PG1B : 전자 세라믹스

PG1B-1 | PZT-PMS 세라믹스에 미치는 초과 PbO와 소결 분위기의 영향

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에너지 하베스팅은 신재생 에너지로서 기술이 발전함에 따라 중요해지고 있으며, 그에 따라 압전 에너지 하베스팅의 소재의 전자기계적 결합계수와 품질계수 향상을 위해 여러 조성이 개발되고 있다. 현재까지도 연구되고 있는 PZT계열에서 Mn, Sb가 합성된 PZT-PMS는 B-site의 억셉터와 도너 도펀트로 인해 높은 전자기계적 결합계수와 품질계수를 가지는 것으로 보고되고 있다. 하지만 Pb계열 세라믹의 소결 중 PbO 휘발로 인한 공공의 형성은 도메인 모션 중 손실을 유발해 품질계수에 악영향을 미친다. 본 연구에서는 PbO 휘발로 인한 공공의 형성을 억제하기 위해 소결 단계 전에 3wt%까지의 PbO 첨가를 하고 일반적인 분위기와 산소 분위기 소결을 추가로 진행하였다. 또한 Pb 함량과 소결 분위기를 달리하여 얻은 소결체의 미세구조, 밀도와 전기적 특성을 관찰 및 측정하고 압전특성을 나타내었다. 2wt%의 PbO 첨가와 산소 분위기에서의 소결은 밀도와 전기적 특성에 긍정적인 영향을 주고, 향상된 전자기계적 결합계수와 품질계수를 가짐을 확인하였다. 따라서 나타난 전기적 및 압전특성의 변화를 공공과 관련하여 미시적인 관점에서 고찰하고 에너지 하베스팅 소재로서 향상된 특성을 보고하고자 한다.

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PG1B-2 | 2차원 금속/반도체 이종구조를 이용한 고감도 이산화질소 가스센서

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이산화 질소(NO_2)는 대기 중에 존재하는 중요한 대기 오염 물질 중 하나로 건강에 해로운 영향을 미치며 대기 오염 문제의 주요 요인 중 하나입니다. 특히 NO_2 가스의 경우 100ppm 의 매우 낮은 농도에서도 인체에 치명적이며, 직접 피부에 노출되면 염증이나 화상을 초래한다. 따라서 NO_2 가스의 이용을 위해서는 NO_2 가스 누출 저농도단계 에서의 조기 검출이 필수적이며, 빠르고 정확한 검출 기술이 요구된다. 본 연구에서는 2차원 물질인 MoS_2와 그래핀을 이용하여 반도체/금속 이종구조를 제작하여 효과적인 가스검지 센서를 제작하였다. 그리고 NO_2 가스의 흡착을 유도하는 물질로 Ag를 스퍼터링하여 2차원 물질의 표면에 장식하였다. 2차원 물질은 부피 비율이 매우 높고 표면적이 매우 크기 때문에 감지 능력의 잠재력이 높습니다. 2차원 재질로 제작된 이 센서를 이용하여 최소 1ppm부터 50ppm까지의 매우 낮은 농도의 NO_2 가스 검출이 확인되었습니다. 1ppm 농도의 NO_2 가스에서는 센서의 저항변화가 20%에 가까운 변화를 보였다. 이는 2차원 물질 기반 센서의 무한한 가능성을 보여주는 것으로, Ag 이외의 장식물을 이용하면 더 많은 종류의 가스를 표적화하고 검출할 수 있을 것으로 생각된다.

PG1B-3 | Photodiode using doping-controlled transition metal dichalcogenide WSe2/MoS2 heterostructure

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A two-dimensional material having an atomic thickness has an advantage in miniaturization of next-generation sensors. Some transition metal dichalgogenide (TMD) materials with semiconducting properties exhibit high light absorption in addition to their thin thickness. However, the optical properties of the current 2D heterostructure are dependent on the inherent properties of the material, and as a way to solve this, it is possible to improve it by forming an ideal PN diode by using the doping control of the 2D heterostructure. To confirm this, we fabricated a WSe2(Nb-doped)/MoS2 PN heterostructure photodetector and confirmed its characteristics. In this study, we propose the utilization of a WSe2(Nb-doped)/MoS2 PN heterostructure photodetector, which offers exceptional performance. To prepare the precursor solution, we employed ammonium metatungstate (AMT) hydrate and ammonium niobium oxalate (ANO) (C4H4NNbO9•xH2O) as precursors for W and Nb, respectively. Additionally, sodium hydroxide (NaOH) was used as an accelerator to expedite the growth process. By dissolving the appropriate amount of powder in deionized (DI) water, we obtained stock solutions of AMT, ANO, and NaOH. The spin coating process involved the use of a medium solution (iodixanol)-Opti to enhance substrate adhesion. Various mixed solutions (AMT, ANO, NaOH, and opti) with different molar ratios of Nb/(W+Nb) were prepared using the stock solutions. The growth process of MoS2 mirrored that of WSe2. For the creation of a heterojunction photodetector, we employed a wet transfer method. Our experimental results demonstrate the intrinsic ambipolar electrical behavior of WSe2, the

prevalence of p-type behavior resulting from hole doping by the Nb dopant, as well as the realization of an n-type MoS2 lateral heterostructure, showcasing excellent rectification capabilities. Furthermore, our device exhibits an impressively high I_{light}/I_{dark} ratio (10^5), which is approximately 100 times higher than that of reported lateral 2D PN heterostructured photodiodes.

PG1B-4 | 고상 단결정 성장법을 이용한 제 3 세대 압전 PMN-PZT 단결정 개발

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Crystallographically engineered Relaxor-PT single crystals, specifically PMN-PT (Generation I) and PIN-PMN-PT/PMN-PZT (Generation II), offer much higher piezoelectric and electromechanical coupling coefficients (d_{33} 〉 1,500 pC/N, k_{33} 〉 0.9), when compared to polycrystalline PZT ceramics. Ceracomp Co., Ltd. (www.ceracomp.com) has developed the solid-state crystal growth (SSCG) technique and successfully fabricated Gen III PMN-PZT single crystals modified with acceptors and/or donors. The piezoelectric constants (d_{33}) of (001) Gen III PMN-PZT single crystals were measured to be higher than 5,000 pC/N and thus approximately two times higher than those of PMN-PT/PZN-PT (Gen I) and PIN-PMN-PT/PMN-PZT (Gen II) single crystals. And the Gen III PMN-PZT single crystals have been applied to single crystal-epoxy composites, ultrasonic transducers (medical and NDT), piezoelectric sensors, and piezoelectric actuators. In this presentation, we will introduce the recent progress in development and application of high performance Gen III PMN-PZT single crystals.

PG1B-5 | Comparative Analysis of Iron Oxide Deposition Methods: Thermal Atomic Layer Deposition vs. Plasma-Enhanced Atomic Layer Deposition Employing Bis(N,N'-di-butylacetamidinato)iron(II)

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Hematite (α-Fe_2O_3) can be utilized in various electronic and electrochemical devices, including water electrolyzers, gas sensors, and supercapacitors, in the form of thin films. Atomic Layer Deposition (ALD) is employed for the precise deposition of thin films, offering atomic-level thickness control and excellent thickness uniformity on a large wafer scale. In this investigation, we compare the physical and chemical characteristics of FeO_x thin films deposited via thermal Atomic Layer Deposition (thermal ALD) and Plasma-Enhanced Atomic Layer Deposition (PEALD) using bis(N,N′-di-butylacetamidinato)iron(II) (FeAMD) as the iron precursor. We compare the growth per cycle (GPC) trend as a function of the partial pressure of FeAMD in the FeO_x thin films deposited through thermal ALD and PEALD using Spectroscopic Ellipsometry (SE). Atomic Force Microscopy (AFM) is employed to measure the surface roughness of FeO_x thin films deposited under different FeAMD partial pressures. Moreover, we compare the surface roughness of FeO_x thin films deposited via thermal ALD and PEALD under similar FeAMD partial pressures. We analyze the impurity concentration and local chemical bonds in the FeO_x thin film using X-ray Photoelectron Spectroscopy (XPS). It is noteworthy that the concentration of impurities in the FeO_x thin films is found to be similar regardless of the deposition method. Furthermore, it is confirmed that a Chemical Vapor Deposition (CVD)-like reaction occurs in a thin film when FeAMD is dosed without an oxidant. After subjecting the deposited FeO_x thin films to heat treatment, we perform Grazing Incident X-ray Diffraction (GIXRD) to ascertain the crystalline phase and compare crystallinity. Lastly, we assess the conformality of FeO_x thin films on trenches with varying aspect ratios through Scanning Electron Microscopy (SEM). This assessment is conducted after depositing FeO_x thin films via thermal ALD on two distinct trench-structured wafers. We have confirmed the effects of FeAMD partial pressure on the GPC, surface roughness, and crystallinity of the FeO_x thin films deposited through thermal and PEALD using FeAMD, employing various characterization techniques. Additionally, we compare the advantages and disadvantages of each deposition method for the FeO_x thin film.

PG1B-6 | Pd-V_2O_5-TiO_2 촉매층과 In2O3 감지층으로 이루어진 고성능 에틸렌 검지용 가스센서 개발

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Ethylene is a plant hormone gas that plays a crucial role in plant health and status. The precise detection of trace concentrations of ethylene is essential for controlling various aspects of plant growth and development. However, ethylene's simple chemical

structure and low reactivity have made it challenging to develop highly sensitive and selective detection methods. This challenge persists despite the strong demand for such technology in the agricultural industry. In this study, we introduce a novel bilayer ethylene gas sensor consisting of two layers: the first layer is a Pd-doped V_2O_5–TiO_2 catalytic overlayer, and the second layer is an In_2O_3 sensing layer. The addition of the Pd-doped V_2O_5–TiO_2 catalytic overlayer to the In_2O_3 sensing layer significantly enhances the sensor's ability to detect ethylene over a wide range of operating temperatures (300–400 °C). The improved sensor performance is attributed to the catalytic properties of the Pd-doped V_2O_5–TiO_2 overlayer. This catalytic layer is capable of reforming ethylene into more reactive acetaldehyde and filtering interference gases into non-reactive forms, achieved through heterogeneous Wacker oxidation promoted by the unique yolk–shell sphere structure. Finally, the outstanding capabilities of the sensor proposed in this study make it suitable for various applications, such as monitoring the ripeness of fruits. This capability is confirmed by comparing the sensor signal with the results of proton transfer reaction-quadrupole mass spectrometry (PTR-QMS).

PG1B-7 | Photoinduced polymerization of cross-linked perovskite polymer composites for highly stable and efficient perovskite solar cells

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Mixed-halide perovskites have emerged as outstanding light absorbers that enable the fabrication of efficient solar cells; however, their instability hinders the commercialization of such systems. Grain-boundary defects and lattice tensile strain are critical intrinsic-instability factors in polycrystalline perovskite films. In this study, the light-induced cross-linking of acrylamide (Am) monomers with non-crystalline perovskite films was used to fabricate highly efficient and stable perovskite solar cells. The Am monomers induced the preferred crystal orientation in the polycrystalline perovskite films, enlarged the perovskite grain size, and cross-linked the perovskite grains. Additionally, the liquidity of Am effectively released lattice strain during perovskite-film crystallization. The cross-linked interfacial layer functioned as an airtight wall that protected the perovskite film from water corrosion. Devices fabricated using the proposed strategy showed an excellent power conversion efficiency (PCE) of 24.45% with an open-circuit voltage (V_{OC}) of 1.199 V, which, to date, is the highest V_{OC} reported for hybrid PSCs with electron transport layers comprising TiO_2. Large-area perovskite solar cell modules fabricated using the proposed strategy showed a PCE of 20.31% (with a high fill factor of 77.1%) over an active area of 33 cm^2, with excellent storage stability.

PG1B-8 | 홀 에치형 수직 어레이 구성 적용을 위한 자가 정류 저항 변화 메모리 소자의 특성 최적화

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홀 에치형 (hole-etched) 수직 적층형 구조는 공정 비용과 집적 밀도 측면에서 전형적인 수평형 크로스바 어레이 (crossbar array; CBA) 구조에 비해 강점을 가지며 초고집적 메모리 어레이 적용에 유리하다.[1] 하지만 저항 변화 메모리 (resistive switching random access memory; ReRAM)에 이러한 구조를 적용 시 메모리층에 정류 소자를 적층하기 위해 도입한 중간 전극으로 인해 단락이 발생할 수 있다. 따라서 누설 전류 (sneak current)를 효율적으로 억제하고 소자의 단락 문제를 방지하여 정상적인 어레이 동작을 확보하기 위해서는 정류 소자의 직렬 연결 대신 정류 층을 저항 변화 층에 적층하여 자가 정류 동작을 보이는 메모리 소자, 자가정류형 저항 변화 메모리 (self-rectifying ReRAM; SR-ReRAM)의 도입이 필요하다. Pt/Ta_2O_5/HfO_2/TiN (PTHT) 구조의 SR-ReRAM은 Pt/Ta_2O_5 계면이 높은 쇼트키 배리어를 형성하여 전하 캐리어 (전자)의 주입을 억제한다. HfO_2/TiN 계면에는 준-오믹 (quasi ohmic) 접합이 형성되어 전자가 주입 및 방출될 수 있다. HfO_2 층은 인가 전압의 극성에 따라 전자를 트랩 (trap)/디트랩 (detrap) 함으로써 비휘발성 저항 변화 동작을 보인다.[2] 고밀도 수직형 저항변화 메모리 (vertical ReRAM; V-ReRAM) 어레이의 안정적인 동작을 위해서는 우수한 소자의 동작 균일성과 높은 정류 기능이 요구되는데 전자의 트랩/디트랩을 기반으로 동작하는 PTHT 소자의 경우 전자를 이동을 안정적으로 조율하기 위한 트랩 엔지니어링이 중요하다. 본 연구에서는 HfO_2에 형성되는 트랩의 깊이를 알루미늄 (Al) 도핑을 통해 조절한다. 이는 전자의 트랩/디트랩을 기반으로 동작하는 SR-ReRAM의 동작 신뢰성을 향상시킬 수 있는 방안이 된다. 최적화된 Al의 도핑 비율은 전기적 특성 평가 결과 분석을 통해 확보되었다. 도핑 결과에 따른 HfO_2 내부의 변화는 박막의 물성 분석 (XPS, AES)을 통해 검증되었고, 이러한 결과를 바탕으로 Al 도핑에 따른 소자의 동작 메커니즘이 제안되었다. 최적화된 Al 도핑 농도를 적용하여 스위칭 레이어를 제작하였고 이 PTHT SR-ReRAM을 적용한 9x9x2 V-ReRAM 어레이가 구현되었다.[3]

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PG1B-9 | Fabrication of Triboelectric nanogenerators using transition metal ions chelated mesoporous silica

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This study reports on the enhancement of triboelectric nanogenerators (TENGs) efficiency through the improved ability of mesoporous silica particles (MSPs) pores and chelated transition metal ions within these pores to trap and transport charges. TENGs are devices that harness the triboelectric effect to convert mechanical motion into electrical energy, finding applications as solutions in various fields including self-powering and energy harvesting systems. To enhance the efficiency of TENG, the charge transfer capability was improved by chelating transition metal ions such as Co, Ni, and Fe onto MS, thereby enhancing the charge transfer capability. We prepared solutions by dissolving $CoCl_2$, $NiCl_2$, and $FeCl_2$ hydrates in water, and then added MSPs to the solution, stirred it, and dried it to obtain metal-chelated MSPs (MMSPs). We prepared MMSPs-PVA films by mixing MMSPs with PVA, and subsequently fabricated a TENG by coupling the MMSPs-PVA film with a PTFE film. We characterized MMSPs through ICP, EDS, XRF, and BET analyses, and assessed the efficiency of the TENG by measuring out-put voltage, out-put current, and capacitance. The results of ICP analysis indicated that Co-MMSPs, Fe-MMSPs, and Ni-MMSPs were found to be chelated with metal ions at 21.5 wt.%, 17.5 wt.%, and 15 wt.%, respectively. The measured maximum output voltages for pristin PVA-TENG, MMSPs-TENG, Ni-TENG, Fe-TENG, and Co-TENG were 62 V, 182 V, 204 V, 220 V, and 250 V, respectively.

PG1B-10 | 깁스 자유에너지 계산을 이용한 H_2와 Cl_2 분압에 따른 Si (001) 표면 흡착 상 연구

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본 연구는 깁스 자유에너지 계산을 통하여 H_2와 Cl_2 분압에 따라 Si (001) 표면 흡착 상이 어떻게 변화하는 것에 관한 것이다. 반도체 제조에 주로 사용되는 Si 웨이퍼는 (001) 표면이며 세정과 건조과정을 거친 후 후속 증착 공정을 위해 반응기 내부로 이동된다. 건조 후 Si 표면은 bare가 아니라 수소가 흡착되어 있는 것으로 알려져 있다 [1]. 본 연구에서는 반도체 공정에서 주로 사용되는 Si (001) 표면에 대해 온도, H_2와 Cl_2 분압에 따른 표면 상태를 깁스 자유에너지 계산을 통해 분석하였다. 두 기체의 분압이 높고 낮은 온도에선 염소가 흡착된 표면이 안정하였고, 반대로 두 기체의 분압이 낮고 온도가 높으면 bare Si 표면이 안정하였다. 계산의 정확도를 향상시키기 위해 영점 에너지 (zero point energy), 온도에 따른 내부에너지 변화 ($\int C_p dT$), 그리고 격자 내 원자의 진동으로 인한 엔트로피 (S_{vib})를 고려하였다 [2]. [1] D. B. Fenner et al., Journal of Applied Physics 66, 419 (1989). [2] V. Wang et al., Computer Physics Communications, 267, 108033 (2021).

PG1B-11 | Electrochemical Immunoassay Using Pyrolyzed Parylene-C

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The advantages attributed to carbon electrodes encompass an expansive electrochemical range, minimal background current, and favorable biocompatibility, rendering them a widely favored selection. However, their utility encounters limitations in the context of three-dimensional structures. In a bid to surmount this impediment, a carbon electrode was synthesized through the pyrolysis of parylene-C, capable of forming a uniform film upon intricate frameworks. The process of depositing parylene-C involves a triadic sequence: precursor evaporation, precursor decomposition, and subsequent polymerization. While traditional deposition techniques rely on thermal energy for the second phase, the present investigation employs a plasma deposition approach. Both thermal and plasma-deposited parylene-C were harnessed to fabricate films of carbon electrodes, with the latter yielding a more substantial residual carbon electrode film. The electrochemical attributes of these two categories of pyrolyzed carbon films were subjected to analysis via amperometric assessments, encompassing double-layer capacitance, electron transfer rate, and electrochemical range. The findings unveiled analogous electrical characteristics in pyrolyzed carbon films derived from both thermal and plasma-deposited parylene-C. The resultant pyrolyzed carbon electrode found utility in immunoassays utilizing an anti-HCV (IgG) ELISA kit, thereby underscoring its practical viability and potential for broader applications. Keywords : Parylene-C, Plasma deposition, carbon, double layer capacitance, electron transfer rate, immunoassay, switching peptides.

PG1B-12 | Heterosynaptic Plasticity in Solution-Processed Vertical Two-Terminal Synaptic Devices

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The synaptic devices, which is the basic components for neuromorphic computational systems, hold the potential to overcome the limitations of the prevailing von Neumann architecture bottleneck. Especially, the development of artificial synapses having tunable multiple synaptic response can be an essential step forward for the advancement of novel neuromorphic computing. Three-terminal transistors, utilizing floating gates or charge-trapping layers to control channel conductance via gate pulses, have demonstrated multiple synaptic responses. However, a vertical two-terminal device, offering higher energy efficiency and heterosynaptic behavior, remains unexplored until now. Herein, high-performance and low-power consumption Pt/bi-layer $Sr_2Nb_3O_{10}$/Nb:$SrTiO_3$ memristors are demonstrate. We successfully controlled oxygen vacancies as trap site in $Sr_2Nb_3O_{10}$ nanosheet through the A-site modification, and the tunneling current of Pt/Nb:$SrTiO_3$ interface is modulated by controlled electron trap/detrap amounts in $Sr_2Nb_3O_{10}$ nanosheet layer. The A-site modified perovskite nanosheets were synthesized by 2-step cation exchange method and deposited Langmuir-Blodgett method via solution-based process. The synaptic devices exhibit good biological synaptic functions of excellent stability, high endurance, long-term potentiation/depression, and paired-pulse facilitation.

PG1B-13 | 페로브스카이트 구조의 $PbTiO_3$ (PTO) nanotube 제작 및 상 변화 특성

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Nanostructures show physical differences such as very small size and large surface area compared to bulk materials, and new physical phenomena can be expected as a result. In this study, porous anodic alumina (PAA) was used as a mold and $PbTiO_3$ nanotubes (PTO-NTS) were fabricated by sol-gel spin coating method. PAA was fabricated through two-step anodization and has well-aligned pores with a diameter of ~50 nm and a length of ~20 μm. 0.3 M PTO solution was deposited on the prepared PAA by a spin-coating method. Next, polycrystalline PTO nanotubes were fabricated through drying at 200 °C for 2 minutes, pyrolysis at 400 °C for 5 minutes, and crystallization at 650 °C (O_2 atmosphere) for 30 minutes. Finally, the PAA was removed through chemical etching (using 10 wt% NaOH). After that, changes in structure and morphology due to the post annealing effect were investigated. The Raman analysis results show the change from tetragonal PTO structure to anatase TiO_2 structure through post annealing at 750 °C for 9 hours. These structural changes are expected to be due to the high volatility of Pb and the large surface area of the nanotubes.

PG1B-14 | Pressure sensing via transparent organic electrodes based on conductive polymers with tunable plasma frequency

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When an electromagnetic wave impinges on a conductor, most of the incident wave is reflected, which makes metals and transparent conducting oxides (TCOs), such as tin-doped indium oxide (ITO), opaque to visible light (429–750 THz) and far-infrared (FIR) (< 20 THz). This incompatibility between optical transparency and electrical conductivity is well-defined fundamental material properties, but this is often not easy to enhance both simultaneously. Opacity due to electrical conductivity is more pronounced in the lower frequency range. This fundamental incompatibility creates a barrier for the realization of enhanced user-interface and device integration. We present a design strategy for preparing megahertz-range transparent conductor and a concept towards 'device-to-device integration' enabled by electromagnetic wave transmittance. The approach to the properties of conductors is verified using a conducting polymer, Poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS), whose microstructure is effectively controlled by solution process. The use of a transparent conducting polymer as an electrode enables the fabrication of a fully functional touch-controlled display device and magnetic resonance imaging (MRI)-compatible biomedical monitoring device, which would open up a new paradigm for transparent conductors.

PG1B-15 | X-ray Photoelectron Spectroscopy를 이용한 Au, Ag, Cu의 일함수 측정

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현대 반도체 기술 및 소재 개발에 있어, 세라믹소재에 대한 관심도

가 매우 높아지고 있다. 물리적 구조와 화학적 특성에 따라 세라믹 또는 전자세라믹 소재의 전자 구조를 이해하고 조절하는 것은 이러한 소재 개발 기술의 핵심이 되고있다. X-ray Photoelectron Spectroscopy (XPS)는 표면 및 인터페이스의 전자 구조를 이해하는데 중요한 실험방법 중 하나이다. XPS는 광전자 효과를 기반으로 하여 소재의 표면에서 나오는 전자의 에너지를 분석한다. 이론적으로, XPS는 전자의 초기 운동 에너지를 측정함으로써 일함수를 도출할 수 있다. 일함수 측정에 있어서 기존의 방법인 울트라 바이올렛 광전자 분광학 (UPS)과 비교하여 상대적으로 측정조건 및 샘플링이 비교적 간단하고 작은 면적에서의 측정이 가능하다. 본 연구에서는 XPS를 활용하여 표준시료로서 Au, Ag, Cu 소재의 일함수(Work Fuction)를 비파괴적으로 측정하고 비교 분석하였다. 분석결과들은 소재의 일함수를 정량화하고, 각 소재의 전자 특성을 이해하는 데 중요한 정보를 제공한다. 또한, 이러한 소재의 표면 특성과 화학적 상호작용에 대한 깊은 이해는 나노전자소자, 센서, 촉매 및 다양한 응용 분야에서의 소재 설계 및 최적화에 기여할 것으로 기대된다.

PG1B-16 | 흡착 탄소의 결합 에너지 변화와 일함수의 상관성 연구

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세라믹 소재 및 부품에 있어 불순물 및 오염원에 대한 분석은 매우 중요하다. 시료를 대기중에 노출 시킬 때 시료 표면에 쌓이게 되는 탄소를 오염 탄소(contamination carbon) 또는 흡착 탄소(adventitious carbon) 이라고 한다. XPS 분석에서는 이 흡착탄소가 시료의 최상층에 존재하여 시료로부터 나오는 전자의 진행을 방해하는 단점으로 작용하므로 일반적으로 sputter cleaning 하여 분석을 진행하게 된다. 이러한 단점에도 불구하고 흡착 탄소는 오랜 동안 XPS 분석에서 binding energy reference 로써 중요한 역할을 해왔다. 하지만 이 역할에 대한 의구심이 오랜 동안 있어 왔고 최근에 Hultman 등은 흡착 탄소의 C1s 의 binding energy가 vacuum level에 정렬하여 시료의 work function에 따라 C1s의 binding energy가 바뀐다는 사실을 보고하였다. 일반적으로 work function의 측정은 UPS (Ultraviolet photoelectron spectroscopy)를 통해 이루어지나 분석 접근성이나 시료의 제한 등이 있다. 본 연구에서는 Hultman등의 연구 내용에 착안하여 흡착탄소의 C1s binding energy를 측정함으로써 보다 쉬운 시료의 work function의 측정법을 개발하여 표준 시료들에 대해 연구 조사 하였다.

PG1B-17 | 달팽이관의 기능을 모사한 미세전자기계시스템 기반의 고성능 압전 질화알루미늄 캔틸레버 어레이 개발

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달팽이관은 인간의 청각 시스템에서 소리 인식을 위한 핵심 기관으로써 기계적 소리 진동을 생체 전기 신호로 변환한다. 달팽이관 내부의 기저막은 유연한 박막으로써 너비, 두께 및 강성도 같은 구조적 특성으로 인해 기계적 주파수 분리 기능을 가지고 있다. 본 연구에서는 달팽이관의 에너지 변환 기능 및 주파수 분리 기능을 모사한 압전 멤스 (Piezoelectric-microelectromechanical system, piezo-MEMS) 기반의 음향 센서 어레이를 제안하였다. 에너지 변환을 위한 압전 소재로 사용된 Aluminum nitride (AlN) 박막은 c-axis 방향으로 배향 정도에 따라 압전 특성이 결정된다. 따라서 고배향성의 압전 AlN 박막을 제작하기 위해 AlN seed layer (10nm)/하부전극 Molybdenum (Mo, 200nm)/압전층 AlN (1μm)을 스퍼터링 공정을 통해 제작하였고, XRD 분석을 통해 AlN peak (17.8 degree)의 반폭측 (Full width at half maximum, FWHM)이 1.5° 이하인 고배향성을 확인할 수 있었다. 또한, 유한요소해석을 기반으로 팁 매스 (Tip-Mass)를 포함하는 캔틸레버 어레이 구조로 압전 음향 센서를 설계하여 민감도 향상 및 가청 주파수의 소리를 감지할 수 있도록 하였다. 본 연구는 향후 차세대 인공와우 장치 개발에서 음성 변환을 위한 핵심 부품으로 활용될 수 있을 것으로 기대된다.

PG1B-18 | Characteristics of layer-controlled perovskite nanosheet films using the Langmuir Blodgett method

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Recently, there has been an increasing interest in solution-processable high-k 2D ferroelectrics for potential applications in next-generation nanoelectronics. Although studies on locally isolated 2D ferroelectric nanosheets are occasionally reported, there is a lack of reports on films that can be applied to devices. To address this gab, our focus has been directed towards the synthesis of high-k 2D nanosheets of $Sr_{1.8}Bi_{0.2}Na_{n-3}Nb_nO_{3n+1}$ (SBNNO, n=3-5). This endeavor involves modifying the A-site followed and converting the NbO_6 octahedral layers to 3-5 layers, thereby facilitating the synthesis of ultrathin films with nanometer thickness. The resultant nanosheets were successfully synthesized, and their ferroelectric characteristics were validated. The synthesis of these nanosheets was performed using a soft chemical method including two-step cation exchange process, and the films were deposited using the Langmuir-Blodgett (LB) method. As the number of NbO_6 octahedral layers increased, the thickness of the nanosheets increased and their band gaps decreased. In addition, significant distortions were induced by the size mismatch of Sr/Bi/Na ions at the A-site as the number of perovskite layers increased. This distortion led to local ferroelectric instability driven by spontaneous polarization along the c-axis. In particular, the SBNNO nanosheet film with 5 layers of NbO_6 showed ferroelectric properties with

a coercive electric field (E_c) of 338 kV/cm and a remanent polarization (P_r) 2.36 μC/cm2. The ferroelectric properties exhibited by these ultrathin 2D materials suggest the possibility of leading interesting innovations for next-generation electronic products.

PG1B-19 | Local pressure sensing thermochromic panel display

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Interactive response upon external pressure such as touching is essential for human-machine interface devices. This function is usually achieved by the combination of sensor, processor and display. This configuration, however, is bulk and expensive to be adopt tiny application such as IOT device and e-skin. Here, we introduced visually pressure-mappable touch device using thermochromic panel and resistive pressure sensor. In this study, we designed microstructured PDMS chain as resistive pressure sensor with high spatial sensitivity and the multilayer PDMS composite for display and heater made by various micro- and nano particles. By combining them, resistive response of device can be converted to visual readout by heat as medium. In order to show pressure mapping capability, we demonstrated pressure dependent dot writing and 3D force touch note that suggests potential uses as future electronics.

PG1B-20 | Phase diagram study of the In_2O_3-SnO_2-ZnO ternary system

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In_2O_3 – SnO_2 – ZnO ternary system is of importance for the development of In_2O_3-based transparent conducting oxides (TCO). In this study, the isothermal phase diagrams of this system at 1400 ℃ and 1500 ℃ were constructed for the first time by equilibration and quenching experiments followed by XRD phase analysis and EPMA composition analysis. As reported in earlier phase diagram study at 1275 ℃, large solid solutions of $In_{(2-2x)}Zn_xSn_xO_3$ and $ZnIn_2O_4$-Zn_2SnO_4 were still found at 1400 ℃ and 1500 ℃. In addition, a ternary compound of $In_2Sn_2Zn_2O_9$ was newly found in this study. This ternary compound was stable only above 1320 ℃, and its crystal structure was confirmed by Rietveld refinement.

PG1B-21 | Introducing surface roughness for paper-based capacitive pressure sensor

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Pursuing “simplicity” for the production process and “functionality” for a device, in general, are mutually exclusive. One of these demands is usually met by compromising the other, therefore, strategies that are less expensive, less equipment-intensive, and more accessible to researchers for the highly functional device, are required. Here, we present a conceptually different approach, utilizing the surface roughness of paper for a capacitive pressure sensor with high performance compared with sensors produced by costly microfabrication processes. We utilize a writing activity with a pencil and paper, which enables the construction of a fundamental capacitor that can be used as a flexible capacitive pressure sensor with high sensitivity and short response time and that can be inexpensively fabricated over large areas. Unlike previous studies, all three parameters in the context of a capacitor (i.e., electrode area, electrode separation, and dielectric constant) are simultaneously controlled by utilizing surface curl and roughness, which maximizes the sensing capabilities. We successfully integrated the capacitor elements into a fully functional 3D touch-pad device acting as a pressure sensor-based input device, which is a step toward the realization of advanced paper electronics that achieves high simplicity and functionality.

PG1B-22 | Large electrostrictive response via tailoring ergodic relaxor state in $Bi_{1/2}Na_{1/2}TiO_3$-based ceramics with $Bi(Mn_{1/2}Ce_{1/2})O_3$ end-member

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Lead-free $Bi_{1/2}Na_{1/2}TiO_3$ (BNT)-based relaxor ferroelectric ceramics with superior electrostrictive coefficient features have recently gained much attention due to their application in high-precision displacement actuators. In this work, we propose an effective approach to enhance the electrostrictive effect via tuning the phase transition temperature around ambient temperature in BNT-based ceramics. Herein, a novel $Bi(Mn_{1/2}Ce_{1/2})O_3$ (BMnCe) modifier was adopted as an activator into $0.935Bi_{1/2}Na_{1/2}TiO_3$-$0.065BaTiO_3$ (0.935BNT-0.065BT)

for modifying the phase boundary (T_{F-R}) around ambient temperature. Compositional and temperature- dependent dielectric, ferroelectric, and electrostrain were systematically investigated. All samples exhibit a pure perovskite structure. Rietveld refinement revealed that 0.935BNT-0.065BT ceramic presents a coexistence of rhombohedral (R3c) and tetragonal (P4bm) phases. As the BMnCe content increases, the tetragonal (P4bm) phase becomes more prevalent and eventually shifts into a pseudocubic phase. It was found that adding BMnCe can effectively tune the T_{F-R} below ambient temperature and enhance the relaxor behavior. Polarization and electrostrain analysis revealed that the long-range ferroelectric ordering decreases with increasing BMnCe. Specifically, a unique region emerges where remnant polarization, quasistatic $d_{33,}$ and negative strain abruptly drop. As a result, a high electrostrain (S) of 0.43% with normalized strain (S_{max}/E_{max}) of 716 pm/V was achieved at critical composition (0.01 molar concentration of BMnCe). More importantly, (0.935-x)BNT-0.065BT-xBMnCe (x =0.01) shows a large electrostrictive coefficient (Q_{33}) of 0.032 m^4/C^2 with a giant normalized electrostrictive coefficient (Q_{33}/E) of 5.33×10^{-9} m^5/C^2V at room temperature. Furthermore, the Q_{33} and Q_{33}/E values show temperature insensitivity up to 120 °C, rendering the compound suitable for actuators and high-precision positioning devices. These results offer an effective avenue to design high-performance BNT-based materials with giant electrostrictive coefficients.

PG1B-23 | 초고주파용 Ceramic Super Power Resistor의 재료 선정 및 평가

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초고주파 칩저항은 IT & 이동통신 관련 다양한 종류의 모듈(Amplifier, Divider, Circulator, Isolator, Filter, Coupler 등)에서 1종 이상은 반드시 소요되는 부품이며, 이동통신용 중계기에는 필수적으로 장착되는 주요한 부품이다. 일반적으로 고전력 고주파 칩 저항은 1 watt에서 150 watts급의 의미하며, 고전력 저항(Super power resistor)은 250 watts를 초과한 고전력 저항을 말한다. 이러한 후막형 칩 저항의 구성은 Cu 플랜지 위에 적절한 세라믹 기판에 도체 및 저항 페이스트를 이용하여 후막법으로 제조한 도체 및 저항 pattern 위에 dl pattern을 위한 절연체 세라믹 페키지가 장착되는 구조로 이루어져 있다. 250W급 이상의 초고전력 저항을 성공적으로 제조하기 위해서는 고주파, 고전력에 적합한 패턴 설계기술과 함께 적절한 세라믹 기판과 적합한 도체 및 저항체 페이스트를 선정하는 것이다. 따라서, 본 연구는 국내 최초로 250W 및 400W급 초내전압 초고전력 에 사용이 가능한 플랜지 타입의 RF Resistor 개발을 위해 세라믹 기판과 도체 및 저항체 페이스트 선정을 위한 표준화를 위해 수행하였다.

PG1B-24 | Charge Trap Engineering and Synaptic Behavior of Transition Metal Dichalcogenides Transistor, via Molecular Dynamics

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The electrical performance of semiconductor devices has a significant dependence on the surface states of the semiconductors because the channel between source and drain regions for charge carrier transports is mostly formed near the surface with applying gate bias. Therefore, it is critical to engineering the surface chemistry of the semiconductor material. Coupling an intrinsically atomically thin body with a finite bandgap, layered transition metal dichalcogenides (TMDCs) have been employed as semiconducting channel platforms with a large ON/OFF ratio and near theoretical subthreshold swing. Here, chemically reconfigurable synapse behaviors of TMDC via molecular semiconductor interaction are demonstrated with three terminal $MoSe_2$ synapse devices. Molecular adsorption on the $MoSe_2$ surface is induced with dipping in $(NH_4)_2S$(aq) diluted in H2O with 25%, while the solution temperature is held at 50℃. H_2S or HS molecules can be adsorbed on the $MoSe_2$ surface during this chemical treatment and act as trapping centers for transported carriers. The adsorbed molecules can be desorbed from $MoSe_2$ surfaces with wash with isopropanol. In the transfer characteristic of $MoSe_2$ devices, molecular adsorption induces a significant increase of hysteresis from 38.3 V_{TH} to 59.0 V_{TH}, consistent with charge carrier trapping near the channel. In contrast, molecular desorption from $MoSe_2$ surfaces results in a decrease of value to 45.3 V_{TH} with the removal of trapping center from the surface of synapse devices. Afterward, to mimic the biological synapse, the electrical synapse response of $MoSe_2$ transistors is modulated by a pulse generator wherein excitatory modes; thereby synapse plasticity is controlled by spike-like gate bias as a presynaptic input. To emulate the visual sensory behavior of humans, the artificial synaptic plasticity of synaptic devices has been explored by applying light pulse. As light stimulation with pulse modulation, the channel's conductance near-linearly increases as the number of light pulses increases, consistent with optical potentiation. Afterward, electric depression of molecularly

functionalized synapses can be observed with the linear decrease of conductance.

PG1B-25 | 용융염을 이용한 $MoWCh_2$ 합금 합

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Graphene is one of the best known 2dimensional material. Graphene not only has atomic level thinness and excellent electrical conductivity, but also strong and flexible. However, there was a limit to its utilization because it did not have semiconductor characteristics due to its low band gap. $MoWS_2$, $MoWSe_2$ and $MoWTe_2$ alloys are the representative TMDC materials. they have an indirect band gap in a layered material, but has the characteristic of directly changing to a band gap when it becomes a single layer by exfoliation. In this study, we synthesis $MoWS_2$, $MoWSe_2$ and $MoWTe_2$ by molten slat flux using Chloride slat. We analysis using XRD, SEM, EDS, etc.,

PG1B-26 | Fabrication of textured $0.685(Na_{0.5}Bi_{0.5})TiO_3$-$0.065BaTiO_3$-$0.25SrTiO_3$ ceramics by templated grain growth using $NaNbO_3$ templates

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Fabrication of textured $0.685(Na_{0.5}Bi_{0.5})TiO_3$- $0.065BaTiO_3$-$0.25SrTiO_3$ ceramics by templated grain growth using $NaNbO_3$ templates Kiran Andleeb[1], Nazım Ecebaş[1], Huyen Tran Tran[1], Jong-Sook Lee[1], John G. Fisher[1]*, Wook Jo[2] [1]School of Materials Science & Engineering, Chonnam National University, Gwangju 61186, Republic of Korea. [2]School of Materials Science and Engineering, Ulsan National Institute of Science and Technology, Ulsan 44919, Republic of Korea *Corresponding author: johnfisher@jnu.ac.kr Abstract Lead-free replacements for $Pb(Mg_{1/3}Nb_{2/3})O_3$ electrostrictive materials for actuator applications are of interest due to environmental concerns. $(Na_{0.5}Bi_{0.5})TiO_3$-based electroceramics are one of the candidates for lead-free electrostrictive materials. However, their properties are still inferior to lead-based electrostrictive materials. Efforts are being made to enhance their properties for practical applications. Templated Grain Growth (TGG) is a method used to fabricate ceramics which imparts controlled grain growth and preferred crystallographic orientation, which is crucial for the performance of the ceramics. It has been found that orientation in the [001] crystallographic direction greatly improves performance. In the TGG method, anisotropic particles or templates are aligned in a ceramic matrix, and textured ceramics are prepared by sintering the compacted matrix. Anisotropic templates give preferred orientation growth. In this work, textured $0.685(Na_{0.5}Bi_{0.5})TiO_3$-$0.065BaTiO_3$-$0.25SrTiO_3$ (NBT-BT-ST) ceramics are prepared by the TGG method using 1,3,5,7 wt% $NaNbO_3$ (NN) templates. Plate-like NN templates with perovskite structure are prepared by two-step molten salt synthesis (MSS). The NBT-BT-ST ceramic powder is prepared by the mixed oxide process. The ceramic powder, NN templates, and organic additives are ball milled to prepare a slurry. The tape-casting process is used to align NN templates in the matrix powder with a blade gap of 180μm. After stacking and lamination of cut and punched green tapes, organic additives are burnt off in a furnace. Samples are sintered at 1200°C for 12 hours with different amounts of NN templates in a sealed crucible. The densities of the sintered samples are measured using the Archimedes principle. Sample structure and degree of texturing are studied using X-ray diffraction. The microstructure of the ceramic samples and NN templates is observed by Scanning Electron Microscopy. After the determination of the optimum template content, the textured ceramic samples are sintered at 1200°C for 5h, 10h, and 20h and the densities are evaluated. Sample structure and microstructure are studied as before. The dielectric properties, polarization–electric field (P–E), and bipolar strain–electric field (S–E) hysteresis loops of textured ceramics are investigated.

PG1B-27 | 초고주파용 Flanged Type RF Super Power Resistor의 설계 및 제작

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전기 및 전자부품에서 사용되는 기본적인 수동소자는 저항(R), 인덕터(L), 캐패시터(C) 등이 있다. 이러한 수동 부품들은 직류영역에서는 각각 구별된 고유 기능을 발휘하고 있으나, 고주파 영역에서는 각 부품의 기능 구별이 다소 모호해지며 복합 임피던스 (Complex Impedance)로 작용하게 된다. 특히 저항소자의 경우 고주파 영역에서 L, C는 손실로 작용하여 저항소자의 특성을 감소시키는 주요한 요인이 되므로 저항소자의 재료인 세라믹 기판, 도체 및 저항 paste, 절연체 등의 종류와 회로 페턴의 형성 방법에 따라 고주파의 특성이 크게 달라진다. 제조하는 제품의 특성의 편차를 줄이기 위해서는 여러 번의 시뮬레이션과 제작을 통해 이론과 실제에 대한 많은 경험이 필요하다. 또한, 250W급 이상의 초고전력의 RF 저항은 그 자체에서 많은 열이 발생하므로 열방산에 대한 열역학적 해석 또한 중요하다. 즉, 열 방출에 대한 열역학적 계산을 통해 저항의 기본적인 크기와

배치를 결정한 이후 패턴의 형태를 구성하여야 하므로 이를 구현하기 위해서는 고주파와 열역학 해석에 의한 복합기술이 필요하다. 따라서 본 연구에서는 설계 시뮬레이션을 통해 250W 이상 초고전력 저항을 성공적으로 개발하는 것을 목적으로 하였다.

PG1B-28 | Electrical Properties and Centimeter-Scale Growth of NiTe2

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TMDC materials with an MX2 structure have a strong covalent bond between metal and Chalcogens atoms, and a relatively weak van der Waals bond between each layer. Because of these characteristics, it can be peeled off into flakes with a thickness of several nm through mechanical or chemical methods and then used in various fields such as memory, logical devices, and sensors. Among them, Nickel ditelluride (NiTe2) has metallic properties while also having catalyst or superconducting properties depending on temperature and composition control. In this study, NiTe2 grown in a large area was peeled off, the crystal structure and surface composition were analyzed using an electron microscope, and its electrical behavior was observed by manufacturing it with a Field Effect Transistor. First, the crystal structure of NiTe2 was analyzed using Raman spectroscopy, and as a result, Eg and A1g signals were detected. As a result of mapping the surface of NiTe2 peeled off with KPFM (Kelvin Potential Force Microscopy), it was confirmed that homogeneous CPD was distributed, which is consistent with the result of the homogeneous Ni:Te composition that can also be confirmed by EPFM. As a result of analyzing the magnetic characteristics in the temperature range of 50 K-300 K, Diamagnetism was detected.

PG1B-29 | 화학기상증착법을 이용한 h-BN의 결정구조 변형을 통한 비정질 BN 성장

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Resistive Random Access Memory (RRAM) is a next generation non-volatile memory type. A two terminal resistive switching device with a MIM (Metal-Insulator-Metal) structure can be developed. Amorphous boron nitride (a-BN) is grown using ammonia borane as the dielectric material. Here, as the growth conditions are adjusted, the degree of oxidation is measured by controlling hydrogen, and the crysatl properties change according to the thickness of the film and the growth temperature as a growth time is measured. Accordingly, it was confirmed that BN has the characteristics of Raman measurement, TEM image, and EDS image using Raman spectroscopy.
RRAM takes advantage of the phenomenon that when a sufficienctly high voltage is applied to a non conductive material, a filament is created and a path through which current can flow occurs, and the resistance is lowered. When a voltage is applied, the ions agglomerate to form filament. Through the generation of this filament, it can be seen that electrical characteristic are measured to have a memory characteristic having a memory window. Through these measurements, it was possible to control the growth conditions to analyze the film states of various BN, and to make better RRAM devices using amorphous BN.