히 수소를 사용한 대체에너지에 대한 관심이 높아지면서, 빛에 의한 물분해 수소 발생용 광촉매의 연구가 중요하게 다루어지고 있다. 이러한 광촉매 물질이 가지는 성질 중에 띠틈(band gap)이 빛의 주파수에 따른 촉매효과를 크게 결정한다. 그래서 우리는 제일원리 계산 방법(VASP)을 이용하여 $CdLa_2S_4$의 전자구조와 함께 광촉매 가능성을 알아보았다. $CdLa_2S_4$의 구조는 Th_3P_4-type으로 $I4^{-}3d$ 대칭성을 가지고 있지만, 정확한 구조는 알려지지 않았다. 그래서 우리는 먼저 결정의 크기와 구조가 비슷한 Th_3P_4-type의 La_3S_4로부터 $CdLa_2S_4$ 구조를 조사하였다. 이렇게 결정된 $CdLa_2S_4$에서 전자구조계산을 다시 수행하였다. 연구결과 $CdLa_2S_4$는 띠틈(band gap)이 약 1.8eV로 광촉매 가능성을 확인하였다.

Dp-213 **The recovery of Inversion symmetry in multilayered $Bi_{3.75}La_{0.25}Ti_3O_{12}$ thin film** PARK sungmin, PARK Doyoung, JEON yoonnam, PAK jaemoon, KIM doseok, CHEONG Hyeonsik, PARK Gwang-Seo(*Dept. of Physics, Sogang University.*) The inversion symmetry of multilayered $Bi_{3.75}La_{0.25}Ti_3O_{12}$ (BLT0.25) thin film deposited on Pt (111)/ $Ti/SiO_2/Si$ was investigated. The films were prepared by chemical solution deposition process. The crystal orientation of films was measured by x-ray θ-2θ method. In particular, Polarized Raman spectroscopy and Second harmonic generation (SHG) were em-

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ployed to observe the modification of the internal vibration modes in TiO_6 octahedra and the inversion symmetry, respectively. The films have preferentially (117) orientation. $B_{2g}+B_{3g}$ modes identified by 537 and 566cm^{-1} get close as an increase in the number of layer, largely implying the recovery of inversion symmetry of the BLT0.25 thin film. In this study, we will investigate the reason why this modification of inversion symmetry occurs.

Dp-214 **RRAM에 이용되는 Nb_2O_5 박막의 특성 연구** 최정애, 강 성웅, 최 진식, 황 인록, 전 상호, 김 상훈, 홍 사환, 이 진호, 오 광택, 박 배호, VADIM Yalishev(*건국대학교, 물리학과.*) 차세대 메모리 중 RRAM은 인가된 특정 전기장에 따라 두 가지의 안정된 저항상태로 전이되는 전도성 전이 특성을 이용한 메모리 소자이다. RRAM은 금속산화물을 이용한 비교적 간단한 MIM(Metal Insulator Metal) 구조로써 제작이 용이하고 빠른 속도와 저전압 동작과 같은 차세대 메모리가 갖추어야 할 조건들을 많이 갖추고 있다.본 연구에서는 RRAM(Resistance Random Access Memory)로 쓰일 수 있는 binary oxide 중 Nb_2O_5 (Niobium oxide) 박막을 PLD(Pulsed Laser Deposition)방법을 이용하여 온도와 laser power를 변화시키며 다양한 조건에서 박막을 증착하고 XRD(X-Ray Diffraction)와 AFM(Atomic Force Microscopy)으로 Nb_2O_5 박막의 구조적 특성을 Probe station과 Keithley 2400 sourcemeter를 이용해 Nb_2O_5 박막의 전기적 특성을 분석하였다 실험을 통하여 Nb_2O_5 박막은 온도가 200 ℃, laser power가 50 ~ 135 mJ 범위 내에서 switching 특성이 잘 일어났다. 이로써 Nb_2O_5 박막의 memory switching 특성이 laser power보다는 온도의 변화에 민감하다는 것을 확인하였다.

Dp-215 **Properties as Alternative RRAM Materials in EuO Thin Films** KIM Sanghoon, HWANG Inrok, PARK Bae Ho, LEE Jang-Won[1], SEO Sunae[1](*건국대학교. [1]Samsung Advanced Institute of Technology.*) In non-volatile memory field, Resistive Random Access Memory (RRAM) which utilizes resistive switching properties of oxide materials is an attractive part. Therefore, several materials to reveal RRAM properties are studied. Among studying materials, we had interesting about Eu_xO_y as RRAM material. In general, Eu and Eu_xO_y have been studied about optical and magnetic properties. Hence, we have studied structural and electrical properties of Eu_xO_y thin films as RRAM materials. Performing this study, we first deposited Eu_xO_y thin films on Pt/Ti/SiO_2/Si (111) substrate by using EuO target and Radio Frequency (RF) sputter, and then analyzed the structural properties of Eu_xO_y thin films by using X-ray diffraction (XRD) and Scanning Electron Microscope (SEM) and surface properties of Eu_xO_y thin films by using Atomic Force Microscope (AFM). The Eu_xO_y thin films showed poly-crystalline behaviors and mixed structures of Eu_2O_3 and Eu_3O_4. To have proper properties as RRAM material, we deposited Eu_xO_y thin films in various conditions. Especially, we mainly studied the mixed structures with different gas conditions. In addition, we measured the electrical properties of Eu_xO_y thin films by using probe station. The Eu_xO_y thin films showed reproducible resistance switching behaviors. Therefore, studying properties of Eu_xO_y thin films, we knew that an atomic level of Eu_xO_y thin films affects mixed structures and reproducible resistance switching behaviors.

Dp-216 **비정질 유전체 $CaTiO_3$-SiO_2의 결합과 관련된 유전 완화 및 전기 전도 특성 연구** 송 철호, 김 맥, 최 현우[1], 양 용석(*부산대학교 나노과학기술대학, 나노융합기술학과, 밀양 627-706. [1]부산대학교 물리학과, 부산 609-735.*) 페로브스카이트 유형의 ABO_3 산화물은 독특한 전기적 특성 때문에 많은 관심 속에서 단결정, 분말 다결정, 박막 형태로 연구 및 응용이 되고 있는 물질이다. 최근에는 이러한 ABO_3 산화물이 나노 크기가 될 때 나타내는 다양한 물성에 대한 연구가 활기를 띄고 있다 나노 크기의 물성은 장거리 질서와 단거리 질서가 혼합된 상태의 특징을 나타내는 경우가 많다. 한편 단거리 질서를 갖는 대표적인 경우가 비정질 물질이다. 따라서 비정질에 대한 정보는 나노 계를 이해하는 데 필수적이다. 또한 나노 크기를 만드는 가장 좋은 방법 중의 하나가 비정질을 이용하는 것이다. 본 연구에서는 ABO_3 산화물 중, 결정상에서 매우 높은 강유전 상전이 온도 (T_c = 1523 K)를 갖는 $CaTiO_3$를 비정질로 만들었을 때 나타나는 유전 특성을 측정 분석하였다. 시료는 $CaTiO_3$에 비정질 형성제인 SiO_2를 첨가 하여 제조하였다. 유전 완화와 전기 전도 특성은 Cole-Cole 식과 지수법칙을 이용하여 분석하였다. 실험 결과, 유전 특성과 전기 전도는 온도 변화와 지연 시간에 따라 매우 특이한 완화 현상을 보임을 발견하였다. 분석을 통하여 이러한 현상의 주된 요인이 비정질의 구조적 결함과 밀접하게 관계됨을 밝혔으며 이는 비정질 뿐만 아니라 나노 크기 및 덩어리 결정의 결함에서 나타나는 유전 특성을 이해하는 데에도 중요한 정보를 제공할 것으로 기대된다.

Dp-217 **The effect of the spin-orbit interaction on the stabilization of simple cubic structure in polonium (Po)** 김 규, 민 병일(*포항공대 물리학과.*) Po is reported as the only element in the periodic table that has a simple cubic structure. In this study, with the help of tight binding model calculation and the first principles FLAPW band calculation, we have shown that the relativistic effects, especially the spin-orbit (SO) interaction, are responsible for the stabilization of SC Po. Both the LDA and GGA exchange-correlation potentials are used and various schemes of the relativistic treatment are examined. Based on the analysis of electron charge density, Fermi surface, and the charge susceptibility, we have discussed the origin of the stabilized simple cubic structure in Po.

Dp-218 **혼합 알칼리 유리 $(Li_{1-x}Cs_x)_2B_4O_7$의 온도 및 주파수에 따른 전기적 특성 연구** 김 맥, 송 철호, 최 현우, 임 영훈[1], 양 용석(*부산대학교, 나노과학기술대학, 나노융합기술학과, RCDAMP, 밀양 627-706. [1]세명대학교, 교양과정부, 충북 제천 390-711.*) 혼합 알칼리 효과는 한 종류의 알칼리가 포함된 물질에 다른 알칼리를 치환함으로써, 이온 거동과 관련된 이온 전도도, 이온 확산, 유전 완화 등의 특성이 비 선형적으로 변하는 현상이다. 최근 혼합 알칼리 효과의 근원 및 소자로의 응용성에 대한 연구가 활발하게 이루어지고 있다. 본 연구에서는 혼합 알칼리 유리 $(Li_{1-x}Cs_x)_2B_4O_7$의 온도 및 주파수에 따른 전기적 특성을 Jonscher의 보편 법칙 및 복소 임피던스 Cole-Cole 식을 이용하여 해석하고, 이를 앞서 연구했던 $(Li_{1-x}M_x)_2B_4O_7$ (M=Na, K, Rb) 유리에서

나타나는 혼합 알칼리 효과와 비교하였다. 혼합 알칼리 효과는 알칼리 이온간의 크기 차이가 클수록, 온도와 주파수가 낮을수록 강하게 나타난다. 기존의 Li 이온에 이온반경이 매우 큰Cs 이온을 섞었을 때 dc 전도도가 가장 작았으며, 실험한 모든 혼합 알칼리 유리계(Li-Na, Li-K, Li-Rb, Li-Cs)에서 온도가 올라갈수록dc 전도도의 최대값과 최소값의 차이가 줄어드는 것을 발견했다. Arrhenius 식을 이용하여 구한 성분비에 따른dc 전기 전도도의 활성화 에너지는 전형적인 혼합 알칼리 효과를 보였다. 혼합 알칼리 효과를 해석하는 좋은 방법중의 하나는 RMD (random distribution model)인데, RMC(reverse Monte Carlo) 시뮬레이션을 이용한 이 RMD 구조적 모델에 바탕을 두어 본 연구의 결과를 구체적 논의하였다.

■ SESSION: P3
4월 18일(금), 13:00 - 14:45
장 소: 109호

Kp-001 **ZnSe/GaAs 박막 성장 및 구조적 광학적 특성**
유 평열, 정 태수[1], 최 용대[2](*순천대 물리교육전공.* [1]*전북대 반도체 물성연구소.* [2]*목원대 광전자물리학과*) RF magnetron sputtering과 HWE 방법으로 성장한 ZnSe/GaAs 박막의 특성을 비교하였다. RF 스퍼터링으로 성장한 시료의 Photoluminescence 측정 결과 질소를 주입하지 않고 성장한 n형 ZnSe/GaAs 시료는 bound exciton I_2세기가 I_1보다 우세하게 나타났고 bound exciton I_1은 깊은 받개 준위인 I_{1d}를 나타냄을 확인할 수 있었다. 질소를 주입하며 성장한 ZnSe/GaAs 시료에서는 I_1 봉우리가 I_2 봉우리보다 매우 컸으며 반폭치값은 상대적으로 작게 나타났다. 이때 bound exciton I_1의 근원은 질소의 doping으로 인하여 방출되는 봉우리이며 p형 ZnSe/GaAs 박막이 성장되었음을 확인하였다. HWE 방법으로 성장된 시료에 대해 최적 성장 조건을 확인하였으며 PL 스펙트럼에서는 단파장대에서 미약하나마 free exciton이 재결합하면서 발광하는 Ex 봉우리가 나타났다. 강한 intensity를 갖는 두 봉우리는 neutral donor bound exciton $I_2(D_0,X)$에 기인한 발광으로 각각 upper polariton과 lower polariton인 I_{2u}와 I_{2L}이다. HWE 방법으로 성장한 박막의 광학적 결정성은 좋은 것으로 평가된다.

Kp-002 **Growth and properties of GaN nanowires grown by MOCVD**
SHIN Dae Keun, WOO Si Kwan, O Byung Sung, KIM Tae Gyu[1], LEE Hyung Gyoo[1](*Department of Physics, Chungnam National University.* [1]*School of Electrical &Computer Engineering, Chungbuk National University.*) 일차원 구조체인 nanowire는 nanophotonics와 nanoelectronics에 가장 기본이 되며 이 분야에서의 응용 가능성이 높다. 이중에서도 GaN nanowire는 Si과 같은 상대적으로 저렴한 기판에 양질의 성장을 시킬 수 있기 때문에 관심의 대상이 된다. 본 실험에서는 Si(100) 기판에 산화 막과 Ni층을 성장시킨 후 Metal-Organic Chemical Vapor Deposition 방법으로 GaN nanowire를 성장시켰다. Photoluminescence, X-ray diffraction, Scanning Electron Microscopy, Interference Microscopy를 이용하여 성장 시간의 변화에 따른 GaN Nanowire의 광학적, 구조적 특성 변화를 관찰하였다. 성장 시간을 증가 시킬수록 wire의 길이가 길어지고 luminescence 특성도 향상되었다.

Kp-003 **Transparent Al-Doped ZnO Thin Films Synthesized by RF Magnetron Sputtering**
SEO SOO YOUNG, KWAK CHANG HA, PARK SUN HONG[1], KIM SEON HYO, HAN SANG WOOK[2](*POSTECH, Department of Materials Science &Engineering.* [1]*RIST, New Materials &Components Research Center.* [2]*Chonbuk National University, Division of Science Education.*) Transparent and conductive Al-doped zinc oxide thin films were fabricated on Al_2O_3 substrates by a RF-magnetron sputtering procedure from a ZnO target mixed with a various wt% Al_2O_3. The quantity of aluminum at the target was varied from 2 to 5 weight %. The structural and optical characteristics of Al-doped ZnO thin-films were studied using field emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), UV-VIS-IR and photoluminescence (PL) measurements. The XRD measurements revealed that all of Al-doped ZnO thin-films had a wurtzite crystal structure and had the (002) preferred orientation. We did not observed any extra peak from the XRD patterns. The best visual light transparency of the films was 90%. The band gap of the films was about 3.35 eV and the visual light absorption edge was about 350 nm. We will discuss the chemical and optical properties, comparing with the structural properties and Al-doping ratio.

Kp-004 **Non-volatile Memory Behaviors of Al_2O_3/Cu/Al_2O_3 and Al_2O_3/CuO/Al_2O_3 Multi-layers prepared by ALD**
이 병국, 채 원묵[1], 이 준영[2], 이 선숙[1], 황 진하[2], 정 택모[1], 김 창균[1], 안 기석[1](*한국화학연구원 소자나노재료센터, 홍익대학교 신소재공학과.* [1]*한국화학연구원 소자나노재료센터.* [2]*홍익대학교 신소재공학과.*) Recently, non-volatile memory devices have been widely researched as the next generation semiconductor devices. Among them, two types of floating gate memory are investigated with nano-crystal floating gate memory (NFGM) and silicon-oxide-nitride-oxide-silicon (SONOS) type of multi layer thin films. Although, they were obtained good memory performances, they have some problems in the deposition process, such as high temperature process for forming nano-crystal, hard control of particle size and density at large area, etc. In this study, Al_2O_3/Cu/Al_2O_3 and Al_2O_3/CuO/Al_2O_3 multi-layers were fabricated using atomic layer deposition (ALD) technique on p-type Si(001) in order to investigate the floating gate memory characteristics. Al_2O_3 thin films, as control layer and tunneling layer, were grown using TMA {$Al(CH_3)_3$} and H_2O. Cu and CuO layers, as a charge-trap layer, were prepared using Cu aminoalkoxide precursor and hydrogen plasma, H_2O and oxygen plasma. The films were characterized by XPS, AFM, and SEM, etc depending on the surface preparations and deposition conditions. Non-volatile memory behaviors of Al_2O_3/Cu/Al_2O_3 and Al_2O_3/CuO/Al_2O_3 multi-layers were measured by high frequency capacitance-voltage (C-V) measurements.

Kp-005 **Physical Vapor Transport에 의한 CdSxSe1-x (0< x <1) nanostructure의 구조변화와 PL측정**
김 유리, 정 재훈, 김 경호, 송 만석, 김 용, GAO Qiang[1], TAN H. Hoe[1], JAGADISH Chennupati[1](*동아대학교 신소재물리학과.* [1]*The Australian National University.*) 반도체 nanostructure의 다양한 특성은 전자공학과 광학적 소자로의 적용가능성에 있어서 주목 받고 있다. 이로써 반도체 nanosturcture는 결정학적, 광학적인 특성의 조절이 요구된다. 본 실험은 간단한 장치인 single-zone quartz tube furnace를 이용하여 nanostructure를 성장시키고 PL을 관찰하였다. CdS와 CdSe의 몰 비율의 변화에 따라 nanowire에서 nanosaw로 구조변화가 일어남을 관측하였다. 이렇게 성장한 nanosturcture의 PL을 측정함으로써 가시영역에서의 몰 비율에 따른 스펙트럼이 이동함을 관찰하였다.
*We acknowledge support by the Korean Science and Engineering Foundation (KOSEF) through Grant No. Fol-2007-000-10087-0.

Kp-006 **큰 에너지 갭을 가진 화합물 반도체 양자세선에서 변형 효과와 비포물선 효과가 전자적 구조에 미치는 영향**

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유 주형, 권 혜영, 우 준택, 김 재호, 유 건호[1], 이 홍석[2], 박 홍이[2](*한양대학교 전자통신컴퓨터공학부.* [1]*경희대학교 물리학과.* [2]*연세대학교 물리학과.*) 저차원 나노양자구조에서 전자적 구조에 대한 연구는 전자소자나 광소자의 효율을 증진시키는데 대단히 중요한 역할을 하기 때문에 많은 연구가 활발하게 진행되고 있다. 전자적 부띠 구조를 정확하게 계산하기 위하여 여러 가지 효과를 고려하여야 하며 지금까지 계산의 복잡성 때문에 많은 어려움을 겪고 있는 변형효과와 비포물선 효과에 대한 연구는 화합물 반도체 양자세선에 대한 전자적 구조를 정확하게 결정하기 위해서는 대단히 필요하다. 이와 같은 문제를 해결하기 위하여 본 연구에서는 양자세선의 미세구조 형태를 바탕으로 한 변형효과를 고려하며 변형효과와 비포물선효과가 화합물 반도체 양자세선의 전자적 부띠 에너지에 어떤 영향을 미치는지에 대한 연구를 하였다. 에너지 밴드 갭이 큰 나노 양자구조에서 전자 및 정공의 부띠에너지,파동함수 및 부띠천이 에너지를 가변메시 유한차분법으로 결정하였고, 변형 효과를 고려한 것과 고려하지 않은 화합물 반도체 양자세선의 부띠 에너지 천이를 계산하였다. 계산 결과 변형효과는 큰 에너지 밴드 갭을 가진 화합물 반도체 양자세선의 전자적 구조에 많은 영향을 미치나 비포물선 효과는 영향을 미치지 않는 것을 알 수 있었다. 이러한 결과는 화합물 반도체 양자세선의 저차원적인 전자적 구조를 이해하는데 대단히 도움이 된다고 생각된다.This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (No. R0A-2007-000-20044-0).

Kp-007 **Hydrogenation Effect On Light Emission From Si Nanocrystals Embedded In Silicon Dioxide** JUNG Yoon-Jin, YOON Jong-Hwan(*강원대학교, 물리학과.*) Si nanocrystals embedded in silicon dioxide films are exposed to an atomic hydrogen plasma at different temperatures in the range from 100°C to 350°C. Photoluminescence (PL) from the nanocrystals is shown to increase in intensity with increasing exposure time before saturating at a level that depends on the exposure temperature. The saturation level depends on the final exposure temperature and shows no dependence on the thermal history of exposure. Analysis showed that this saturation was consistent with a difference in activation energies for the passivation and depassivation reactions of ~ 0.2 eV, with the activation energy for the passivation reaction being larger than that for the depassivation reaction. Comparison between samples annealed in atomic and molecular hydrogen confirmed that atomic hydrogen leads to a greater level of passivation than molecular hydrogen, and that samples passivated in atomic hydrogen show a very fast initial (T <500 °C) depassivation compared to those passivated in molecular hydrogen

Kp-008 **Structural and optical characterization of hybrid structures composed of ZnO nanocrystals and Si nanocrystals** 김 성, 김 창오, 황 성원, 홍 승휘, 김 민철, 최 석호(*경희대 국제캠퍼스 응용물리 전공.*) Hybrid nanostructures composed of ZnO nanocrystals (NCs) and Si NCs have been fabricated by annealing double layers of ZnO and SiO_x thin films on Si (100) wafer grown by radio-frequency sputtering and ion beam sputtering deposition, respectively. The oxygen content (x) of SiO_x is varied from 1.0 to 1.8, which is controlled and determined by x-ray photoelectron spectroscopy analysis. ZnO/SiO_x films are annealed at 1100℃ for 20 min by using rapid thermal annealing to form hybrid structures of ZnO NCs and Si NCs. High-resolution transmission electron microscopy images demonstrate the coexistence of 4 ~ 5 nm ZnO NCs and 2 ~ 10 nm Si NCs depending on x value. The PL intensity of ZnO is almost 10 times enhanced by the hybridization with $SiO_{1.0}$ for the NC formation and decreases with increasing x above 1.0, exactly consistent with the x-dependent intensity behaviors of the near-edge x-ray absorption fine structure features. This suggests that the excitonic transition of the conduction electrons in Si NCs to unoccupied Zn 4*sd* states is largest at x = 1.0. These results are very promising in view of the enhancement of the luminescence efficiency of ZnO by its hybridization with SiO_x for the NC formation.

Kp-009 **SiO_X 박막 위에 형성된 ZnO 박막의 구조적 및 발광 특성 연구** 김 창오, 김 성, 황 성원, 정 필성, 김 혜룡, 최 석호(*경희대 국제캠퍼스 응용물리 전공.*) 이온빔 스퍼터링 증착 방법을 사용하여 실리콘 기판 위에 300nm 두께의 SiO_X 박막을 증착한 후 radio-frequency (RF) 스퍼터링 증착 방법을 이용하여 100nm 두께의 ZnO 박막을 증착하였다. SiO_X 박막의 x 값은 0.8부터 2.0까지 변화하였고 X선 광전자분광기 (XPS)를 사용하여 결정하였다. 급속열처리기 (RTA)를 이용하여 900℃에서 20분 간 열처리한 ZnO/SiO_X 박막을 단면투과전자현미경 (cross-section TEM)으로 분석한 결과 ZnO/SiO_X 박막이 양질의 이중 박막 구조로 잘 성장되었음을 확인할 수 있었다. ZnO/SiO_X 박막의 광루미네센스 (PL)의 peak는 ZnO의 밴드끝 (near-band edge, NBE) 발광에 기인하는 자외선 영역에서 관찰되었다. ZnO/SiO_X 박막의 PL 세기는 x 값이 0.8부터 1.0까지 증가함에 따라 증가하다가 1.0 이상일 때에는 감소하였다. 실리콘 기판 위에 제작된 ZnO 박막의 PL세기와 비교해 볼 때 ZnO/SiO_X 박막의 PL 세기가 x 값이 1.0에서 5배 정도 더 강하게 관찰되었다. 그리고 ZnO/SiO_X 박막의 ZnO NBE 발광과 관련된 PL 스펙트럼의 반치폭 (FWHM)은 x 값이 0.8에서 1.0으로 증가함에 따라 감소하다가 1.0 이상일 때는 증가하였다. 또한 ZnO/SiO_X 박막의 ZnO NBE PL peak는 x 값이 0.8부터 2.0까지 증가함에 따라 적색 천이함을 보였다. 이는 ZnO/SiO_X 박막의 near-edge x-ray absorption fine structure (NEXAFS)을 사용하여 ZnO/SiO_X 박막의 O K-edge에서 측정한 전도대의 최저 에너지가 ZnO/SiO_X 박막의 x 값이 0.8부터 2.0까지 증가함에 따라서 낮은 에너지 쪽으로 이동하는것과 깊은 관련이 있는 것으로 보인다.

Kp-010 **GaAs 기판 방향에 다른 Si Nanowire Heteroepitaxy의 특성 연구** 정 재훈, 김 경호, 김 유리, 송 만석, 김 용, GAO Qing[1], TAN H. Hoe[1], GAO Qing[1], JAGADISH Chennupeti[1](*동아대학교 물리학과.* [1]*The Australian National University.*) Lamp Heated CVD(Rapid Thermal Chemical Vapor Deposition)법에 의해 GaAs (100), (111)B, (110) 기판에 각각 heteroepitaxy한 Si Nanowires(NWs)를 성장하였다. Si NWs는 VLS (Vapor-Liquid-Solid) 메커니즘을 통해 성장하며, 촉매로는 50 nm인 Au colloid 용액을, source gas로는 diluted SiH4를 사용하였다. Au 입자들을 정전기적으로 고정시키기 위해poly-L-lysine 용액에 기판을 1분간 담근 후, Au colloid 용액을 살포하였다. Au와 Si의 공융점 온도 근방인 섭씨 320 - 400 도 사이 온도에서1 Torr 압력

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에 30분씩 성정시킨 샘플은 FE-SEM(Field Emission Scanning Microscope)을 이용하여 Si NWs의 이미지를 관찰하였다. 각 샘플의 평면과 단면 SEM 이미지를 통해 온도에 따른Si NWs의 성장 방향과 모양을 분석하였다. This Work was supported by the Korean Research Foundation Grant Funded by the Korean Government (MOEHRD) (KRF-2007-313-C00222)

Kp-011 **HfO2 내에 형성된 Ge 나노 결정의 온도에 따른 전기 전도도 특성 연구** 김 혜룡, 김 성, 홍 승휘, 남 지선, 신 동희, 최 석호, ELLIMAN R. G.[1](*경희대 국제캠퍼스 응용물리 전공;* [1]*호주국립대학교 전자재료공학과*) 원자층 증착법 (ALD)으로 제작한 25nm/5nm 두께의 HfO_2/SiO_2 복층 박막 내에 15 keV의 에너지로 각각 $8.5x10^{15}$, $1.7x10^{16}$, $2.5x10^{16}$ Ge cm^{-2}의 Ge^- 이온을 주입하였다. 그리고 600℃부터 1000℃까지 5분간 100℃ 간격으로 급속열처리(RTA)를 하였다. 광루미네센스(PL), 고분해능 투과 전자현미경 (HRTEM), X선 광전자 분광(SRXPS)으로 HfO_2 내에 Ge 나노 결정의 구조적 및 광학적 특성을 조사하였다. PL 결과에서 Ge 나노 결정 크기의 영향으로 열처리 온도가 600℃부터 1000℃까지 증가함에 따라 PL 피크의 파장이 1300 nm(0.95 eV)부터 1400 nm(0.88eV)까지 적색천이하고, 열처리 온도 700℃에서 가장 큰 PL 세기를 보였다. 전기전도도는 1V 인가 전압 하에서 측정 온도를 500 K에서 600 K까지 변화시키며 측정하였다. 각각의 활성화 에너지를 산출하였는데 이온 주입량이 $1.7x10^{16}$ Ge cm^{-2}이고 열처리 온도가 700℃인 시료에서 가장 급격한 변화를 보였다. 이온 주입량이 $1.7x10^{16}$ Ge cm^{-2}인 시료는 활성화 에너지는 열처리 온도가 증가함에 따라 1092.36 meV에서 601.26 meV로 감소하였으며 열처리 온도가 700℃인 시료는 이온 주입량이 증가함에 따라 813.07 meV에서 646.83 meV로 감소하였다. 이러한 결과들을 바탕으로 Ge 나노 결정과 HfO_2의 경계면 상태 및 Ge 나노 결정의 크기에 따른 전기 전도도의 온도 의존성을 논의하고 그 메커니즘을 규명하고자 한다.

Kp-012 **비정질 GaInZnO 박막의 수소화 온도에 따른 광학적 및 전기적 특성 연구** 정 필성, 김 혜룡, 박 준우, 이 호선, 최 석호(*경희대 국제캠퍼스 응용물리 전공*) PECVD에 의해 실리콘 기판위에 100 nm 두께의 SiO_2 박막을 증착한 후 RF 스퍼터링 증착 방법을 이용하여 70 nm 두께의 GaInZnO (GIZO) 박막을 증착하였다. 증착된 GIZO의 박막을 저온에서 광루미네센스 (PL)를 측정한 결과 산소 결함에 기인한 PL peak가 가시광 영역인 750 nm 부근에서 관찰되었다. 수소화의 효과를 보기 위하여 급속열처리기 (RTA)를 이용하여 100 - 650 °C까지 30분간 1 sccm의 flow rate로 수소화를 한 후에 PL을 측정하였다. 수소화 온도가 증가함에 따라서 PL의 세기가 감소하여 500 °C 정도에서는 거의 PL이 관찰되지 않았으나 그 이상의 온도에서는 PL이 다시 증가하였다. 수소 없이 비슷한 온도에서 열처리 한 경우에는 PL이 없어지지 않는 것으로 보아 산소에 기인한 결함의 감소는 수소화와 관련된 것으로 보인다. 타원편광분석기(ellipsometry)를 이용하여 수소화 온도에 따른 GIZO 박막의 띠간격 에너지, 캐리어 농도, 표면의 평탄도 등을 분석하였다. 수소화 온도가 증가함에 따라 띠간격 에너지와 캐리어 농도가 증가함을 알 수 있었다. 600 °C 이상의 온도에서 수소화 처리를 한 GIZO 박막은 박막의 질이 나빠짐을 알 수 있었다. 수소화 온도에 따른 GIZO 박막의 전류-전압 특성에서는 수소화 온도가 100 - 500 °C 사이일 때 수소화 온도가 증가함에 따라 같은 전압에서 전류가 증가하였으나 500 °C 이상의 온도에서는 전류가 다시 감소하였다. 이는 PL 측정 결과와 부합되는 결과로서 500 °C까지 수소화 온도를 증가시켰을 경우에는 산소에 기인한 결함의 감소에 의해 전류가 증가함을 알 수 있다. 이러한 실험결과와 FTIR, SIMS 등의 측정결과를 바탕으로 수소가 박막의 구조적, 전기적, 및 광학적 특성에 미치는 효과를 고찰하고자 한다.

Kp-013 **SiO_2 내부에 형성된 SiC 나노입자의 전기 및 광학적 특성 연구** 이 태희, 이 동욱, 김 선필, 서 기봉, 김 은규, 신 진욱[1], 조 원주[1](*한양대학교 물리학과;* [1]*광운대학교 전자재료 공학과.*) Silicon carbide (SiC)는 Ⅳ족 화합물 반도체로서 열 전도성 및 화학적 안정성이 기존의 Si에 비하여 우수하고, 에너지 밴드갭은 2.0～3.2 eV를 갖고 있기 때문에 광학 및 전자 소자로서 다양하게 연구되어 왔다. 따라서 본 연구에서는 SiC를 수 나노미터 크기의 나노입자로 제조하는 방법과 더불어 제조 방법에 따른 광학적 특성을 측정하였다. 제조 방법은 SiO_2 quartz 및 4 nm 의 SiO_2 터널층이 있는 *p*형 Si기판위에 SiC 박막을 Ar 분위기에서 radio-frequency (RF) magnetron sputtering을 이용하여 5～10 nm 두께로 증착하였다. 그리고 30～50 ㎚ 두께의 SiO_2를 sputtering을 이용하여 추가적으로 증착한 후, rapid thermal annealing (RTA)를 사용하여, 700～1000 ℃의 온도로 3～20 min 동안 질소 분위기로 열처리를 실시하여 SiC 나노입자를 제조 하였다. 그리고 전기적 특성 분석을 위하여 추가로 20～30 nm 두께의 컨트롤 층을 증착한 후 금속 전극을 직경 200 ㎛, 두께 150 nm 로 형성하여 나노 부유 게이트 커패시터를 제조 하였다. 본 연구에서는 VARIAN Carry 300 UV-Vis 분광광도계를 이용하여 열처리 조건의 변화에 의하여 형성된 SiC 나노입자의 크기에 따른 광흡수도의 변화를 측정하였으며, 또한 Boonton 7200 1-MHz 전기용량 측정기 및 Agilent 81101A 펄스 발생기를 사용하여 전기적 특성을 측정 하였다. 이를 통하여 SiO_2 내부에 형성된 다양한 크기의 SiC 나노입자를 사용하여 광소자 및 비휘발성 메모리 소자에 응용 가능성을 확인 할 것이다.

Kp-014 **IBAD 증착법에 의한 SiNW 성장과 특성분석** 김 경호, 정 재훈, 김 유리, 송 만석, 김 용, TAN H. Hoe[1], GAO Qiang[1], JAGADISH Chennupeti[1](*동아대학교 물리학과;* [1]*The Australian National University.*) IBAD(Ion Beam Assisted Deposition)법에 의해 Si(100)과 (111) 기판에 각각 Si Nanowires(Si NWs)를 성장하였다. Si NWs는 IBAD 증착법을 통해 성장하며, 촉매로는 지름이 50 nm인 Au colloid 용액을, Sputtering 타겟은 Si을 사용하였다. Au colloid사용 시 자연산화막의 개입을 막기 위해 HF 용액을 혼합하여 Hydrogen passivation해 주었다. Au와 Si의 공융점 온도인 섭씨 363도 근방의 온도에서 1시간 동안 각각의 기판 위에 Si NWs를 성장하였고, FE-SEM(Field Emission Scanning Microscope)을 이용하여 평면과 단면의 이미지를 관찰하였다 This Work was supported by the Korean Research Foundation Grant Funded by the Korean Government (MOEHRD) (KRF-2007-313-C00222)

Kp-015 **Charge storage characteristics of nanocrystalline-Si embedded in SiN_x films** 한 문섭, 장 승훈, 정 기영, 고 창훈, 박 경완[1](*서울시립대학교 물리학과;* [1]*서울시립대학교 나노과학기술학과.*) Sillicon 기반의 nano-structures는 발광 특성 및 charge storage 특성 등 다양한 성질을 나타내고 있다. 본 실험은 SiN_x matrix 안에

형성된 nanocrystalline-silicon (nc-Si)의 size와 density에 따른 capacitance-voltage (C-V) 특성을 관찰하여 메모리 소자에의 응용 가능성을 연구하는데 목적이 있다. 반도체 공정에서 상용화 되어 널리 쓰이는 PECVD 기법을 이용하여 SiN_x 박막을 증착하였으며, 가스 조성비 (N_2/SiH_4)에 따라 nc-Si의 size를 조절하고 고진공 내에서의 후열처리를 통하여nc-Si의 개수 밀도를 높였다. 이렇게 제작된 시료를 PL 및 XPS 측정을 통하여 물성을 분석하였다. 이후 Metal-Insulator-Semiconductor (MIS)구조를 형성한 뒤, voltage sweep range의 폭을 바꾸어가면서 C-V hysteresis curve를 측정하였으며, voltage sweep range의 폭이 증가함에 따라 positive와 negative의 양쪽 방향으로 C-V curve의 hysteresis 폭이 증가함을 발견하였다. nc-Si 구조의 사이즈가 다른 시료에 대해서, retention time 값에 따른 charge density의 측정 및 hysteresis 폭 측정과 이들의 분석을 통하여 효과적인 charge storage 기능을 보이는 nc-Si 구조의 메모리소자에의 응용 가능성을 논의하고자 한다.

Kp-016 **Photoluminescence properties in Ge nanocrystals formed by nitridation of Ge surface modified by dry etching** 한 문섭, 정 기영, 장 승훈, 고 창훈, 박 경완[1], 김 정호[1](*서울시립대학교 물리학과.* [1]*서울시립대학교 나노과학기술학과*) Dielectric matrix 안에 자발적으로 형성된 나노미터 크기의 금속 또는 반도체는 차세대 메모리 소자뿐만 아니라 광소자의 개발 및 응용에 큰 가능성을 부여하고 있다. 특히, 그동안 Ge nanocluster이 실험은 Ge thin film (두께: 약 5-10 nm) 표면에 dry etching 을 이용해 나노미터 사이즈의 roughness 를 형성시킨후, nitridation 과 RTA 를 통해 만들어진 Ge nanocrystals 의 사이즈에 대한 PL 특성을 관찰하는데 그 목적이 있다. 모든 공정은 UHV chamber 안에서 in-situ 하게 연속적으로 이루어졌다. Ge thin film growth 는 MBE, surface etching 을 이용하였고, nitridation은 ion gun, RTA는 e-beam heater를 사용하였다. 제작된 시료에서 가시광 영역인400, 500, 600 nm 에서 PL 특성을 보였으며, Ge nanocrystal 의 크기에 영향을 주는 parameter (roughness 의 사이즈, RTA 시간) 에 따라 발광하는 빛의 파장과 intensity 가 변하는 결과를 얻었다. 이러한 공정은 Ge nanicrystals 의 성장을 3차원 (z: film growth 방향, x-y: surface roughness 방향) 적으로 제한하기 때문에, 기판 orientation의 strain 효과나 Ge + ion의 implation을 이용하는 기존의 공정 기법보다 Ge nanocrystals의 density 및 사이즈 조절이 더 용이할 것으로 기대된다.

Kp-017 **Ru thin film prepared by atomic layer deposition as a barrier material for Cu interconnection** CHOI BumHo, KIM Young Mi, LEE Jong Ho, PARK Jong Woon, LEE Hong Kee[1], SON Seong Ho[1], KIM Young Back, BAN Tae Hyun(*National Center for Nanoprocess and Equipment, Nano-Electronics Team, Gwangju Research Center, Korea Institute of Industrial Technology.* [1]*Surface nano-technology team, Production Technology Division, Incheon R&D Center, Korea Institute of Industrial Technology.*) Recently, Ruthenium(Ru) layer has been extensively studied as a barrier material for Cu metalization. In order to be used as a barrier material, several parameters should be considered such as adhesion between barrier material and interconnection, inter-level dielectric and stress. In this study, Ru layer was prepared by atomic layer deposition method on non-patterned and nano-patterned Si substrate. First of all, the thickness of 10 nm of Ru layer was deposited on 8-inch non-patterned substrate. The measured uniformity taken from 9 points was 2.4% with 0.59 Å/cycle deposition rate. By controlling feeding time and purge time, uniform Ru layer can be obtained. To get optimal condition for Ru deposition, the distance shower head and substrate was varied with fixed substrate temperature. Also, 5 nm thick Ru layer was deposited on 50 nm width pattern with a aspect ratio of 10. In order to characterize the Ru layer, the stress , adhesion, and step coverage was measured. More detail experimental results will be presented on conference.

Kp-018 **Prediction about Effects of CUSP Magnetic Fields on 450mm Single Crystal Silicon Growth** KIM Joon-Hoi, LEE In-Ji, LEE Gon-Sub, PARK Jea-Gun(*Nano SOI Process Laboratory, Hanyang University.*) The diameter of silicon wafers used in the microelectronics devices tends to be larger in the view of production cost reduction. The next-generation wafer size, 450 mm in diameter, will start mass-production from 2012 according to ITRS. Thus, we designed a hot-zone of 450 mm Czochralski silicon grower for a simulation program of dynamic heat flux on 450-mm single-crystal silicon-growth. In this work, we considered the effects of magnetic flux density and magnetic coil position to achieve the successful growth of pure silicon ingot (agglomerated defect free) on the 450-mm-diameter Czochralski silicon-crystal growth. Silicon melt convection, temperature distribution in furnace, and defect distributions were calculated as 450mm-silicon-single crystal grew. It was shown that lowering of zero position from silicon surface on electro-magnetic field suppressed the silicon melt convection and contributed to achieve uniform temperature gradient near the melt surface that determine the structural loss yield and agglomerated defect density. *This work was supported by Brain Korea 21 project in 2008.

Kp-019 **Dependence of Nickel Gettering Efficiency on Crystal Nature in a Czochralski Silicon Wafer** KIM Dong-Kyum, LEE In-Ji, LEE Gon-Sub, PARK Jea-Gun(*Nano-SOI Process Laboratory, Hanyang University.*) We investigated the gettering efficiency of nickel in Czochralski (CZ) silicon wafers depending on crystalline nature such as interstitial silicon dominant or vacancy dominant crystal growth. After a typical heat treatment for NAND flash memory, the density of silicon oxide precipitates in the vacancy-dominant crystal regions was approximately two orders higher than interstitial silicon dominant crystal regions. In the nickel contamination of $1x10^{12}$ atoms/cm^2 followed by the NAND flash heat treatment, the recombination lifetime degradation induced by nickel in the interstitial silicon dominant crystal regions is much severe than in vacancy dominant crystal regions. This result indicated that the gettering efficiency of nickel in the vacancy dominant crystal regions much stronger than in the interstitial silicon dominant crystal regions. However Silicon wafers designed with extreme gettering ability via rapid thermal annealing(RTA) at 1175°C for 10 sec using NH_3 and Ar gas mixture produced the "M" shape of oxygen precipitates across the silicon wafer. The RTA silicon wafer com-

pletely eliminated nickels from the wafer surface that are gathered at oxygen precipitates in silicon bulk during a NAND flash heat treatment. *This work was supported by Brain Korea 21 project in 2008.

Kp-020 **탄화규소 (3C-SiC) 나노선 트랜지스터의 제작 및 2D ATLAS 시뮬레이션 비교 연구** 김 동주, 형 정환, 이 승용, 이 상권(*전북대학교, 반도체물성연구소, 반도체과학기술학과*) 본 논문에서는 3C-SiC 나노선 트랜지스터 관련 실험 결과를 2D ATLAS 시뮬레이션을 이용하여 구현하였다. 실험에서 제작된 3C-SiC 나노선은 hot-wall 방식 화학기상증착 방법을 이용하여 합성하였으며, 두께는 60 ~ 100 이었다. 합성된 3C-SiC 나노선을 트랜지스터로 제작하였으며, 이를 2D ATLAS 시뮬레이션을 통해 3C-SiC 나노선 트랜지스터 소자 동작특성을 비교 분석하였다. 2D ATLAS 시뮬레이션에서의 3C-SiC 나노선의 길이와 두께는 각각, 이었으며, 일정한 전하 농도와 두께가 작아짐에 따른 양자효과는 배제하였다. 실험결과와 시뮬레이션 결과를 비교한 후 다른 전하 농도에서의 3C-SiC 나노선 트랜지스터 소자 특성을 예측하였다.

Kp-021 **비휘발성 메모리 소자 응용을 위한 전자빔 조사에 의한 실리콘 산화막 내부의 Ge 나노결정 성장 및 전기적 특성 연구** 양 우철, 김 도형, 한 영환[1], 이 병철[1](*동국대학교 물리학과. [1]한국원자력연구원 양자광학연구실*) 본 연구에서는 실리콘 산화막 안에 전자빔 조사에 의해 합성된 Ge 나노결정의 전기적 특성을 조사하였다. 산화막 내부에 Ge 나노결정이 형성된 구조의 전기적 특성은 나노결정의 크기, 결정성 및 공간적 분포에 따라 큰 영향을 받기 때문에 Ge 나노결정 형성의 구조 및 위치적 조절이 중요하다. 따라서 본 연구의 접근방법은 나노결정의 공간적 분포를 제어하기 터널링 산화막 층위에 비정질 Ge 박막을 증착하였고, 결정성은 높은 에너지의 전자빔 조사를 통해 조절하였다. 열산화법에 의해 성장된 터널링 옥사이드 층(10nm) 위에 두께가 0.5nm - 5nm인 비정질 Ge 박막을 e-beam evaporation을 이용하여 성장시켰고 20nm 두께의 컨트롤 산화막층은 PECVD를 통해 증착시켰다. 준비된 시료에 전자빔 조사가 없는 시료를 700°C-900°C 열처리 한 시료와 1MeV의 에너지 및 1×10^{14} e/cm^2 - 5×10^{16} e/cm^{2}의 선량을 갖는 전자빔을 조사한 후 열처리 한 시료를 비교하였다. 전기적 특성은 시료에 Al을 증착하고 MOS 구조를 제작한 후 C-V측정을 통하여 메모리 효과를 분석하였다. 전자빔이 조사되지 않은 시료들에서는 900℃ 이상의 열처리를 한 시료에서 대략 3.0V-3.5V의 메모리 윈도우가 관찰되었다. 반면, 5×10^{16} e/cm^2 정도의 선량을 갖는 전자빔을 조사한 후 비교적 저온인 700℃에서 열처리를 시행한 시료에 대해서는 대략 4.5V-5.0V 정도의 메모리 윈도우를 관찰 할 수 있었다. 그러나, 1×10^{14} e/cm^2 의 선량으로 전자빔을 조사한 후 700℃-800℃의 열처리가 시행된 모든 시료에 대해서는 어떠한 메모리 효과도 관측할 수 없었다. 따라서 이러한 결과를 통해 전자빔은 실리콘 산화막내 Ge 나노결정의 형성 및 결정성을 향상시키고 동시에 전자빔의 에너지 및 선량을 통해 나노결정의 성장과 결정성을 조절할 수 있다는 사실을 보여주었다. 또한, Photoluminescence(PL), Raman, TEM 측정을 통해 산화막 내부에 Ge 나노결정의 형성을 확인하였다. 전자빔을 조사하지 않고 900℃ 이상의 열처리를 통해 Ge 나노결정이 성장된 시료에서는 대략 2.55eV (487nm)를 중심으로 반치폭이 대략 126.2nm 정도로 비교적 넓은 PL 스펙트럼이 관측되었고 5×10^{16} e/cm^{2}의 선량을 갖는 전자빔을 조사한 후 700℃에서 열처리를 시행한 시료에 대해서는 대략 2.45eV를 중심으로 반치폭이 87.4nm의 비교적 좁은 PL 스펙트럼을 관찰할 수 있었다. 또한 라만 측정 결과 위의 두 시료에 대해 300cm^{-1} 근처의 Raman peak을 관찰하였고 이러한 사실은 비정질 Ge 박막이 Ge 나노결정으로 변화되었음을 나타낸다. 또한 TEM 사진을 통해 성장된 Ge 나노결정의 크기 및 밀도를 계산하였다. 전자빔 조사를 통해 산화막 안의 Ge 나노결정의 형성이 향상되고 에너지 및 선량으로 결정성을 조절하며 나노결정의 성장 온도를 비교적 저온으로 낮출 수 있음을 확인하였다.

Kp-022 **Fabrication of CNT-FEA by Resist-Assisted Patterning Process for X-ray source** 임 한얼, 유 제황, 송 나영, 정 일옥, 임 준원, 손 병택, S. Manivannan, 장 진, 박 규창, 최 해영[1], 김 종욱[1](*경희대학교, 정보디스플레이학과. 차세대디스플레이연구센터. [1]한국전기연구원*) 탄소나노튜브(CNTs) 는 다양한 형태와 물성을 지닌 특성으로 인하여 나노전자 산업분야로 활발하게 응용되고 있다. 그 중에서도 낮은 임계전계에서의 높은 전자방출 특성으로 인하여 다양한 전자방출소자로의 연구가 활발히 이루어지고 있다. 특히 엑스레이 방출원으로의 적용시, 기존의 열전자 방출을 이용한 소자를 대신하여 간편하고 고효율 소자로의 응용이 가능하다. 이는 장수명 엑스레이 램프의 전자 방출원으로 기대되고 있다. 본 연구에서는 기 연구된 레지스트패터닝법(resist assisted patterning, RAP) 을 이용하여, 높은 전류 방출특성을 갖는 탄소나노튜브 에미터 어레이(carbon nanotube-field emitter array, CNT-FEA) 제작 기술을 연구하였으며, CNT-FEA 의 특성과 전자방출 특성과의 상관 관련성을 규명하였다. 또한 향상된 전자방출 특성을 얻기 위하여 다양한 후처리 연구와 기판의 구조적인 전자방출 전류의 안정성 확보를 위하여 레이저 가공을 이용 실리콘 기판의 모양을 사각형에서 원 모양으로 변화에 따라 시료의 가장자리에서 발생하는 과전류 현상을 최소화 할 수 있었다. 결과적으로 CNT-FEA 의 우수한 전자방출 특성을 얻을 수 있었으며, 이를 이용하여 엑스레이 발생 실험을 하여 우수한 특성의 엑스레이 이미지를 얻을 수 있었다.

Kp-023 **Surface Roughness Mobility Analysis of Ultra-thin Body Silicon-on-insulator n-MOSFET using Improved Electric Field Model** CHOI Ki-Ryoung, BAEK Ji-Young, KIM Seong-Je, SHIM Tae-Hun, PARK Jea-Gun(*Nano-SOI Process Laboratory, Hanyang University.*) Silicon-on-insulator (SOI) has been attracted for the next generation device structure because it has some advantages such as a low power dissipation and a high speed operation. In the partially depleted (PD) SOI MOSFET, holes are accumulated on the buried oxide by impact ionization generating in the end of the drain, that is called the floating body effect. It causes the kink effect, increasing the saturation current, so the fully depleted (FD) SOI is preferred. To operate SOI MOSFET with 45nm gate length to FD type, the thickness of top Si should be less than 20nm. In the ultra-thin body (UTB) SOI with the thickness less than 10nm, not only the surface roughness of the gate oxide but also that of the buried oxide should be considered. The effective mobility depending on the surface roughness has '-2' order of dependency with the effective field in agreement with Matthiessen's rule. It was reported that the problem of the conventional method must be caused by the model-

ing without considering the Si thickness fluctuation and the back surface scattering. Therefore, the models considering those have been suggested and they show the more accurate results. In this study, we investigated the effective mobility simulation by the relaxation time approximation (RTA) method via calculating electron occupancy, energy difference, and 2-fold, 4-fold valleys. we suggested the model approaching from the aspect of the effective field, excepting for the previous suggestion. Because the effective field in the conventional one was applied without considering the electron occupancy of each subband and it makes the accuracy reduced. In particular, we suggested the improved electric field model to show the more accurate dependency of the surface roughness mobility on effective field. In contrast with the conventional effective field, we calculated the average field reflecting the electron occupancy of each subband in 2-fold and 4-fold valleys, then, established the relation with effective field. Finally, the proposed model can be applied to Matthiessen's rule.

Kp-024 **Comparative Study of Electron Mobility involving Self-heating Effect in 45-nm Ultra-thin Body SOI, Strained Si SGOI, and Strained SOI n-MOSFETs** OH Jung-Mi, KIM Seong-Je, SHIM Tae-Hun, PARK Jea-Gun(*Nano-SOI Process Laboratory, Hanyang University.*) As the gate length of device becomes less than 45-nm, fully depleted (FD) SOI n-MOSFETs are required ultra-thin body (UTB) SOI structure of less than 15-nm top Si layer because of high speed and low power consumption. In addition, both strained-Si SiGe-on-insulator (ε-Si SGOI) and strained SOI (ε-SOI) structure enhance the electron mobility resulting from inducing strain in Si channel layer. On the other hand, SOI structure has a serious problem in spite of such advantages. Since the thermal conductivity of SiO_2 layers is very low, the self-heating is becoming a major problem in such a ultra thin body SOI n-MOSFETs. In particular, devices with thinner top silicon and higher complexity are prone to self-heating, which degrades performance by decreasing mobility and drive current.In our study, we investigated the self-heating effect in 45-nm UTB SOI, ε-Si SGOI and ε-SOI through 2-dimensional numerical simulation. In addition, we compared the electron mobility characteristics taking account of T_{Si}, $T_{\varepsilon\text{-}Si}$ and strain. In particular, it was confirmed that ε-SOI indicates the superior operation characteristic to the others. Thus, we suggested ε-SOI n-MOSFETs for device application with high performance.*This work was supported by Brain Korea 21 project in 2008.

Kp-025 **열처리 온도에 따른 저온성장 GaAs의 Carrier lifetime 변화** 김 창섭, 김 지희, 이 기주, 윤 두협[1], 강 광용[1](*충남대학교.* [1]*한국전자통신연구원*) 테라헤르츠 발생방법 중의 하나로 GaAs와 펨토초레이저를 이용한 테라헤르츠발생 등이 관심의 대상이 되면서 저온성장GaAs의 특성에 대한 연구가 활발하게 이루어져왔다. 저온성장 GaAs(LT-GaAs)는 성장 온도와 열처리 온도에 따라 다양한 특성변화를 보이게 되는데 그 중 가장 대표적인 Carrier lifetime의 변화를 단색 펌프프로브 방법을 통하여 측정해 보았다. 본 실험은 성장온도가260℃, 290℃, 320℃인 LT-GaAs를 400℃에서 800℃까지 50℃간격으로 온도를 변화시키며 열처리한 시료를 사용하였고, 중심파장이 800 nm, 펄스폭이 30 nm인 펄스 레이저를 사용하여Carrier lifetime을 측정하였다. 성장온도290℃의 GaAs를 500℃, …, 800℃로 열처리하면 17 fs에서 824 fs 으로 carrier lifetime이 증가하는 것을 확인할 수 있었다. LT-GaAs의 strain은 성장 후의 열처리 온도에 따라 감소하는 경향을 보인다 LT-GaAs의 TEM 이미지와 LO phonon frequency 등을 비교하여 defect의 개수 및 크기가 carrier lifetime에 미치는 영향을 분석하였다.

Kp-026 **Mass Production and Characterization of Free-standing ZnO Nanowires by Chemical Vapor Deposition** CHOI Min-Yeol, PARK Hyun-Kyu, CHOI Jae-Young[1], KIM Sang-Woo (*금오공과대학교 신소재시스템공학부.* [1]*삼성종합기술원*) Synthesis, characterization, and applications of quasi-one-dimensional (1D) ZnO nanostructures such as nanowire, nanorod, and nanobelt structures have been studied extensively because of its excellent chemical, physical, and optical properties. In particular, a large number of groups have reported the fabrication of ZnO nanorods and nanowires using a vapor-liquid-solid process on substrates. However, growth of ZnO nanowires on substrates processes seriously limits large-scale device applications. The other side, mass synthesis of free-standing ZnO nanowires is suitable at large-scale device applications, and moreover it may offer an inexpensive and simple method for device fabrication via hybrid with polymer materials.In this work, we report on mass production of free-standing ZnO nanowires by a chemical vapor deposition technique without substrate and catalyst. Mixture powders of ZnO and graphite were used as growth of free-standing ZnO nanowires. Field-emission scanning electron microscopy (FE-SEM) image and transmission electron microscopy (TEM) images of as-grown ZnO nanowires were used to investigate the morphology and crystal structure. It was found that the ZnO nanowires are single crystalline with a hexagonal structure in X-ray diffraction and HRTEM measurements. Optical property of as-grown ZnO nanowires was examined using the temperature-dependent photoluminescence measurements. These results show excellent characteristic of as-grown ZnO nanowires.

Kp-027 **Seed Density Controlled Aqueous Solution Growth of ZnO Thin Films and Nanostructures on Si Substrates** JIN Mi-Jin, LEE Sam-Dong, KIM Sang-Woo(*금오공과대학교 신소재시스템공학부.*) ZnO has many of useful property such as wide band gap (3.37eV), high exciton binding energy (60mV), n-type semiconductor, and piezoelectric characteristic. For nano scale devices, such as chemical sensor, light emitting diode, solar cells and piezoelectric device, the size and density of ZnO nanostructures and thin films should be controlled. In this work, we studied density controlled ZnO nanostructures and thin films on Si substrates that depending on the seed generation at low temperature below 100 °C. Zinc acetate dehydrate [$Zn(CH_3COO)_2 \cdot 2H_2O$, 0.01 M] dissolved into Acetone (100 ml) was used as a seed solution. Cleaned Si substrates were spin coated at 1000 rpm and dried at hot plate 100 °C. The seed generation process was repeated from 3

times to 12 times to achieve uniformly and densely coated seed layers on the Si substrates. Then, a thermal treatment of the seed-coated Si substrates was carried out in oxygen ambient for 30 min at 500 °C to improve the crystallinity of the seed layer. After the ZnO seed generation, ZnO nanostructures and thin films were formed by the continuous supply of zinc ions and hydroxyl radicals into the aqueous solution consisting of zinc nitrate hexahydrate [$Zn(NO_3)_2 \cdot 6H_2O$, 0.025 M], hexamethylenetetramine(0.025 M) and DI water (250 ml). The main growth of ZnO nanorods and thin films was carried out at 95 °C. Density controlled ZnO nanostructures and thin films were manufactured from aqueous solution growth route via seed generation on Si substrate.

Kp-028 **MOCVD를 이용한 구멍 있는 알루미늄 산화막 위에 쌓인 선 모양의 ZnSe** 이 상욱, 남 윤성, 손 민수, 김 성인, 유 경화, 백 경선, 장 수경(*연세대학교 물리학과*) 구멍 있는 알루미늄 산화막은 나노미터 크기의 시료들을 만드는 데 주로 이용되는 것 중의 하나이다. MOCVD 방법을 이용하여 알루미늄 산화막 위에 ZnSe를 올렸다. SEM을 통한 이미지에서 박막의 형태가 아닌 선(wire) 모양의 ZnSe가 관측되었다. 선 모양은 짧은 시간을 쌓은 경우는 수십 나노미터 두께의 막대 형태들이 이어지는 형태였고, 그보다 긴 시간을 쌓은 경우는 수백 나노미터 두께의 밧줄과 같은 형태였다. 이 시료들에 대해 PL 연구도 진행하였다.

Kp-029 **비정질 SiN 박막 위에 성장시킨 ZnSe에 관한 연구** 남 윤성, 이 상욱, 장 수경, 백 경선(*연세대학교 물리학과*) 비정질 SiN 박막 위에 MOCVD 방법으로 ZnSe를 성장하였다. X선 회절과 SEM, 그리고 PL 등을 통하여 조사하였다. SEM 이미지에서 약 백나노사이즈의 그레인들이 관측되었으며 XRD 상에도 결정상의 피크들은 아주 약하게 보일 뿐이다. 따라서 SiN 박막은 비정질이므로 그 위에 성장시킨ZnSe 역시 비정질인 것으로 보인다. PL 상에서 벌크 ZnSe의 피크와는 다른 피크들이 관측되었으며 예상되는 광학적 천이에 대해 조사하였다.

Kp-030 **투명 기판에 성장된 GaZnO의 광학적 및 전기적 특성** 김 득영, 김 형준, 조 현칠, 현 유미, 유 승용, 이 영민, 봉 하종, 심 다혜, 성 준제, 이 세준, 우 용득[1](*동국대학교, 반도체과학과.* [1]*우석대학교, 반도체IT과학과.*) 투명한 기판(Polyethersufone(이하 PES),ITO/PES,Corning 1737)위에 RF 마그네트론 스퍼터법으로 Ga이 도핑된 ZnO 박막을 성장하였다. 박막 성장 후에 X-ray diffraction(XRD)와 Scanning Electron Microscopy(SEM)을 이용하여 결정성을관찰하였고, four-point probe 방법을 이용하여 전기적 특성을측정하였다. 또한 UV-visible spectrometer를 사용하여 박막의 광학적 특성을 조사하였다. 결과로써, 종류에 따라 다양한결정성을 가지는 박막이 증착되었음을 알 수 있었고, 박막의 전기적 특성을 조사한 결과 면저항 값은 기판에 따라 다양한 값을 보였다. 가장 좋은 결과는 39Ω/sq의 값이 나타났으며, 이는 투명전극으로써 응용할 수 있는 결과를 보여주었다. 또한 UV-visible spectrometer를 사용하여 200nm~1000nm 범위의 파장에서 투과율을 관찰한 결과 모든 박막은 가시광 영역에서 약80%이상의 값을 보였다. 투과율 측정으로부터 모든 박막은 약360nm 파장에서 흡수단이 나타나는 것을 확인 할 수 있었으며, 흡수단은 기판에 따라 약간씩 변화하는 모습을 보였다. 이는 기판과 박막의 경계면에서의 결정성 차이로 인해 박막의 결정성이 변화하여 광학적 밴드갭 에너지가 변화한 것으로 판단되며, 또한 기판에 따라 박막의 전기적 특성 또한 변화하는것을 확인할 수 있었다.

Kp-031 **Al 및 Ga이 첨가된 ZnO 박막의 구조적 · 전기적 · 광학적 특성** 김 득영, 조 현칠, 김 형준, 유 승용, 현 유미, 이 영민, 심 다혜, 봉 하종, 성 준제, 이 세준(*동국대학교, 반도체과학과.*) 본 연구에서는상온에서 Polyethersufone (PES) 기판위에 RF 마그네트론 스퍼터법을 이용하여Al-doped ZnO와 Ga-doped ZnO 박막의 구조적·전기적·광학적 특성을 비교분석하였다. 박막 증착 후 결정성과 표면특성을 분석하기 위해X-ray Diffraction (XRD)과 Scanning Electron Microscopes (SEM)를사용하였다. 그 결과 모든 박막은 강한 C축 우선 배향성을 가진 hexagonal 다결정 구조를 보였다. 4-point Probe를 이용하여 측정한 면저항은75Ω/square였고, Hall Effect 방법을 이용해 전기적 특성을분석하였다. 광학적 특성은 UV-visible Spectrometer를 사용하여 가시광 영역에서85%이상의 높은투과율을 보였다.

Kp-032 **Flexible 기판을 이용한 분압가스 변화에 따른 GZO박막 제작** 김 득영, 유 승용, 조 현칠, 김 형준, 현 유미, 봉 하종, 이 영민, 심 다혜, 성 준제, 이 세준(*동국대학교 반도체과학과.*) 본 연구에서는Transparent Conduction Oxide (TCO) 로서의 응용을 위한 Ga doped ZnO 를 가스분압비 변화에 따른 전기적, 구조적, 광학적 특성에 대하여 연구하기 위하여Polyehtersulfone (PES) 기판위에 RF 마그네트론 스퍼터법을 이용하여 증착하였다. 박막 증착 시간은 2시간으로 일정하게 유지하였고, RF power는 150W로 유지시켜주었다. Ar가스를 10sccm 부터 35sccm까지 5sccm 단위로 실험하였으며, Ar/O_2가스비에 따른 특성변화도 조사하였다. 박막의 결정성과 표면특성은X-ray Diffraction(XRD) 과 Scanning Electron Microscopes(SEM)를 사용하여 측정하였고 전기적 특성은 Four-point Prober 와 Hall Effect 방법을 이용하여 분석하였다. 또한, 박막들의 광투과도 특성을 비교하기 위해 UV-visible spectrometer 을 사용하였다. 그 결과, 모든 박막들이 가시광 영역에서의 평균 투과율이 약 80% 정도로 우수한 값을 나타내었으며 Ar가스가 25sccm 일때 82% 로 가장 높은 투과율을 나타내었다.

Kp-033 **CdSe 양자점에서 2D plate가 Photoluminescence에 미치는 영향** 김 태수, 이 병우, 박 정현, 오 은순, 이 상훈[1], FURDYNA J. K.[2](*충남대학교 물리학과.* [1]*고려대학교 물리학과.* [2]*University of Notre dame.*) Molecular beam epitaxy (MBE)로 ZnSe 위에 성장시킨 CdSe 양자점의 크기에 따른 continuous wave - photoluminescence (cw-PL)와 time - resolved photoluminescence (TRPL)를 측정하였다. 2.5 mono layer (ML)나 3 ML 두께로 성장된 양자점의 경우에는 PL lifetime의 에너지 의존성이 관찰되며, 이는 carrier가 양자점 사이에서 이동하기 때문으로 해석된다. 1.5 ml 두께로 성장된 양자점의 경우에는 온도 구간에 따라 두 개의 peak이 관찰되었는데, 양자점에 의한 peak과 이보다 약간 높은 에너지에 위치한 2D plate에 의한 peak으로 생각된다. 여기 광원의 세기가 감소하면 양자점에 의한 peak이 2D plate에 의한 peak보다 상대적으로 증가하고 이에 따라 PL lifetime의 에너지 의존성이 증가하는 것이 관찰되었는데, 이는 2D plate에서는 에너지 의존성이 없고 양자점에서는 에너지 의존성이 강하기 때문으로 생각할 수 있다.

Kp-034 **분광학적 엘립소미트리와 광전류 분광법을 이용한 $Cd_{1-x}Mn_xS$ 박막의 임계점 구조에 관한 연구** 김 대중, 박 재환[1], 최 용대[2], 이 종원[3], 유 평열[4], 김 택성[5](*목원대 테크노과학연구소. [1]충남대 물리학과. [2]목원대 기술마케팅학과. [3]한밭대 신소재공학부. [4]순천대 물리교육전공. [5]전북대 반도체 물성연구소.*) $Cd_{1-x}Mn_xS$/GaAs (111) 박막들이 열벽 적층 성장법(hot-wall epitaxy; HWE)을 이용하여 성장되었다. 성장된 박막들의 광학적 특성을 알아보기 위하여 분광학적 엘립소미트리(spectroscdopic ellipsometry; SE)를 사용하여 실온에서1.5-8.7 eV 사이 포톤에너지 범위에서 측정되었다. 측정된 데이터들은 유사유전함수 스펙트럼 $<\varepsilon(E)>=<\varepsilon_1(E)>+i<\varepsilon_2(E)>$에 나타난 E_0, E_1, E_1,+Δ_1, E_0`, $F_1$, $E_1$` 와 같은 임계점 구조에 대하여 연구되었다. 또한 박막의 복소 유전함수와 밀접한 관계를 가지고 있는 굴절지수n(E), 소광계수 k(E), 반사계수 R(E) 그리고 흡수계수 α(E)와 같은 광학적 특성 등을 연구하였다. 특히, 광전류 분광법(photocurrent spectroscopy; PCS)은 1차 미분 광전류(derivative photocurrent; DPC) 스펙트럼을 이용하여 시료의 에너지 띠 간격을 결정할 수 있다. 그런 결과로 광전류 분광법을 이용하여 정확한 광학적 에너지 밴드 갭을 구하고SE 측정으로 획득된 광학적 에너지 밴드 갭이라고 일컬어지는E_0 구조에 대하여 비교 분석하였다. 특히 Mn 성분비에 변화에 따른E_0 구조와 다른 임계점 구조에 대한 포톤 에너지의 피크 포지션의 변화를 알아보았다. (본 연구는 학술진흥재단의 지원을 받아 연구되었음; KRF-2005-075-C00012)

Kp-035 **Photoluminescence study of CdS film grown by hot-wall epitaxy** 엄 영호, 정 수성, 이 주용(*울산대학교 물리학과.*) We report a systematic investigation of band-edge photoluminescence of II-VI wide gap semiconductor CdS film as a function of growth temperature. The specimens investigated were in the form of thin films fabricated by hot-wall epitaxy. The near band-edge emissions of bound excitons were systematically investigated as a function of temperature. These studies enabled us to determine the behavior of the Varshni coefficients a and β for a wide spectrum on growth temperatures. In addition, the measurements made it possible to analyze and discuss in detail the broadening mechanisms of the exciton emission lines, and their dependence on growth temperature.

Kp-036 **Study of ZnSe nanowires' optical properties using photoluminescence (PL) and Raman spectroscopy.** CHOI Kyeong min, CHEONG Hyeonsik, CHOI Young-Jin[1], PARK Jae-Gwan[1] (*서강대학교, 물리학과. [1]한국과학기술연구원, 나노과학연구본부.*) Ⅱ-Ⅵ족 화합물 반도체는 넓은 밴드갭을 갖고 있으며 파란색과 UV 영역에서 exciton들이 안정성 있게 존재하여 관심을 받고 있다. GaAs의 경우 상온에서 exciton binding energy가 4.2 meV인 반면에, ZnSe의 경우에는 21 meV 가까이나 된다. 이러한 큰 exciton binding energy로 인해서 Ⅱ-Ⅵ족 반도체 화합물이 나노 크기로 작아지게 되면 Ⅲ-Ⅴ족 반도체 화합물보다 많은 장점들을 보이게 된다. 최근 이러한 나노 크기의 ZnSe을 가지고 짧은 파장의 레이저, photoelectronic 장치들을 만들 수 있다. 본 연구에서는 성장 온도에 따라서 ZnSe nanowire들을 성장하였다. 800 ℃에서 자란 ZnSe들은 wire의 모양으로 보이지만 온도를 900 ℃로 올렸을 때에는 ribbon(sheet) 또는 saw의 모양으로 보이게 된다. 또한 800 ℃에서 성장한 ZnSe은 균일한 입방(cubic) 구조를 확인 할 수 있었으나 900 ℃에서 자란 ZnSe nanowire들의 경우에는 입방(cubic) 구조뿐만 아니라 육각형의(hexagonal) 구조도 확인할 수 있었다. 이러한 nanostructure들의 photoluminescence(PL)를 측정하고, Raman 산란을 이용해서 LO phonon mode를 분석하였다. 상온에서 측정한 ZnSe nanowire의 micro-PL 경우 대부분 2.68 eV 밴드갭을 갖고 있음을 확인하였다. 이 밴드갭을 가지고 PL scanning을 하여서 ZnSe nanowire 발광 스펙트럼을 2D로 확인해 보았다.

Kp-037 **Physical Properties of Magnetic Impurity in ZnO Grown by Pulsed Laser Deposition** KIM Jae-Hoon, SONG Hooyoung, KIM Eun Kyu(*Quantum-Function Spinics Lab. and Department of Physics, Hanyang University.*) Wide-bandgap semiconductors have been widely investigated for their applications to ultraviolet (UV) light emitters and high-power and high-temperature electronics due to their wide-bandgap nature and high breakdown electric fields. ZnO and GaN are typical materials such wide-bandgap semiconductors. Especially, the ZnO has much interesting for a based material for the diluted magnetic semiconductor, because of its theoretical high Curie temperature. ZnO has much interesting for a based material for the diluted magnetic semiconductor, because of its theoretical high Curie temperature. The pulsed laser deposition (PLD) system has an advantage to control the composition ratio of the grown film from the mixture target. We deposited ZnO with magnetic impurity by PLD technique. A cobalt and a manganese was used as the magnetic impurity and the atomic ratio was 5 %. ZnO with Co or Mn films were grown by PLD on sapphire substrates with ZnO buffer layer at some varied temperature between from 200oC to 500oC. The defects in the films were investigated by using deep level transient spectroscopy(DLTS) and photo luminescence measurements. For the DLTS measurement, Ti/Au was deposited over the large area of the sample to form an Ohmic contact. On the prepared sample the DLTS measurements were performed at temperature range from 20K to 370K.

Kp-038 **ZnO 박막의 불순물 주입 특성 연구** 노 승정, 권 새롬, 최 민식, 이 두형, 이 석관, 정 보현, 김 희수, 김 용민, 현 준원 (*단국대학교, 응용물리학과*) ZnO 박막은 열전도성이 우수하고 밴드갭 조절이 용이하여 광전자 소자, p-n junction 소자에의 응용이 기대되어 최근 많이 연구되고 있다. 특히, p형 ZnO 박막 성장을 위해 RF magnetron sputtering, 원자층 박막 증착(Atomic Layer Deposition ; ALD), 분자 빔 에피택시(Molecular Beam Epitaxy ; MBE) 등의 여러 가지 기법으로 증착이 시도되고 있지만 그 결과는 아직까지 불안정하며, 신뢰성 있는 p형 ZnO 박막은 나오고 있지 않다. 본 연구에서는 p형 ZnO 박막 성장을 위해 기존의 원자층 박막 증착 장치(ALD)에 유도 결합 플라즈마 발생 장치를 결합 시킨 plasma enhanced ALD (PEALD) 장치를 이용하여, 증착 공정 간에 불순물이 주입되도록 하였다. 불순물 주입 반응 가스는 암모니아(NH_3)를 사용하였다. 증착된 ZnO 박막의 열처리 전후의 광학적, 전기적 특성 분석은 photoluminescence와 Hall measurement 분석을 수행하였다.

Kp-039 **Mn 조성비에 따른 $Cd_{1-x}Mn_xS$ 단결정 박막의 특**

P3 포스터세션

성 변화 박 재환, 오 병성, 김 대중[1], 최 용대[2], 김 창수[3], 윤 만영[4] (*충남대 물리학과.* [1]*목원대 테크노과학연구소.* [2]*목원대 기술마케팅학과.* [3]*한국표준과학연구원 첨단산업측정그룹.* [4]*중부대 정보통신학과.*) Hot-wall epitaxy법을 사용하여 GaAs(100)±2° off와 GaAs(111)±0.5° off의 두 종류의 기판 위에 각각 cubic 구조와 hexagonal 구조로 $Cd_{1-x}Mn_xS$ 단결정 박막을 성장시켰다. 성장된 박막의 표면 특성은 Nomarski 간섭 현미경과 AFM을 사용하여 표면의 거칠기를 살펴보았다. 그리고 XRD와 DCRC, phi-scan을 측정하여 결정구조, 결정성과 결정방향을 살펴보았다. RSM으로는 격자상수를 구하여 cubic과 hexagonal의 결정구조를 비교하고 분석하였다. 광학적 특성은 PL을 이용하여 외부 자기장이 없이 측정 온도 및 Mn 조성비에 따른 intra-Mn^{2+} 천이를 살펴봄으로써 peak position과 intensity의 변화를 연구하였다. Mn의 조성비는 EDX로 결정하였고, 이에 따른 Mn의 조성비 변화에 따라 격자상수, 각 분리, 반치폭, 성장률, 두께 등의 차이를 구하였다. 분석결과 GaAs(100)±2° off 기판 위에서 성장한 박막은 Mn이 x=0.05 이하일 때 cubic 구조로 성장되었고, 그 이상일 때는 hexagonal 구조와 공존을 하였지만, γ-MnS 구조도 관측되었다. GaAs(111)±0.5° off 기판 위에서 성장한 박막은 hexagonal 구조이었는데, x=1일 때 α-MnS 구조의 박막이 성장되었다.

Kp-040 **Feasibility of ZnO:In Nanocrystals as a Cathode Material for Field Emitting Device** CHANG Jiho, JUNG Mina[1], OH Seungjun[1], CHO Youngrae[2], JEON Tae-In[3], MAKINO Hisao[4], MURAKAMI Yoshihiro[5], YAO Takafumi[5] (*KMU., Major of Nano-Semiconductor.* [1]*KMU., Major of Nano-semiconductor.* [2]*Pusan National Univ., Materials Science and Engineering.* [3]*KMU., Division of electrical and electronics engineering.* [4]*Kochi University of Technology.* [5]*Tohoku Univ., Institute for Materials Research.*) Novel cathode material is absolutely required due to the problems such as short-lifetime and high-threshold voltage in existing cathodes such as CNT and ZnO. In this research, In-doped ZnO nano-crystals (NCs) have been proposed as a new cathode material for FEDs and successfully synthesized by mixed-source vapor phase transportation method. It was confirmed that tetrapod-type ZnO:In NCs with considerably high In-content (up to ~15 %) has an uniphase crystal structure without considerable structural defects. Photoluminescence (PL) measurement reveals Burstein-Moss (BM) shift of UV emission peak at room temperature and the metallic states at the low energy (< 0.8 eV) induced by In-doping were confirmed by diffuse-reflectance-spectra (DRS). The carrier concentration in ZnO:In NCs were measured by tera-heltz time-domain spectroscopy (THz-TDS). Also, a field emitting device was fabricated by using the ZnO:In NCs (In~ 8%). Although, the device structures are not optimized yet, it shows a turn-on voltage of 5.4 V/mm at the current density of 0.1 mA/cm^2, which is compatible to the previous results.

Kp-041 **In-situ Annealing on ZnO:Li Thin Films by PLD** 전 병억, 김 유성, 최 병춘, 문 병기, 정 중현(*부경대학교 물리학과 및 기초과학 연구소*) The Li doped ZnO (ZnO:Li) thin films were near-epitaxially grown on Al_2O_3 (0001) substrate by using the pulsed laser deposition method, and displayed n-type semi conductive. The targets were employed as the ZnO ceramics with different Li contents of 0 ~ 0.10 at%. The resistivity of ZnO:Li thin films was increased with increasing the Li contents. The surface of ZnO:Li thin films was featured with sub-micron sized grains. The grains seemed to be aligned along the c direction and were confirmed by the X-ray diffractions. The in-situ annealing was performed under dilute O_2 gas atmosphere in order to investigate the Li doping on ZnO:Li(0001)/Al_2O_3(0001), where ZnO:Li thin films displayed the n-type conduction. The Hall coefficient and carrier density were weakly varied with the annealing temperature. The atomic concentrations of ZnO:Li thin films were investigated by the depth profiles of secondary ion mass spectroscopy. The n-type semi conductive properties of ZnO:Li thin films were also discussed with the defects model of Li_{Zn}, Li_i and V_O.

Kp-042 **Vapor-Phase-Transportation 법에 의한 ZnMgO 나노막대의 성장과 광학적 특성** 오 승준, 정 미나, 황 현희[1], 이 원재[1], 정 희정[2], 이 병우[2], 이 삼녕, 장 지호(*한국해양대학교 나노반도체전공.* [1]*동의대학교 나노공학과.* [2]*한국해양대학교 재료공학과.*) ZnO는 2-6족 화합물 반도체로서 넓은 밴드갭(실온 3.37 eV) 과 강한 엑시톤 결합 에너지(60 meV) 를 가지고 있어 여러 광소자 분야로의 응용이 기대되고 있다. 특히, ZnMgO는 Mg 조성에 따른 밴드갭 변조가 가능해 (3.3 ~ 4 eV) 많은 주목을 받고 있다. 하지만, 1차원 나노구조 ZnMgO가 광소자로 응용 되기 위해서는 조성제어 및 구조적 형상적 변화에 대한 연구가 많이 필요하다. 본 연구에서는 수직형 Vapor-Phase-Transportation 법으로 $Zn_{1-x}Mg_xO$ 나노막대를 AuGe (10 nm) 이 증착 된 Si (111) 기판을 사용하여 성장시켰다. ZnO 나노막대는 평균적으로 5.26 ㎛ 의 길이와 70 nm 의 직경을 가지며, 기판면에 수직한 방향과 ±10° 의 분산각을 가지며 성장 하였고, 측정된 시료의 powder X-ray Diffraction; XRD 측정 결과 ZnO 는 WZ 결정구조의 전형적인 회절 각에서 회절 피크들이 관찰되었다. 또한 ZnMgO의 경우 Mg 첨가에 따라 (002) peak이 높은 각으로 이동하였다. Scanning Electron Microscopy (SEM) 측정 결과, Mg 첨가에 따라 나노막대의 형상과, 굵기, 밀도의 변화가 관찰되었다. Mg 첨가에 의한 발광 특성을 알아보기 위해 Photoluminescence; PL 측정을 실시하였다. 실온에서의 PL 측정 결과, ZnO나노막대는 3.236 eV 에서 UV 발광을 보였으며, 서로 다른 조성의 $Zn_{1-x}Mg_xO$ 는 각각 3.232, 3.235, 3.244 eV 에서 UV 발광을 보였다. 본 연구에서는 VPT 법을 이용한 ZnMgO 나노막대의 성장조건을 조사하였으며, 성장된 ZnMgO 나노막대의 조성에 따른 형상과 광학적/구조적 결정성의 변화에 대하여 고찰하였다.

Kp-043 **Growth of Well-Aligned ZnO Nanorods on ITO glass** 오 승준, 최 성국[1], 정 미나[2], 황 현희[3], 이 원재[3], 정 희정[4], 이 병우[4], 이 삼녕[2], 장 지호[2](*한국해양대학교 나노반도체전공.* [1]*한국해양대학교 전기전자공학과.* [2]*한국해양대학교 나노반도체전공.* [3]*동의대학교 나노공학과.* [4]*한국해양대학교 재료공학과*) ZnO는 UV영역의 넓은 밴드갭 (3.37 eV) 과 큰 엑시톤 결합에너지 (60 meV) 를 가지는 직접 천이형 반도체로서 UV sensor, UV laser, LEDs 등 광소자 분야에 응용이 가능한 유망한 재료로 주목 받고 있다. 이러한 ZnO가 광소자의 발광재료로서 높은 효율을 얻기 위해서는 결정성을 높여 내부 결함을 감소시키며 발광 면적을 높일 수 있는 구조가 요구된다. ZnO 나노막대는 이러한 요구를 충족시켜 현재 많은 연구가 진행되고 있다. 본 연구에서는 Vertical Vapor

Phase Transportation (V-VPT)법으로 ITO가 (75 nm) 코팅 된 유리판 위에 ZnO 나노막대를 성장하였으며 성장 온도(500~650 °C)와 케리어 가스 유량(500~800 ml/min) 을 조절하여 형성된 나노막대의 밀도, 크기, 분산 각을 제어하였다. 이를 평가하기 위해 SEM과 PL을 이용하여 구조 및 광학적 성질의 변화를 고찰하였다. 특히, 성장온도650 °C, 케리어 가스 유량 600 ml/min 의 조건에서 성장 된 ZnO 나노막대의 직경은 150 nm 였으며, 길이는 1.2 ㎛, 밀도는 32 unit/ ㎛^{2}, 그리고 분산각은 18° 였다. V-VPT법으로 성장된 나노막대는 다양한 성장 조건에서도 재현성을 가졌으며, 특히, 성장온도는 나노막대의 밀도와 크기에 큰 영향을 미쳤으며, 케리어 가스 유량은 막대의 분산 각에 주로 영향을 주었다. 이러한 실험 결과를 바탕으로 나노막대형ZnO 의 형성 메커니즘에 대한 고찰을 실시하였다.

Kp-044 **AuGe 촉매를 사용한 ZnO:Al 나노로드 성장과 전계발광형 소자로의 응용** 김 시내, 정 미나, 오 승준[1], 구 지은, 정 희정[2], 이 병우[2], 황 현희[3], 이 원재[3], 이 삼녕, 장 지호[1](*한국해양대학교, 나노 반도체 전공.* [1]*한국해양대학교, 나노 반도체 전공.* [2]*한국해양대학교, 재료공학과.* [3]*동의대학교, 나노공학과.*) 전계발광형 소자는 차세대 디스플레이 응용을 목적으로 많은 연구가 진행되고 있으며, 현재 음극물질의 성능 향상이 응용연구의 관점에서 주목을 받고 있다. 본 연구에서는 전계발광형 소자의 성능향상을 위한 음극물질용 나노구조로서ZnO:Al 을 제안하고, AuGe 촉매를 사용하여 수직형 기상 이동법 (Vertical vapor-phase-transportation)으로 ZnO:Al 나노로드를 성장시켰다 ZnO:Al 나노로드의 성장조건으로는 550-800 °C의 온도에서 성장하였으며, 분위기 가스로는 Ar을 사용하고 그 유량을 100-1000 sccm 범위로 제어하면서 최적조건을 조사하였다. 주사전자현미경을 이용하여 관찰한 결과, 600 °C의 800-1000 sccm에서 성장된 ZnO 나노로드는 17.125 ea/μm^2 (1000 sccm 기준)의 밀도와, 50±10 nm 균일한 직경과 기판면에 수직한 방향에서 ±5 degree의 분산각을 갖는 균일한 형태를 가짐을 확인하였다. 제작된 나노로드의 결정성은 실온에서 발광특성 통해서 평가하였고, 3.24 eV의 강한 UV 발광과 작은 green-emission 이 관찰되어 양호한 결정성을 가지고 있다고 판단하였다. ZnO:Al 나노로드는 600 °C 성장온도와 800-1000 sccm의 Ar 유량하에서 서로 다른 질량 비의 혼합 소스(Zn and Al) 파우더를 사용하여 합성되었다. Al 함유에 따른 나노로드의 형상 변화가 관찰되었으며, AuGe 촉매 유무에 따른 ZnO 나노로드의 성장 메커니즘의 변화와 ZnO:Al 나노로드의 형상 및 광학적 특성의 변화에 대해서 고찰하였다. 마지막으로 AuGe 촉매를 음극단자로 이용하고 그 위에 성장된 ZnO:Al 나노로드를 음극물질로 이용한 전계발광형 소자를 제작하여 Al-농도에 따른 동작개시전압의 변화를 관찰하였다.

Kp-045 **Tetrapod 형 ZnO:Al 나노결정의 자기조직화 성장 조건에 대한고찰과전계 발광형 소자로서의 응용** 구 지은, 정 미나, 오 승준, 김 시내, 정 희정[1], 이 병우[1], 황 현희[2], 이 원재[2], 장 지호(*한국해양대학교, 나노반도체전공.* [1]*한국해양대학교, 재료공학과.* [2]*동의대학교, 나노공학과.*) 전계 발광형 소자는 차세대 디스플레이 응용을 목적으로 많은 연구가 진행되고 있으며, 현재 음극물질의 성능 향상이 응용연구의 관점에서 주목을 받고 있다. 본 연구에서는 전계발광형 소자제작 및 기타 응용이 가장 용이한 파우더 형태의 ZnO:Al 나노 결정을 Zn와 Al의 혼합소스 파우더를 이용하여 자기조직화법으로 합성하기 위한 실험조건을 고찰하였고, 제작된 파우더형 ZnO:Al 나노결정을 이용하여 전계발광소자를 제작하여 그 동작을 확인하였다. 본 실험에서 최적화된 tetrapod 형 ZnO 나노결정 파우더의 성장 조건은 Ar 분위기 가스를 사용하고, 성장온도는 700~900 °C 였으며, 동일한 조건에서 Al 도핑을 실시하였고, Zn 대 Al 소스 양을 변화시켜서 Al 도핑량을 조절하였다. 주사전자현미경을 이용하여 관찰한 결과, ZnO tetrapod 나노결정은 120 nm의 직경과 1 μm의 길이를 갖는 4개의 대칭형 방사형 다리를 가지며, 제작된 시료내에서 균일한 형태를 나타냈다. 제작한 시료의 결정성을 조사하기 위하여 시료의 광학적 평가를 실시하였으며, 실온에서 3.20 eV의 강한 UV 발광과 약한 green emission을 관찰되어 양호한 결정성을 가지고 있다고 판단하였다. 또한 Al 도핑량에 따라 ZnO:Al 나노결정의 형상 변화가 관찰되었다. 성장조건에 따른 형상의 변화는 Photoluminescence, Cathodoluminescence, powder XRD 등을 이용한 측정 결과를 이용하여 고찰하였고, ZnO:Al 나노결정을 이용한 전계발광소자를 제작하여 그 동작을 확인하였으며, Al 도핑에 의한 형상의 변화를 이용한 동작개시전압의 저감 방법에 대하여 고찰하였다.

Kp-046 **DEP-prepared Multiple ZnO Nanowires Field Effect Transistors (FETs)** HYUNG Jung-Hwan, LEE Seung-Yong, KIM Dong-Joo, LEE Sang-Kwon(*Department of Semiconductor Science and Technology, Semiconductor Physics Research Center, Chonbuk National University, Jeonju 561-756, Korea.*) 1-dimensional (1D) semiconductor nanowires are especially fascinating building blocks for assembling nano-scale electronic and photonic devices. In this paper, we report on the multiple ZnO nanowires field effect transistors (FETs), which were formed by AC dielectrophoresis (DEP) technique. The AC DEP was optimized with a bias voltage of 5 Vp-p at a frequency of 10kHz. The DEP results indicated that the number of aligned ZnO nanowires increased with increasing AC voltage and ZnO nanowires were well aligned on the metal electrodes (Ti/Au=50/150 nm). Moreover, to have lower resistivity ohmic contact to ZnO nanowires, the multiple ZnO nanowires FETs were covered with the additional capping layer of the metal electrodes (Ti/Au) which were formed on the top of the source and drain metal electrodes.

Kp-047 **RHEED 분석을 통한 InN 변형 에너지 연구** 김 문덕, 박 세린, 이 재완, 오 재응[1], 김 송강[2], 정 관수[3](*충남대학교 물리학과.* [1]*한양대학교 전기전자제어계측공학과.* [2]*중부대학교 정보통신학과.* [3]*경희대학교 전자공학과.*) InN는 에너지 대역이 0.7 eV로 밝혀짐에 따라, 고효율 태양전지 및 광소자 응용이 가능한 물질로 관심이 집중되고 있다. 하지만 InN의 안정적인 성장 기술이 확보되지 않아, 이에 대한 연구가 필요하다. 따라서 본 연구에서는 molecular beam epitaxy (MBE) 법으로 Si 기판 위에 InN을 성장시켰다. 또한 reflection high-energy electron diffraction (RHEED) 와 atomic force microscopy (AFM) 측정을 통하여 박막의 성장 과정과 변형 에너지를 분석하였다 특히, RHEED는 MBE 성장 시 시료의 표면 변화를 실시간으로 관찰할 수 있는 가장 효과적인 분석 방법이다. 따라서 RHEED와 AFM 결과를 종합하여 InN 형성 과정을 단계별로 도식화하였다. 또한 InN 형성의 중요 요소인 N 원자량을 달리하여 그 변화 양상을 분석하였다. N 원자량이 적을수

록 3 dimension 으로 더 빨리 변하는 것을 확인하였다. 이처럼 RHEED를 통한 분석 결과는InN의 형성 과정을 이해하는데 도움을 줄 수 있음을 확인하였다.

Kp-048 **성장 조건에 따른 AlN/Si(111) 박막의 특성 향상**
손 철구, 이 재완, 신 윤희, 박 세린, 김 문덕, 김 송강[1](*충남대학교 물리학과.* [1]*중부대학교 정보통신학과*) Ⅲ-N 계열의 화합물 반도체는 고온, 고전력의 전자 소자와 자외선 영역에서 적외선 영역에 이르는 발광소자의 응용이 가능하다. 하지만 GaN와 Si 기판 사이의 55.28 % 의 큰 열팽창 계수 차이와 16.9 % 의 큰 격자 부정합 때문에 Si 기판 위에 직접 GaN 박막을 성장하는 것이 어렵다. 따라서 본 실험에서는 완충층 역할을 하는 AlN층을 molecular beam epitaxy 법으로 성장시켰으며, 이 층의 질적 향상을 위하여 층 내부에 Al 과다 층을 추가 하여 Al 흡착시간에 따른 AlN층의 표면, 결정성 등의 차이를 atomic force microscopy (AFM), scanning electron microscope (SEM), X-ray deflection (XRD) 등으로 조사 하였다. AFM 및 SEM 을 통하여 분석한 결과60 초 이하일 때가 60 초 이상 흡착 하였을 때 보다 RMS roughness 값이 ~0.7 nm, 10 nm 로 표면이 더 좋은 결과를 얻을 수 있었으며 40 초 일 때에 RMS roughness가 0.511 nm 로 가장 우수하였다. 또한 XRD 분석과 KOH용액 etching후 관찰한 SEM을 통하여 40 초 만큼 Al을 흡착시킨 AlN층이 가장 좋은 결정성을 보임을 알 수 있었다.

Kp-049 **InN/GaN nanorod의 성장과 특성 분석** 김 문덕, 신 윤희, 박 세린, 손 철구, 이 상태, 정 관수[1], 김 영헌[2](*충남대학교, 물리학과.* [1]*경희대학교, 전자공학과.* [2]*한국표준과학원*) 최근 고효율, 저가격의 새로운 차세대 태양전지는 나노 기술이 적용된 태양전지로 개발 및 연구가 진행중이다. 본 실험은 반도체의 광 흡수 스펙트럼과 태양광 스펙트럼의 극대화를 위해 기존Si 물질을 Ⅲ-N 물질구조를 이용해 자외선 가시광선 및 근적외선 영역까지 확장 하고자 한다. Si 기판위에 질화물계 구조를 성장할 때 격자 부정합에 의한 자유운반자의 생성 및 운반을 억제하는 문제점이 생기게 된다. 따라서 본 연구에서는molecular beam epitaxy 법을 이용하여 InN/GaN nanorod 연구를 통해 위 문제점을 개선하고자 한다. 우선 태양전지의 기본구조인 p-i-n 구조 중 i-층의 확보를 위해 InN nanorod 성장 실험을 하였다. 안정적인 InN nanorod의 성장을 위해 완충층의 효과를 연구하였으며, 이때 사용된 완충층으로는 AlN, GaN 완충층이 있다. 또한, GaN 완충층에 Si, Mg dopant를 사용하여 dopant를 사용하지 않은 경우의 GaN 완충층과의 구조적 특성을 관찰하였다. GaN 완충층을 사용하였을 경우 비교적 균일한 InN nanorod를 성장할 수 있었으며 GaN 완충층을 doping 하여 성장하였을 경우의 doing을 하지 않은 InN nanorod에 비해 더 가늘고 균일하게 성장함을 관찰하였다. 위 실험 결과는 scanning electron microscope와 cathodluminescence 및 X-ray diffraction 등을 통하여 확인하였다.

Kp-050 **High Field Dependence of the Energy of Excitons in Narrow GaAs/$Al_{0.25}Ga_{0.75}As$ quantum well** SUNG Min Gyu, JEONG In-Taek, LEEM Young Ahn[1], WOO Jong-Chun (*Department of Physics and Astronomy, Seoul National University.* [1]*Electronics and Telecommunications Research Institute.*) Magnetic field dependence of the ground state energy of exciton in GaAs/$Al_{0.25}Ga_{0.75}As$ single quantum wells (QW) grown by molecular beam epitaxy (MBE) is studied from radiative recombination spectra. For undoped QW samples having various well widths, the photoluminescence obtained at the field of several orientations up to 30 T at 4 K is indicative that anisotropies in excitonic binding and cyclotron effective mass becomes more significant as QW width becomes narrower. However, in the case of very narrow QW, the excitonic binding becomes nearly isotropic showing large penetration of electron into the barrier. Increasing wave function penetration effect of cyclotron orbit into the barrier leads to larger effective mass in titled magnetic field orientation angle. The results are explained by introducing an anisotropic harmonic potential and effective mass.

Kp-051 **Effects of Rapid Thermal Annealing on Self-assembled InAs Quantum Dots with Various InGaAs Structures** KIM Do Yeob, KIM Min Soo, PARK Ho Jin, KIM Jongho, KIM Goon Sik, CHOI Hyun-young, RYU H. H., JEON Minhyon, CHO Guan Sik, KIM Jong Su[1], KIM Jin Soo[2], LEE D.Y.[3], SON J.S.[4], LEEM J. Y.(*Inje University, School of Nano Engineering.* [1]*Advanced Photonics Research Institute, Nano Photonics Group.* [2]*Chonbuk National University, Division of Advanced Materials Engineering.* [3]*Samsung Electro-Mechanics Co., Ltd., Lighting Module Research and Development.* [4]*Kyungwoon University, Department of Visual Optics.*) The effects of rapid thermal annealing (RTA) on the InAs quantum dots (QDs) with asymmetric $In_{0.15}Ga_{0.85}As$ layers, which were grown by a molecular beam epitaxy (MBE), were investigated by photoluminescence (PL) spectroscopy. After rapid thermal annealing, the PL spectra from the InAs QDs showed blue-shift and significant narrowing of photoluminescence linewidth, compared with the as-grown samples. It can be attributed to the interdiffusion between the InAs QDs and the InGaAs layer and to the size homogeneity of the QDs. Especially, by annealing treatment, the emission energy for the InAs QDs inserted between two combination $In_{0.15}Ga_{0.85}As$ layers becomes higher than that of InAs QDs with $In_{0.15}Ga_{0.85}As$ overgrowth layer only. This result can be attributed to strong intermixing at the interface between QDs and barrier layer for the samples having InAs QDs inserted between two combination $In_{0.15}Ga_{0.85}As$ layers. The energy-level spacing between the ground states and the first excited states are decreased with increasing the annealing temperature. The reduction of energy-level spacing is largely related to the change in the QD shape and size, especially the aspect ratio (height/width), during annealing treatment.

Kp-052 **Electrical Properties of Mg-doped $Al_xGa_{1-x}As$ Epitaxial Layers Grown by Molecular Beam Epitaxy** KIM Min Su, KIM Do Yeob, PARK Ho Jin, KIM Jongho, KIM Goon Sik, CHOI Hyun-young, RYU H. H., JEON Minhyun, CHO Guan Sik, KIM Jong Su[1], KIM Jin Soo[2], LEE D. Y.[3], SON J. S.[4], LEEM J. Y.(*Inje University, School of Nano Engineering.* [1]*Advanced Photonics Research Institute, Nano Photonics Group.* [2]*Chonbuk National University, Division of Advanced Materials Engineering.* [3]*Samsung Electro-mechanics. Co., Ltd., Lighting Module Research and Development.* [4]*Kyungwoon University, Department of Visual Optics.*) Mg doped

$Al_xGa_{1-x}As$ epitaxial layers were grown on GaAs (100) substrate with varied Mg cell temperature, Al mole fraction, substrate temperature, and As/Ga beam equivalent pressure (BEP) ratio, by molecular beam epitaxy (MBE). The Hall measurements have been carried out to investigate the electrical properties of the Mg doped $Al_xGa_{1-x}As$ samples. The carrier concentration of $Al_{0.13}Ga_{0.87}As$ layers decreased from 1.86×10^{17} to 4.87×10^{14} cm^{-3} with increase in substrate temperature ranged from 530 to 630 ℃. This can be attributed to dramatically decrease in Mg incorporation on Ⅲ-Ⅴ epilayers with increase in substrate temperature. And also, the mobility and carrier concentration of Mg doped $Al_xGa_{1-x}As$ samples are dependent on the Al mole fraction and As/Ga BEP. Finally, the electrical properties of Mg doped $Al_xGa_{1-x}As$ layers were compared with Mg doped GaAs and Be doped AlGaAs samples already reported. We obtained high quality Mg doped $Al_xGa_{1-x}As$ epitaxial layers having high mobility even though at low substrate temperature.

Kp-053 **The study of electric-optical characteristics in GaAs/InAs quantum dots** 유 재인, 고 병수, 배 인호(*영남대학교 물리학과.*) The electromodulation methods of photoreflectance(PR) and the related technique of contactless electroreflectance(CER) are valuable tools in the evaluation of important device parameters for structures such as heterojunction bipolar transistors (HBTs), pseudomorphic high electron mobility transistors (PHEMTs) and quantum dots(QDs). The basic idea of CER is a very general principle of experimental physics. Instead of measuring the optical reflectance of the material, the derivative with respect to a modulating electric field is evaluated. This procedure gives rise to sharp, differential-like spectra in the region of interband (intersubband) transitions. We present electric-optical studies of both GaAs layers and InAs self-assembled quantum dots grown by molecular beam epitaxy. In both structures, strong GaAs bandgap energy was measured. In the case of InAs monolayers in GaAs matrices, the strong GaAs bandgap energy is caused by the lateral quantum confinement.

Kp-054 **Electroreflectance Spectroscopy of $Al_{0.3}Ga_{0.7}As$/GaAs High Electron Mobility Transistor Structure** 고 병수, 유 재인, 배 인호(*영남대학교 물리학과.*) Electroreflectance(ER) studies of $Al_{0.3}Ga_{0.7}As$/GaAs high electron mobility transistor (HEMT) structure were performed in the temperature range of 18-300K. Room teperature ER spectra show three signals around 1.41, 1.80 and 1.75 eV attributed to the band edges of GaAs, AlGaAs and spin-orbital splitting of the GaAs, respectively. From the measured Franz-Keldysh oscillations(FKOs), we found that the strength of interfacial electric field(F) increases as the reverse dc bias voltage(V_{dc}) is increased. We also observed that two dimensional electron gas(2DEG) was separated from GaAs signal of about V_{dc}= -7V. The 2DEG concentrations were taken at various temperatures and the built-in voltage(V_{bi}) was determined from the plot of V_{dc} versus F^2.

Kp-055 **HVPE 방법에 의한 GaN 나노로드 제작에서 가스유량의 영향** 이 삼녕, 신 민정, 최 윤정, 문 진영, 권 해용, 배 민건, 장 지호, 안 형수, 윤 용주[1], 김 상훈[1], 하 동한[1], 박 승환[2](*한국해양대학교 나노반도체전공.* [1]*한국표준과학연구원 나노소자연구단.* [2]*대구카톨릭대학교전자공학과.*) Gallium nitride (GaN)는 상온에서 3.4 eV의 밴드갭을 갖는 직접 천이형 화합물반도체 재료로서, 밴드갭이 각각 1.9 eV, 6.3 eV 인 InN, AlN와 연속적인 고용체를 형성하면 조성에 따라 밴드갭을 조절할 수 있으며, 열팽창계수와 기계적 강도가 우수하고 화학적으로 안정하기 때문에 청색 및 자외선 영역의 light emitting diode(LED)나 laser diode(LD) 소자 및 고온 파워소자의 재료로 주목받고 있다. 또한 nanorod와 nanowire는 결함밀도가 낮은 1차원 구조로서 최근 광전자소자나 화학센서 등에서 응용가치가 높아지고 있다. 예를 들면 nanorod 구조를 이용한 LED는 에피구조에 비해 휘도가 향상된다고 보고되었다. 본 실험에서는 여러 가지 종류의 가스량이 GaN nanorod 성장에 미치는 영향을 관찰하였다. 먼저 RF 스퍼터링으로 Si(111) 기판 위에 AlN 버퍼층을 형성한 후, 온도 및 HCl/NH3의 비율을 변화시켜가며 Hydride Vapor Phase Epitaxy(HVPE) 방법으로 GaN를 성장시켰다. 온도가 650℃, HCl과 NH3의 비율이 1:40 (30 sccm : 1200 sccm)의 조건에서 GaN nanorod가 성장되었다. 이를 바탕으로 HCl과 NH3의 비율을 1:40으로 고정시킨 후 carrier gas인 N2의 유량을 변화시켜 보았다. Carrier gas의 유량을 1340 sccm, 1540 sccm, 1740 sccm으로 하여 1시간씩 성장시켰을 때, nanorod의 직경이 각각 50 nm, 100 nm, 600 nm가 되어 carrier gas의 유량이 1340 sccm (650 ℃, HCl 30 sccm, NH3 1200 sccm)의 조건에서 가장 작은 직경의 nanorod를 얻을 수 있었다.

Kp-056 **Enhancement of Hall mobility of Te-doped GaSb films grown on ZnTe buffer layer by Molecular Beam Epitaxy** 김 시영, 이 웅, 유 진엽, 정 미나, AUNG KHAING nyi[1], 이 상태[1], 이 홍찬[1], 박 승환[2], 오 동철[3], 장 지호, TAKAFUMI Yao[2](*한국해양대학교, 나노반도체전공.* [1]*한국해양대학교, 선박전자기계공학부.* [2]*Tohoku university, Institute for Materials Research.* [3]*호서대학교, 국방과학기술학과.*) III-Sb 계열의 화합물 반도체는 중 적외선 영역의 레이저 다이오드와 광 소자 및 고속 전자 소자 등 군사용 및 상업용에 이르는 다양한 분야에서의 유망한 물질로 평가 받고 있다. 특히 고속전자 소자 응용 목적의 관점에서 큰 Hall 이동도를 얻을 수 있는 결정성장 방법의 제안이 필수적이다. 본 연구에서는 분자선 에피탁시 (MBE : molecular beam epitaxy) 성장법으로 GaSb과 함께 6.1Å 화합물 반도체로 불리는 ZnTe 버퍼층을 사용하여 n-형 도펀트 Te의 도핑을 실시하여 전기적 특성의 변화를 고찰하였다. 성장 중 고에너지전자선 회절법 (RHEED : reflection high electron energy diffraction) 관찰결과에서 ZnTe 버퍼층을 삽입 했을 경우, 보다 2차원 성장에 가까운 표면 회절 패턴을 얻을 수 있었다. 고분해능 X선 회절(HR-XRD: high resolution X-ray diffraction)을 이용한 (115)면과 (111)면, (004)면에 따른 결정성 평가 결과에서도 ZnTe 버퍼층을 사용한 경우가 좁은 반치폭 (FWHM : full width half maximum)을 가진다는 것을 알 수 있었다. 또한 동일한 조건에서 도핑한 두 시료의 상온 Hall 측정 결과에서도 Hall 이동도도가 ZnTe 버퍼층의 유무에 따라 각각 1182 cm^2/Vs 과 431 cm^2/Vs으로 ZnTe 버퍼층을 사용한 경우 이동도가 2.74배 증가하여, ZnTe 버퍼를 사용하는 것이 2차원 성장을 유도하여 결정성을 향상시키며 고이동도를 갖는 박막성장에 적합함을 알 수 있었다.

Kp-057 **Observation of Strong Influence of Photovoltaic Effects on Characterization in InGaN/GaN Light Emitting Diode Structures** 송 재호, 김 대경, 김 호종, 안 병준, 문 영부[1], 여 환국[1], 최 성철[1], 양 승현[1], 송 정훈(*공주대학교 물리학과.* [1]*더리즈(주).*)
We investigated the photovoltaic effect (PVE) in InGaN/GaN blue light emitting diodes (LEDs) on photoluminescence spectra. For the characterization of InGaN/GaN LEDs, the difference in peak position between photoluminescence (PL) and electroluminescence (EL) spectra is one of crucial issues and should be interpreted accurately. In this study, we analyze emission spectra sensitively affected by PVE and change of photovoltages (PVs) with temperature, excitation power and excitation wavelength. The transition energies and intensities of the LED devices in open-circuit condition are significantly different from those in short-circuit condition. The PL spectrum in open-circuit condition, which is most usual, is influenced strongly by the PVE, where the PVs are from 2.29 to 2.76 V, depending on specific sample structures. This result show that the PVE should be taken into account properly, in temperature, excitation power, excitation wavelength dependence PL. Particularly, in calculation of internal quantum efficiency, if PVE shouldn't be taken into account, the interpretation of PL can be totally wrong. And PVE should be taken into account properly, in order to correlate PL with EL spectra and to interpret PL spectra correctly as well.

Kp-058 **HVPE 방법에 의해 성장된 a-plane GaN 에피층을 이용한 SAG-GaN/AlGaN LED의 특성** 안 형수, 한 영훈, 홍 상현, 황 선령, 전 헌수, 이 충현, 허 인혜, 김 은주, 양 민, 김 석환[1], 조 인성[2], 이 재학[2], 시 상기[2], 이 상칠[3](*한국해양대학교나노반도체전공.* [1]*안동대학교 물리학과.* [2]*더리즈(주).* [3]*제주대학교물리학과.*)
본 연구에서는 HVPE 법으로 r-plane 사파이어 기판 위에 a-plane GaN 에피층을 성장한 후 선택성장 방법으로LED를 성장하였다. 먼저 HVPE방법으로 a-plane GaN 을 560 ℃와 820 ℃에서 two-step으로 각각 성장을 하였고 그 위에 multi-sliding boat를 사용한 혼합소스 HVPE 방법으로 선택성장 (SAG : Selective area growth) 하여 GaN/AlGaN DH (Double hetero)구조의 LED를 성장하였다. p형과 n형의 도핑물질로서 Mg과 Te을 각각 이용하였으며 클래드층으로 AlGaN 층을 이용하였다. r-plane 사파이어 기판에 성장된 a-plane GaN 에피층의 SEM 측정결과 대략1.48㎛의 두께로 측정이 되었고 그 위의 GaN/AlGaN의 DH 구조는 ripple을 가진 표면을 보였다. 이러한 ripple은 r-plane 사파이어 기판위에 a-plane GaN을 성장 할 경우 결정구조에 의해 발생되는 것으로 LED 신뢰성에 문제가 없는 정도의 ripple은 발광효율의 증가에 영향을 줄 수 있을 것으로 판단된다. 본 실험에서는 ripple에 의한 면적증가는 약 33 % 정도로 추정된다. 또한 EL (Electroluminescence) 특성 결과 중심파장이 20 mA에서 약 438 nm으로 나타나며 반치폭 (FWHM : Full width at half maximum)은 0.64 eV임을 알 수 있었다. 이 결과로부터 multi-sliding boat를 사용한 혼합소스 HVPE 방법으로 r-plane 위에 a-plane GaN 성장을 통한 SAG-GaN/AlGaN LED 구조를 제작함으로서 기존의 방식에 비해 상대적으로 간단한 구조와 적은 비용으로LED를 개발할 수 있는 새로운 가능성을 확인 할 수 있었고, 향후 DH 구조설계와 성장조건의 최적화를 통해ripple의 효과를 확인함으로서 LED의 광학적, 전기적 특성이 더욱 향상될 것으로 기대된다.

Kp-059 **HVPE Array LED의 성장과 특성** 안 형수, 김 은주, 전 헌수, 황 선령, 이 충현, 홍 상현, 허 인혜, 한 영훈, 양 민, 이 삼녕, 김 경화, 조 인성[1], 이 재학[1], 시 상기[1](*한국해양대학교나노반도체전공.* [1]*더리즈(주).*) 질화물 반도체인 GaN는 LED (Light Emitting Diode)와 LD (Laser Diode)와 같은 광소자 제작에 있어서 매우 관심을 받고 있는 물질로서 가시광 영역을 비롯하여 고휘도의 백색 LED의 구현이 가능하게 됨에 따라full color 디스플레이나 광소자 등에서 매우 유용하게 사용되고 있다 특히 array LED는 최소한의 면적에서 많은 수의LED pixel들을 집적하여 초소형 마이크로 디스플레이를 구현할 수 있으며 이를 위해서는 단일소자들을 정렬시켜 많은 LED를 집적시킨 효과를 낼 수 있다. 본 연구에서는 이러한 소자를 구현하기 위한 기초 실험으로HVPE 법에 의한 array LED를 형성하였다. 본 실험에서는 C-사파이어 기판 위에 MOCVD 방법으로 성장된 n-GaN templated 웨이퍼를 사용하였으며, multi-sliding boat를 이용한 혼합소스 HVPE 방법으로 선택성장(SAG : Selective area growth) 하여 array LED 를 성장시켰다. Array LED 구조의 성장을 위한 마스크pixel의 chip 크기는 100 ㎛, 150 ㎛, 200 ㎛, 250 ㎛이며, 주로 사용된 크기인 200 ㎛에서는 19 × 19의 LED pixel의 multi array를 이루고 있다. 하나의 chip은 pixel과 pad를 포함한 전체의 크기가 5 ㎜ × 5 ㎜ 이다. DH 구조를 위하여 AlGaN 클래드층에 p형과 n형의 도핑물질로서 Mg과 Te을 각각 이용하였고, 넓은 EL spectrum 반치폭을 얻기 위하여 활성층은 AlGaN으로 하였다. n-GaN 위에 성장된 array LED의 SEM 측정결과 선택성장이 잘 되었음을 알 수 있었고, 성장층의 두께는 3.5 ㎛로 같은 두께를 얻었다. 하나의 Chip에 대한 I-V측정과 EL(Electro luminescence)을 측정하였으며, array LED의 발광 chip 수는 수십개 정도로 확인이 되었다. 이 결과로부터 HVPE 방법으로 n-GaN 기판 위에 SAG-AlGaN array LED소자의 제작 가능성을 확인 할 수 있었으며, 차세대 조명의 응용 및 디스플레이 영역에서 큰 영향을 줄 것으로 판단된다.

Kp-060 **저휘도 구현을 위한 CCFL+LED 액정표시소자** 안 형수, 이 아름, 정 효진, 황 선령, 전 헌수, 이 충현, 홍 상현, 허 인혜, 한 영훈, 김 은주, 김 석환[1], 송 장훈[2], 문 근수[3], 신 홍근[3], 하 홍주[3](*한국해양대학교 나노반도체전공.* [1]*안동대학교 물리학과.* [2]*(주)지디일렉트로닉스.* [3]*(주)그랜드디스플레이.*) 해양 환경에 활용하기 위한 선박용 디스플레이는 일반 디스플레이와 차별화 되어야 할 여러 기술 개발들이 필요하다. 바다의 환경에서의 사용조건을 만족시키는 LCD 모니터 기술개발, 강한 햇볕아래에서 모니터를 읽을 수 있는 기술의 개발, 저 휘도 LCD, 그리고 방수와 함께 전자구성요소의 열에 의한 내부열의 방출을 위한 기술 그 밖에 방폭, 방압 등이 있다. 본 연구에서는 이들 기술 요소 중 LCD 모니터가 저 휘도에서 안정적으로 표시를 실현할 수 있음에 초점을 맞추어 연구를 진행하였다. 저 휘도를 구현하기 위한 방법으로 기존의 CCFL과 함께 LED를 옆면에 배치하는 방법을 이용하였다. 구간별 밝기와 평활도를 조사하기 위하여 LCD 모니터를 크게 9개의 구간으로 나누어 각 구간별 밝기를 측정하고 그 차이를 계산하여 평활도를 알아보았으며 그 결과 구간의 위치에 따른 평활도의 차이가 균일함을 보였다. 이에 근거하여 기존의 CCFL에 LED를 추가하였고, 뒷면 전체가 LED였던 BLU 구조와 다르게 옆면 edge에만 LED를 부착하였다. 그 결과 광량이 증가하고 어두운 상태에서

평활도가 유리해졌으며, 소비 전력이 줄어들었다. 또한, 빛을 밝힌 edge LED의 개수를 변화시키면서 그에 따른 모니터 밝기와 소비 전력을 측정하였다. LED의 위치와 개수에 따라 모니터 전체 밝기를 비교하였으며 최종적으로 저 휘도에서도 안정된 표시를 실현할 수 있는 가능성이 있음을 알 수 있었다.

Kp-061 **전자빔 조사 및 후열처리를 통한 GaN 에피층 결함의 종류와 농도 조절에 관한 연구** 하 임경, 이 동욱, 김 진석, 김 은규, 배 성범[1], 이 규석[1], 오 대곤[1], 한 영환[2], 이 병철[2](*한양대학교 물리학과. [1]한국전자통신연구원. [2]원자력연구소 양자광학실험실.*) GaN는 3.4 eV 정도의 넓은 띠 간격이 특징인 물질로 청색 파장의 발광 다이오드(light emitting diodes-LED), 레이저 다이오드 (laser diode-LD), 자외선 감지기 (UV detector) 등 짧은 파장에 대응하는 광소자에 대표적으로 응용되고 있다. 최근에는 양자 구조나 어긋나기(dislocation) 및 결함 구조를 이용하여 출력 효율이나 발광 특성을 조절하려는 노력으로 진행되고 있는데, 반도체 결정에서 어긋나기나 결함은 성장 조건에 의해 성장 과정에서도 발생할 수 있지만, 고에너지로 가속된 입자의 인위적인 조사(irradiation)에 의해서도 생성이 가능하다. GaN 반도체의 경우 전자 소자로 만들었을 때 높은 전압에서 동작할 수 있고, 낮은 누설전류(leakage current) 특성을 보여 고전압, 고전력 소자(hight power device)로의 응용역시 기대되는데, 익히 알려져 있듯이 스윗칭(switching) 소자 등에서 스위칭 속도를 빠르게 하기 위해서는 소수 운반자(minority carrier)의 수명(life time)을 짧게 조절하여야 한다. 적절히 생성된 결함은 소수 운반자를 포획하여 운반자의 수명을 줄여주기 때문에 소자 응용에 매우 중요하다. 본 연구에서는, 유기금속화학기상증착법 (metal organic chemical vapor deposition -MOCVD) 기법으로 증착된 GaN 에피층에 전자빔 조사 및 후 열처리를 통해 결함의 농도와 종류를 조절가능한 지에 관하여 연구하였다. MOCVD 기법으로 성장된 에피층의 두께는2 μm 이고 운반자 농도가 $5\times10^{16}\sim5\times10^{17}$ cm^{-3} 정도범위가 되도록 도핑(doping)되었다. 1 MeV로 가속된 전자빔을 1×10^{16} cm^{-2} 농도로 조사하여 결함을 생성하였다. 그 이후 300 °C부터 900 °C 까지 온도를 변화시켜가며 열처리를 하였다. 결함에 대한 특성 확인은 전기용량(C-V) 및 깊은준위접합과도용량분광법(Deep Level Transient Spectroscopy -DLTS)을 이용하여 운반자의 공간적인 농도분포와 새롭게 고에너지 전자선에 의해 생성된 결함 상태를 분석 연구하였다.

Kp-062 **Optical Characterization of InGaN/GaN MQW with Various Well Width Grown on GaN Substrate** 신 동명, 한 유대, 박 재규, 이 동한, 김 종국[1], 김 치선[1], 최 윤호[1], 노 민수[1](*충남대학교 물리학과. [1]LG전자기술연구원*) 우물층 두께에 따른 InGaN/GaN MQW의 광학적 특성을 연구하였다. 시료는 GaN 기판위에 device구조로 성장하였고, 활성층으로 우물층의 두께가 각 3 nm, 4 nm인 3주기 InGaN/GaN MQW 을 사용하였다. 분석을 위해 Ti:Sapphire laser의 740nm를 second harmonic generation하여 얻은 370 nm를 사용하였고, 일반적인 photoluminescence(PL) 측정장치 및 time correlated single photon counting 장치를 사용하였다. 실험은 여기광의 세기에 따른 PL, 온도에 따른 PL, 온도에 따른 decay curves를 측정을 하였다. 우물층의 두께가 두꺼운 시료(S1)의 경우 여기광의 세기에 따른 PL peak의 이동은 44.8 meV였고, 두께가 얇은 시료의 경우(S2)는 28.6 meV 였고, 저온 carrier lifetime은 각각 70 ns(S1), 17ns(S2)으로 나타났다. 여기광의 세기에 따른 PL peak의 이동과 carrier lifetime의 측정 결과로 부터 S1이 piezoelectric field에 의한 효과가 큰 것으로 나타났다. FWHM은 각각 30 meV(S1), 28 meV(S2)였고, 온도에 따른 PL peak 에너지의 이동은 S1의 경우 'S'자 모양이 더 뚜렷이 나타난 것으로부터 S1의 localization이 더 강한 것을 알 수 있었다. 온도에 따른 decay curve의 측정결과, S1은 S2에 비해 저온 carrier lifetime이 짧았지만, 상온에서는 비슷한 값을 보였고, internal efficiency는 S1이 17% 였고, S2는 6.4%로 S1이 크게 나타났다. 결과적으로, 우물층의 두께가 두꺼운 경우, piezoelectric field의 영향에 의한 wavefunction overlap이 작아 carrier lifetime이 길어도 localization이 강하면 internal efficiency가 큼을 알 수 있었다.

Kp-063 Temperature dependent Hall-effect measurement of Molecular Beam Epitaxial grown GaSb:Te Thin Films NYI Aung Khaing, KIM Si Young[1], LEE Woong[1], PARK Seunghwan[2], OH Dong-cheol[3], YAO Takafumi[2], LEE Sang Tae, CHANG Ji Ho[1], LEE Hong Chan(*Major of Mechatronics, Korea Maritime Univ., Busan, 606-791, Korea. [1]Major of Nano-semiconductor, Korea Maritime Univ., Busan, 606-791, Korea. [2]IMR, Tohoku Univ., Sendai, 980-8577, Japan. [3]Department of Defense Science &Technology, Hoseo Univ., Asan, 336-795, Korea.*) Temperature-dependent Hall-effect measurements of n-GaSb epilayers grown on GaAs substrates with and without ZnTe buffer layer have been studied. The epilayers were grown by solid source Molecular Beam Epitaxy with Tellurium as an n-type doping source. At room temperature, the Hall mobility is 2.5 times higher for GaSb:Te with ZnTe buffer layer (631cm^2/Vs) compare to that in GaSb:Te without buffer layer (249cm^2/Vs). The resistivity is $3.62\times10^{-3}\Omega$cm for GaSb:Te with buffer layer and $5.85\times10^{-3}\Omega$cm for GaSb:Te without buffer layer. Hall mobility increases and carrier concentration decreases along with the measurement temperature decreasing. At the lowest measurement temperature (15K), the Hall mobility for GaSb layer with and without buffer layer were 1320cm^2/Vs and 487cm^2/Vs respectively. The temperature dependent Hall-effect measurement results were analyzed based on four-major carrier scattering mechanisms such as polar-phonon, ionized impurity, dislocation, deformation potential scatterings, which leads us to conclude that ZnTe buffer layer improves not only the crystal quality of GaSb:Te epilayer but also gives a large effect on the resistivity and mobility.

Kp-064 **InGaAs/InGaAsP 양자점 적층구조에서 장벽층의 두께에 따른 전기적인 특성 비교** 이 윤일, 김 진석, 김 은규, 편 수현[1], 정 원국[1](*한양대학교 물리학과. [1]성균관대학교 재료공학과.*) 양자점(QD)은 수소원자나 상자속의 입자와 같이 매우 작게 제한된 영역에 불연속적인 에너지 준위가 분포되어있는 독특한 구조 때문에 그 이론적인 해석이나 여러 분야에의 응용을 관한 많은 연구가 진행되어왔다. 양자점 시스템 안에서 전자나 홀은 불연속적인 에너지 분포를 가지면서 존재하게 되고 이런 성질은 레이저 다이오드나 양자논리소자와 같은 다양한 구조에 응용 가능하다. 특히, GaAs나 InP를 기반으로 하는 자기조립 InGaAs 양자점 시스템은 그 에너지 구조 상1.3 ~ 1.55 ㎛ 영역에서 동작할 수 있기 때문에 광통신에 사용되는 레이저 다이오드 및 광다이오드에

P3 포스터세션

광범위하게 사용되고 있다. 대부분의 경우 양자점 구조의 측정은 photoluminescence와 같은 광학적인 방법으로 하는데, 전자소자로의 응용 및 소자 효율 증대를 위해선 전기적인 물성측정을 수행하였다. 본 연구에서는 측정한 시료는 서로 크기가 다른 두 양자점층 사이에 장벽층을 두고 수직으로 적층시킨 InGaAs/InGaAsP 양자점 구조로서, 양자점은 InGaAs 물질로 장벽층에는 InGaAsP 물질이 사용되었다. 최종적으로 성장된 양자점 구조를 전극절연체-반도체 (metal-insulator-semiconductor) 소자로 만들어 전기용량(C-V) 측정과 접합과도용량분광법(DLTS) 을 통하여 전기적인 특성을 연구하였다. 특히 DLTS 측정을 할 때 인가되는 전압을 변화시켜주면 시료에서 측정되는 영역의 깊이를 제어할 수 있는데, 이를 이용하면 양자점으로 인해 생성된 퍼텐셜안의 에너지 준위를 선택적으로 충전 (charge-selective) 시킴으로 양자점 시스템의 정확한 양자구조를 조사할 수 있다.

Kp-065 **The Structural Property of Cu ion-implanted GaN Single Crystals** PARK K.H, LEE E. K, KANG H. J, YANG D. S[1], SHIN S. W[2], SONG J. H[2](*Department of Physics, Chungbuk National University.* [1]*Physics Division, School of Science Education, Chungbuk National University.* [2]*Advance Analysis Center, Korea Institute of Science and Technology.*) There have been numerous efforts to fabricate a diluted magnetic semiconductor (DMS) with high ferromagnetic transition temperature. Recently, the Cu ion-implanted GaN films showed ferromagnetic property at room temperature [1]. The structural property of Cu-ion-implanted ZnO was investigated. The Cu K-edge Extended X-ray Absorption Fine Structure (EXAFS) revealed the coexistence of Cu-N and Cu-Cu bonds. Here, the Cu-Cu bond indicates metallic clusters and the Cu-N bond denotes nitrided Cu. The Cu-N bond was formed for the samples post-annealed at 700 ℃, and increased for the samples post-annealed at 800 ℃, but the Cu-Cu bond was increased with increasing annealing temperature. EXAFS results show that the interactions among Cu can play an important role in ferromagnetism of these samples.

[1] J. H. Lee, I. H. Choi, S. W. Shin, S. G. Lee, J. Lee, C. N. Whang, S. C. Lee, K. R. Lee, J. H. Baek, K. H. Chae, and J. H. Song, Appl. Phys. Lett. 90, 032504 (2007).

Kp-066 **Optical Properties of Low Density InAs Quantum Dots** 박 수연, 정 현식, 김 정섭[1], 윤 의준[1](*서강대학교 물리학과.* [1]*서울대학교 재료공학과.*) Low density quantum dots (QDs) present attractive characteristics for the realization of single-photon sources at telecommunication wavelengths. Optical properties as a function of the dot density have been reported, but no one focused on the phenomena occurring in the very low density ($\leq 10^7$ dots/cm^2). In this study, very low density InAs QDs imbedded $In_{0.15}Ga_{0.85}As$ strain-reducing layer were grown by metal organic chemical vapor deposition. Samples with QD densities from $\leq 9.6 \times 10^6$ dots/cm^2 to 9.3×10^8 dots/cm^2 emit in the 1250-1350 nm range. Photoluminescence (PL) measurements performed at different excitation powers and temperatures provide information on the recombination process and the efficiency of carrier transfer in the very low density QDs.

Kp-067 **Process optimization of CNTs for enhanced electron emission** 송 나영, 유 제황, 임 한얼, 임 준원, 장 진, 박 규창 (*경희대학교, 차세대 디스플레이연구센터*) 탄소나노튜브(CNTs)는 다양한 형태와 물성을 지닌 특성으로 인하여 나노전자 산업분야로 활발하게 응용되고 있다. 그 중에서도 낮은 임계전계에서의 높은 전자방출 특성으로 전자방출소자(electron emitter) 로의 연구가 활발히 이루어지고 있다.본 실험은 니켈이 증착된 실리콘기판 위에 레지스트패터닝법 (resist-assisted patterning, RAP) 을 이용한 CNTs 의 선택적 위치제어 성장법에 관한 기존의 연구 결과를 바탕으로 진행되었다. RAP 방법을 이용한 패턴 형성 시 레지스트의 두께가 너무 얇은 경우 니켈의 확산으로 인하여 촉매 형성을 하지 못하는 단점이 있었다. 따라서 구조적으로 안정된CNTs 를 얻기 위하여 레지스트의 두께를 조절할 필요성에 따라 레지스트의 두께에 따른 특성 변화를 확인하였다.결과적으로, 레지스트의 두께를 변화시킴에 따라CNTs 의 구조 및 전자방출 특성이 다르게 나타나는 것을 확인하였다. 따라서 본 연구에서는 기존의RAP 공정에서 레지스트의 두께를 조절함으로서 향상된 전자방출 특성을 갖는 CNTs 의 성장 공정을 최적화하였다.

Kp-068 **Si(100)기판 위에 성장한 $Al_xGa_{1-x}Sb$의 전기적, 구조적 특성 조사** 노 영균, 김 문덕, 이 상태, 홍 정우[1], 김 동은[1], 오 재응[1](*충남대학교.* [1]*한양대학교*) Sb 기반 화합물 반도체는 고속전자소자 및 장파장 영역의 광소자 응용이 가능한 물질로서 대면적의 값싼 Si 기판 위에 성장하려는 연구에 관심이 집중되고 있다. 그 중 $Al_xGa_{1-x}Sb$는 Al의 조성에 따라 넓은 밴드갭(~1.6 eV)을 가질 수 있고 산화에 강해 Sb 기반의 전자소자 및 광소자 구조의 포텐셜 장벽과 클레드 층으로 사용된다.본 연구에서는 molecular beam epitaxy 법을 이용하여 Si(100)기판 위에 $Al_xGa_{1-x}Sb$ 박막을 성장하였으며 성장조건에 따른 구조적, 전기적 특성을 double crystal x-ray diffraction (DCXRD), atomic force microscopy, 그리고 temperature dependent Hall 측정을 통하여 조사였다. 또한 schottky diode를 제작하여 I-V 및 C-V 측정을 통하여 전기적 특성을 조사하였다. 성장온도가 570℃ 이며 V/III 비율이 45 인 경우 $Al_{0.8}Ga_{0.2}Sb$의 DCXRD 신호 반치폭이 306 arcsec로 가장 낮게 성장되었고 홀 농도와 이동도는 각각2.74×10^{18} cm^{-3} 과 298 cm^2 /V·s 로 측정되었다.

Kp-069 **HCl-Flow-Rate Dependence of the Growth Temperature of GaN Nanorods** SOHN Yuri, KIM Chinkyo (*Kyunghee University, Dept. of Physics.*) Effect of HCl flow rate on the growth temperature of GaN nanorods was investigated. GaN nanorods were grown by horizontal hydride vapor phase epitaxy (HVPE) on c-plane sapphire substrates with 0.3°miscut toward m-plane (10-10). Typical growth temperature of GaN nanorods is known to be as low as 400~550°C. Interestingly enough, in this work it was found that high quality GaN nanorods could be grown at higher than typical growth temperature by increasing HCl flow rate. The growth temperature was found to be strongly dependent on the flow rate of HCl.

Kp-070 **Preferred Growth Direction of GaN Nanorods Grown by Hydride Vapor Phase Epitaxy** LEE Sanghwa, CHOE Hyeokmin, KIM Chinkyo(*Kyunghee University, Dept. of Physics.*)

GaN nanorods were grown by horizontal hydride vapor phase epitaxy (HVPE) on c-plane sapphire substrates with 0.3°miscut toward m-plane (10-10) and preferred growth direction was investigated by utilizing synchrotron x-ray scattering. Imaging plate with a small angle scattering geometry effectively probed various growth direction of GaN nanorods.

Kp-071 **Characteristic Surface Morphology of GaN Thin Films Grown on r-plane Sapphire Substrates** SHIN Boa, HEOKMIN Choe, MIHEE Jeon, KIM Chinkyo(*Kyunghee University, Dept. of Physics.*) The density of extended defects in non-polar a-plane (11-20) GaN was known to be very high and lateral epitaxial overgrowth (LEO) was typically employed to reduce the defect density. In this work, it was found that under certain growth conditions LEO-like stripe-patterned morphology can be obtained on GaN films grown on r-plane sapphire substrates without either masks or etching substrates. This characteristic surface morphology can be conveniently utilized to reduce a dislocation density in a simpler way than standard LEO.

Kp-072 **Dielectric function and critical points of (GeTe, Sb_2Te_3) pseudo-binary thin films studied with spectroscopic ellipsometry** PARK Jun Woo, BAEK Seoung Ho, KANG Tae Dong, LEE Hosun, KANG Youn-Seon[1], LEE Tae-Yon[1], KIM Ki Joon[1], KIM Cheol Kyu[1], KANG Yoon Ho[1](*경희대학교 물리학과, [1]삼성종합기술원*) We measured the dielectric functions of (GeTe, Sb_2Te_3) end-points and pseudo-binary thin films - GeTe, $Ge_2Te_2Sb_5$, $Ge_1Te_2Sb_4$, $Ge_1Te_4Sb_7$, and Sb_2Te_3 – by using spectroscopic ellipsometry. According to x-ray diffraction, the as-grown thin films were amorphous, the annealed films had FCC, HCP, or rhombohedral phase. In the case of the as-grown thin films, the amplitudes of the complex refractive indexes increased as the Sb to Ge atomic ratio increases. In the case of the annealed thin films, the amplitudes of Ge-containg thin films increased significantly compared to those of the as-grown films, whereas that of Sb_2Te_3 increased slightly. In FCC phase (200°C-annealing) the complex refractive indexes of $Ge_1Te_2Sb_4$ and $Ge_1Te_4Sb_7$ were the largest and that of GeTe was the smallest. By using standard critical point model, we obtained the accurate values of the energy gap of the amorphous phase as well as the critical point energies of the annealed crystalline thin films. The band gap energy values are compared to those determined by the method of linear extrapolation of the optical absorption. As the Sb to Ge atomic ratio increased, the optical gap energy of amorphous phase decreased from 0.8 eV to 0.52 eV. Standard critical point fitting showed several higher band gaps and the corresponding electronic band structures are discussed. Finally we discussed the relation between the critical points determined by SCP model with respect to optical band gap of amorphous thin films and indirect band gap of 200°C- and 250°C- annealed films estimated by liner extrapolation of absorption coefficients.

Kp-073 **Photocurrent spectrum for AgGaSe2 single crystal thin film grown by hot wall epitaxy** 홍 광준(*조선대학교 물리학과.*) Single crystal $AgGaSe_2$ layers were grown on thoroughly etched semi-insulating GaAs(100) substrate at 420 ℃ with hot wall epitaxy (HWE) system by evaporating AgGaSe2 source at 630 ℃. The crystalline structure of the single crystal thin films was investigated by the photoluminescence and double crystal X-ray diffraction (DCXD). The carrier density and mobility of single crystal $AgGaSe_2$ thin films measured with Hall effect by van der Pauw method are 4.05×10^{16} /cm^3, 139 cm^2/V·s at 293K, respectively. The temperature dependence of the energy band gap of the $AgGaSe_2$ obtained from the absorption spectra was well described by the Varshni's relation, $E_g(T)=1.9501$ eV-$(8.79\times10^{-4}$ eV/K$)T^2/(T+250$ K). The crystal field and the spin-orbit splitting energies for the valence band of the $AgGaSe_2$ have been estimated to be 0.3132 eV and 0.3725 eV at 10 K, respectively, by means of the photocurrent spectra and the Hopfield quasicubic model. These results indicate that the splitting of the ΔSo definitely exists in the Γ_5 states of the valence band of the $AgGaSe_2$. The three photocurrent peaks observed at 10 K are ascribed to the A_1-, B_1-, and C_1-exciton peaks for n = 1.

Kp-074 **Growth and point defect for AgGaSe2 single crystal thin film by hot wall epitaxy** 이 상열, 홍 광준(*조선대학교물리학과.*) A stoichiometric mixture of evaporating materials for $AgGaSe_2$ single crystal thin films was prepared from horizontal electric furnace. To obtain the single crystal thin films, $AgGaSe_2$ mixed crystal was deposited on thoroughly etched semi-insulating GaAs(100) substrate by the hot wall epitaxy (HWE) system. The source and substrate temperatures were 630℃ and 420℃, respectively. The temperature dependence of the energy band gap of the $AgGaSe_2$ obtained from the absorption spectra was well described by the Varshni's relation, $E_g(T) = 1.9501$ eV - $(8.79 \times 10^{-4}$ eV/K$)T^2/(T + 250$ K). After the as-grown $AgGaSe_2$ single crystal thin films was annealed in Ag-, Se-, and Ga-atmospheres, the origin of point defects of $AgGaSe_2$ single crystal thin films has been investigated by the photoluminescence(PL) at 10 K. The native defects of V_{Ag}, V_{Se}, Ag_{int}, and Se_{int} obtained by PL measurements were classified as a donors or acceptors type. And we concluded that the heat-treatment in the Ag-atmosphere converted $AgGaSe_2$ single crystal thin films to an optical p-type. Also, we confirmed that Ga in $AgGaSe_2$/GaAs did not form the native defects because Ga in $AgGaSe_2$ single crystal thin films existed in the form of stable bonds.

Kp-075 **Effect of thermal annealing for CdIn2S4 epilayers** 유 상하, 홍 광준(*조선대학교 물리학과*) After the $CdIn_2S_4$ films grown by hot-wall epitaxy method were annealed in Cd-, S- and In-atmospheres, the point defects were investigated by using the low photoluminescence (PL) experiment. In the as-grown $CdIn_2S_4$ films, the free excitons corresponding to the light hole and the heavy hole have been observed, and their splitting gap was 8.2 meV. The gap is associated with the strain caused by the lattice mismatch between the substrate and the film in the heterojunction growth. By means of thermal annealing in various atmospheres, the (D^o, X) emission was observed to originate from the V_S or Cd_{int}. From this emission, the

E_D value of the donor impurity level is extracted to 0.1950 eV. Also, the emission between the free electrons and the acceptor holes (FA) became a dominant peak after S atmosphere treatment, and the E_A value of the acceptor level is turned out to be 0.2371 eV. Thus, the origin of the FA emission is related to V_{Cd} or S_{int}. These PL results led us to confirm that $CdIn_2S_4$:S is converted into the optical p-type. In addition, the origin of the donor-acceptor pair emissions is caused by the recombination between donors such as V_S or Cd_{int} and acceptors such as V_{Cd} or S_{int}. Based on these PL results, we have schemed a new energy-level diagram of the recombination process in $CdIn_2S_4$.

Kp-076 **Photocurrent properties for CdIn2Te4 single crystal grown by Bridgman method** 윤 석진, 홍 광준[1](*조선대학교 화학교육학과*; [1]*조선대학교 물리학과*) The single crystals of p-$CdIn_2Te_4$ were grown by the Bridgman method without the seed crystal. From photocurrent measurements, it was found that three peaks, A, B, and C, correspond to the intrinsic transition from the valence band states of Γ_7(A), Γ_6(B), and Γ_7(C) to the conduction band state of Γ_6, respectively. The crystal field splitting and the spin orbit splitting were found to be 0.2360 and 0.1119 eV, respectively, from the photocurrent spectroscopy. The temperature dependence of the $CdIn_2Te_4$ band gap energy was given by the equation of $E_g(T) = E_g(0) - (9.43 \times 10^{-3})T^2/(2676 + T)$. $E_g(0)$ was estimated to be 1.4750, 1.7110, and 1.8229 eV at the valence band states of A, B, and C, respectively. The band gap energy of p-$CdIn_2Te_4$ at room temperature was determined to be 1.2023 eV.

Kp-077 **Photoluminescience properties for CuAlSe2(112)/GaAs(100) heteroepitaxial layers** 박 창선, 홍 광준[1](*조선대학교금속재료학과*; [1]*조선대학교 물리학과*) The $CuAlSe_2$(112)/GaAs (100) heteroepitaxial layers were grown by the hot wall epitaxy (HWE) method. From the measurements of the Laue patterns and the double crystal X-ray diffraction, the $CuAlSe_2$ epilayer was confirmed to the epitaxially grown layer along the <112> direction onto a GaAs (100) substrate. The Hall mobility and carrier density of the $CuAlSe_2$ epilayer at 293 K were estimated to be 295 $cm^2/V\cdot sec$ and 9.24×10^{16} cm^{-3}, respectively. This mobility is approximately one order higher than the reported value. From the temperature dependence of the Hall mobility, the scattering at a high temperature range was mainly due to the acoustic mode of lattice vibration. The scattering at a low temperature was the most pronounced range due to the impurity effect. From the low-temperature PL experiment, we observed the sharp and intensive free-exciton peak at 2.7918 eV. Also, this peak existed far more in the short-wavelength region than 2.739 eV of free exciton measured from the epilayer grown by the metalorganic chemical vapor deposition (MOCVD). Consequently, these facts indicate that the $CuAlSe_2$ epilayers grown by the HWE method are higher quality crystals than those grown by MOCVD or other methods.

Kp-078 **Growth and solar cell application for $CuGaSe_2$ layers** 홍 명석, 홍 광준[1], 김 혜정[1](*조선대학교 기계공학과*; [1]*조선대학교 물리학과*) $CuGaSe_2$ (CGS) layers were grown by the hot wall epitaxy method. The optimum temperatures of the substrate and source for growth turned out to be 450 and 610 °C, respectively. The CGS layers were epitaxially grown along the <110> direction and consisted of Ga-rich components indicating the slight stoichiometric deviations. Based on the absorption measurement, the band-gap variation of CGS was well interpreted by the Varshni's equation. The band-gap energies at low temperatures, however, had a higher value than those of other CGS. It suggests that the band-gap increase is influenced by the slightly Ga-rich composition. From the low-temperature photoluminescence experiment, sharp and intensive free- and bound-exciton peaks were observed. By analyzing these emissions, a band diagram of the observed optical transitions was obtained. From the solar cell measurement, an 11.17 % efficiency on the n-CdS/p-CGS junction was achieved.

Kp-079 **Germole계 결정들의 Density Functional Theory를 이용한 전자구조 계산 및 광전이특성 분석** 박 영환, 신 용호, 노 승정, 현 준원, 김 용민, 손 홍래[1](*단국대학교 응용물리학과*; [1]*조선대학교 화학과*) OLED는 현재 디스플레이의 가장 큰 비중을 차지하고 있는 LCD의 가장 큰 단점인 시야각이 좁고 자체발광이 아닌 back-light를 이용한다는 단점을 보완할 수 있으며 낮은 구동전압과 빠른 응답속도 때문에 차세대 디스플레이로 큰 각광을 받고 있으며 활발한 연구가 진행되고 있다. OLED의 주요한 과제 중의 하나가 바로 효율적인 전자수송층(ETL)과 새로운 발광층(EML) 물질의 개발이다. 이러한 문제점들을 보완할 수 있는 대체물질로 저분자 중에서 열적으로 안정성이 뛰어나고 진공 증착이 용이한 silole계 중합체에 관한 연구가 활발히 진행되고 있다. 최근 silole 분자의 경우 일반적인 용액상태에서는 빛을 내지 않지만 중합체가 들어간 경우 특이한 발광을 한다는 것이 발견되었다. 일반적으로 빛이 아주 약하며 용·액상태에서는 빛을 내지 못하지만, silole 중합체의 경우 용액상태에 비해 형광 양자 효율이 약 100배 정도 크게 증가하는 특성 때문에 자체 전계발광(EL)을 이용한 광소자인 유기발광소자(OLED)로의 응용가능성에 관한 연구가 활발히 진행되고 있다. 본 연구는 silole 계 시료와 전기화학적인 특성이 유사한 germole에 ligand를 달리하는 중합체 시료들을 제작한 후 상온에서의 photoluminescence(PL) 스펙트럼 및 gaussian 프로그램을 이용한 각 시료의 charge density 및 HOMO, LUMO 에너지 계산을 통하여 광학적 및 구조적인 특성을 분석하는데 그 목적이 있다.

Kp-080 **UV Irradiation 에 따른 전도성 유기물 고분자 박막의 광특성 변화** 정 용우, 차 영훈, 변 준석, 황 순용, 공 태호, 김 영동(*경희대학교, 물리학과*) 유기물 반도체는 무기물 반도체에 비해 대면적 공정가능, 낮은 생산단가, 간단한 공정 등의 장점을 가진 대안으로 제시되어 왔다. 특히 본 연구에 사용된MEH-PPV의 경우 상대적으로 높은 carrier mobility를 갖고 있기 때문에 유기물 반도체 발광소자(LED) 또는 태양전지로의 응용 가능성이 높은 물질로 다양한 분야에서 연구되고 있다. 유기 고분자 물질의 광전자 소자 응용에서 문제점 중에 하나가 수분 및 산화 등의 외적요인에 취약하다는 점이다. 따라서 산업적으로 응용에 적합한 물질을 찾기 위해서 외적요인이 고분자물질에 미치는 영향을 정량화 하는 것이 필요하다. 본 연구는 UV 조사시간에 따라 유

기고분자 물질에서 발생하는 광학적 특성변화를 분광타원 해석기(Spectroscopic Ellipsometry)를 이용하여 측정하였고 이러한 광학적 변화와 고분자 물질의damage의 연관성에 대하여 논의하였다. 분광타원 해석기의 경우 물질의 광학상수를 정밀하게 측정할 수 있으며 비등방 특성분석에도 유용한 측정장비로 알려져 있다.특히 MEH-PPV의 경우 단분자간의 연속적인 결합인bonding chain alignment에 따라 광학적 비등방성이 존재함이 알려져 있으므로 UV 조사 시간에 따른 각 광축의 광학적 특성변화 및bonding chain에 UV가 미치는 영향 등을 효과적으로 분석해 낼 수 있었다.

Kp-081 **증성입자빔을 이용한 SiO_2박막 형성 연구**
SON HYOCK JUN, KIM JONG SIK[1], KIM DAE CHUL[2], YOO SUCK JAE[2], PARK YOUNG CHUN[3], LEE BONG JU[2](*한동대학교, 정보통신 공학과.* [1]*한양대학교, 물리학과.* [2]*국가핵융합연구소.* [3]*한동대학교, 정보통신공학과.*) 최근 반도체 고집적화를 위해 소자의 극미세화가 연구의 핵심을 이루고 있으며CMOS 소자 또한 수십 나노급 게이트 길이를 갖는 기술로 발전하고 있다. 이러한 기술의 동향에 있어서 thermal SiO_2박막은 공정에서 발생되는 여러 문제점을 안고 있어 저온 공정 기술의 필요성이 부각되었다. 저온 공정의 필요성에 의해 플라즈마를 이용한 다양한 저온SiO_2박막 공정 연구가 이루어지고 있다. 하지만 플라즈마 내에 높은 에너지를 갖는 입자들에 의해 SiO_2박막 표면과 Si/SiO2 계면에 plasma damage가 발생하게 되고 SiO_2박막 내 전하 형성의 문제점도 가지고 있다. 이러한 문제점을 해결하기 위하여neutral beam을 이용한 방법이 주목을 받고 있다. 이중 100 eV 이하의 에너지를 가지는 Hyper-thermal Neutral Beam(HNB)을 이용하여 plasma damage 없는 SiO_2박막 형성을 가능케 하였다. 본 연구에서는HNB 방법으로 저온에서 SiO_2박막을 형성하여 게이트 절연층 물질로서의 전기적 특성을 평가 분석하였다. HNB energy 변화와 공정 시간에 따른 Capacitance-Voltage(C-V) 특성, Current-Voltage(I-V) 특성, 박막 두께를 비교 분석하였고, 공정 온도에 따른 HNB SiO_2박막의 특성과 thermal SiO_2박막의 특성을 비교 분석하였다.

Kp-082 **Fe-, Co-doped TiO_2 박막의 광학적 특성** 최 성휴, 서 동주[1], 강 동완[2](*조선대, 물리학과.* [1]*조선대, 물리교육학과.* [2]*조선대, 치과보철학과.*) Fe-, Co-doped TiO_2 박막의 결정구조, 광학적특성 등을 규명하기 위하여 분무 열분해법으로 유리기판 위에 성장시켰다. 600℃에서 후 열처리 한 박막의 결정구조는(101)면이 뚜렷하게 성장된 tetragonal 구조이며, 격자상수는 순수한 TiO_2 박막은 a = 3.873 Å, c = 9.515 Å이었으며, Fe-doped TiO_2 박막은 a = 3.785 Å, c = 9.514 Å이었고, Co-doped TiO_2 박막은 a = 3.784 Å, c = 9.513 Å이었다. 첨가된 불순물(1wt%)에 따라서 격자상수가 약간씩 변화 하였다. 600℃ 온도 산소분위기속에서 후 열처리한 순수한 TiO_2 박막의 광학적 에너지 간격은3.632eV 이었으며, Co-doped TiO_2 박막의 광학적 에너지 간격은3.482eV 이었으며, Fe-doped TiO_2 박막의 광학적 에너지 간격은 3.621 eV이었다.

Kp-083 **Quasi-Particle Spectra of Various Forms of Crystalline Germanium Telluride** KIM JINWOONG, LEE GEUNSIK[1], JHI SEUNG-HOON(*Department of Physics, Pohang University of Science and Technology.* [1]*Department of Physics, University of Texas at Dallas.*) GeTe is known to undergo a very complex structural phase transition under pressure. Also it changes the phase upon heating from crystalline NaCl structure to amorphous phase. Several models were suggested for possible structural transition pathways such as Toledano, Modified Buerger and Watanabe model. We have investigated the dielectric function of GeTe at representative structural phases using the pseudopotential density functional method within the generalized gradient approximation. To calculate the quasiparticle spectra, we carried out the GW calculations. Semicore d-electrons of Te are found to be very critical for calculating correct transition pressures, and they are included explicitly as valence. These electrons affect the electronic structures through the p-d coupling, which is found non- negligible. Our results can help analyze experimental data and investigate the transition pathway of GeTe.

Kp-084 **The study of inserting $F_{16}CuPc$ layer effect on pentacene organic thin-film transistor (OTFT)** PARK Jin Hwan, CHO Sang Wan[1], JEONG Jin Geol[1], PARK Sang Han[1], CHO Mann-Ho[1], WHANG Chung-Nam[1](*Department of Physics and IPAP, Yonsei Univeristy.* [1]*Department of Physics and IPAP, Yonsei University.*) We report on the effect of inserting $F_{16}CuPc$ layer on pentacene(50nm) by using Au electrode and SiO_2(100nm)/Si(100) substrate. As the $F_{16}CuPc$ layer is increased with 5nm, 10nm and 15nm, the electrical performance of pentacene OTFT is improved. For example, the hole carrier mobility and on/off current ratio of the device are improved respectively. The most effective result of this experiment is a decrease of threshold voltage from -15.25V to -6.38V, which is resulted from the change in electronic structure caused by charge transfer. Also, we had observed the morphological changes of $F_{16}CuPc$ layer on pentacene as a function of the layer thickness. Because both lower threshold voltage and low operated voltage are necessary for low power consumption, this effect of inserting $F_{16}CuPc$ layer could be helpful to develop such device.

Kp-085 **$CdGa_2O_4$ 및 $CdGa_2O_4$:Mn 결정의 광학적 특성** 최 성휴, 김 형곤[1], 김 남오[1], 방 태환[2](*조선대, 물리학과.* [1]*조선이공대학, 전기과.* [2]*성화대학, 항공전기전자과.*) $CdGa_2O_4$ 및 $CdGa_2O_4$:Mn(1mol%) 결정을 성장하여 성장된 결정의 구조와 격자상수를 구하였다. 결정구조는cubic 구조이었으며, 격자상수 a=8.6075 Å과 a=8.6057 Å으로 주어졌다. 이들 결정의 광흡수 스펙트럼은 측정시료의 온도를298K에서 200-850nm 파장영역을 측정하였으며, 기초흡수단 영역에서 측정된 광흡수 스펙트럼으로부터 광학적 에너지 간격을 계산하였다. $CdGa_2O_4$:Mn 결정의 직접전이 에너지 간격 및 간접전이 에너지 간격은 3.523eV와 2.861eV이었다.

Kp-086 **Effect of Tunneling Barrier Surrounding Au Nanocrystals on memory characteristics** SEUNG HyunMin, LEE JongDae, KWON KyoungCheol, KIM ChangHwan, PARK Jea-Gun(*Nano-SOI Process Laboratory, Hanyang University.*) Recently, non-volatile polymer memories have been researched as the next generation of non-volatile memory because of high integration(4F^2) and simple device structure. The non-volatile memory effect in organic molecule memories is based on electrical bistability of the conductive was observed in polymer embedded with

Au nanocrystals, sandwiched between Al electrodes. We will present effect of tunneling barrier surrounding Au nanocrystals. The employment of Al2O3 tunneling barrier on Au nanocrystals surface improved non-volatile memory characteristics : i.e. memory margin (Ion / Ioff =~ 1 X 10^3) and endurance characteristics of ~10^5 erase and program cycles. It may be found that tunneling barrier make the larger trapping probability in Au nanocrystals. The larger trapping probability make device more stable and better retention and endurance characteristics. The smaller device scale will require more high density of Au nanocrystals in PVK. But density of Au nanocrystals embedded in PVK will be limited by size of Au nanocrystals. To improve non-volatile memory behavior by other method, the larger trapping probability will be required. In our presentation, we will show electrical, physical and chemical characteristics for our polymer non-volatile memory device.

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Kp-087 **Optical Properties of Thermally Annealed Hafnium Oxide and Their Correlation with Structural Change**

PARK Jun-woo, LEE Do-Kyu, KIM Dong-Hak, LIM Dae-Young[1], LEE Hosun[1], CHOI Suk-Ho[1](*Department of Physics, Kyung Hee University. [1]Department of Physics and Applied Physics, College of Electronics and Information, Kyung Hee University.*) Post deposition anneal results in crystallization of amorphous hafnium oxide films. Changes of optical properties, such as an appearance of a new shoulder-like feature near the optical bandgap and new UV luminescence feature, are found to be correlated with the crystallization of hafnium oxide films. Our experimental results do not seem to support the self trapped exciton(STE) model, where the shoulder-feature and UV luminescence feature are both attributed to STE. Systematic study of structural and optical properties of thermally annealed hafnium oxide films revealed that the new shoulder-like feature is not defect related, but intrinsic in crystallized hafnium oxides. We discuss possible origins of the shoulder-like feature based on our experimental results. On the other hand, the UV luminescence feature seems to be related to defect states in crystalline hafnium oxide, such as interstitial oxygen.

Kp-088 **Thickness dependence of $Ge_2Sb_2Te_5/SiO_2$ multi-layered films**

장 문형, 김 영국, 박 승종, 임 동혁, 조 만호, 황 정남, 이 후정[1], 김 형섭[1](*연세대학교 물리학과. [1]성균관대학교 재료공학과.*) 현재 phase change random access memory (PRAM) 에 적용되는 technology 는 80 nm scale로써, scaling에 대한 연구는 미미한 실정이다. 그러므로, nano scale의 상변화 물질의 특성을 관찰하기 위해, sub 10 nm scale에서의 $Ge_2Sb_2Te_5$ 박막의 물리적 특성을 관찰하였다. 10 nm, 6 nm 그리고 3 nm의 sublayer를 가지는 $Ge_2Sb_2Te_5/SiO_2$ 다층 박막에 대해서 high-resolution transmission microscopy (HRTEM)와 national center for electron microscopy simulation system (NCEMSS) simulation code를 이용하여 열처리 온도에 따른 박막의 결정구조 변화를 관찰하였다또한 4-point probe method를 이용하여 열처리 온도에 따른 전기적 저항 변화를 관찰 하였다. 단일 박막에 비해서 다층박막이 비정질 상에서 FCC 상으로의 전이온도가 더 높았으며 이와는 반대로 hexagonal 상으로의 전이온도는 더 낮았다. HRTEM과 NCEMSS를 이용한 관찰에서는 열처리 온도가 높아지고 두께가 얇아 질수록 $Ge_1Sb_2Te_4$, Sb_2Te_3 와 같은 hexagonal phase가 관찰되었고, 이는 높은 온도에서의 스트레스로 인하여 $Ge_2Sb_2Te_5$의 Ge 원자가 SiO_2층으로 확산하는 현상에 기인하는 것으로 추정된다.

Kp-089 **Nanocrystallized Poly-Si을 이용한 Ballistic 전자 방출원**

최 용운, 이 병철(*한국원자력연구원 양자광학연구부*) P-type Si(100) 위에 LPCVD (Low Pressure Chemical Vapor Deposition)법으로 증착되고 XRD (X-ray Diffraction)분석에 의해 다결정임이 확인된 Poly-Si 박막을 Anodizing 처리법에 의해 nanocrystal로 만들었다. 이것이 나노 다공질이라 불리는 나노 결정체이다. Anodizing 처리법은 porous process와 ECO (Electro-Chemical Oxide) process로 나뉘는데, HF와 ethanol의 혼합용액을 사용한 porous process에 의해 나노결정Si이 만들어지고 황산수용액을 사용한 ECO process에 의해 나노결정표면에 얇은 산화막이 만들어진다. Si 기판 이면에 스퍼터로 증착된 하부전극 Al (300nm)과 나노 결정체 위에 상부전극으로 사용된Au (15nm)나 Pt/Ti (30nm)의 이중층간에 전압을 인가하면 인가전압의 대부분이 나노결정 표면의 얇은 산화막에 걸려 강전계가 형성된다이 산화막은 매우 얇기 때문에 (≤1nm) 전자가 쉽게 통과할 수 있다. 전자가 전계영역을 통과할 때마다 가속이 이루어지는데 이때의 전자는 산란없이 직진성을 가지므로 탄도전자(Ballistic electron)라 불린다. 상부전극에 도달한 전자는 열평형 상태보다 꽤 높은 운동에너지를 가지므로 상부전극을 지나쳐 진공속으로 방출이 되는데 이것을 이용한 것이 Ballistic 전자 방출원이다. 상부전극으로 이중층인 Pt/Ti 경우가 일반적으로 사용되는 Au 전극보다 더 나은 전기적 특성을 얻을 수 있었다.

Kp-090 **전기도금법을 사용한 Cu 박막의 특성 분석**

송 유진, 서 정혜, 이 연승, 이 호준[1], 황 주하[1], 홍 기민[1](*한밭대학교 정보통신공학과. [1]충남대학교 물리학과.*) 본 연구에서는 sputter 방식으로 증착된 Cu seed위에 전기도금법으로 Cu 박막을 성장시켜, Cu seed가 Cu박막 성장에 미치는 영향에 대해 연구하였다증착온도와 열처리 유무에 따라 스퍼터 방식으로 증착된Cu seed의 구조적 특성과 결정성이 commercial seed (Si/Ti/Cu seed)와 함께 비교 분석되었다. 그리고 전기도금에 의해 형성된Cu 박막의 특성을 분석하여 Cu seed가 미치는 영향을 비교 검토하였다. XRD(X-ray Diffraction), AFM(Atomic Force Microscope), FE-SEM(Field Emission Scanning Electron Microscope)을 이용하여 성장된Cu박막 및 Cu seed의 결정성, 표면의 roughness, 단면 형상 등을 측정하였고, XPS(X-ray Photoelectron Spectroscopy)를 이용하여 전기도금에 의한 Cu의 화학구조및 불순물 상태를 조사하였다.