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KIT Energy News

에너지융합기술 혁신인재 양성사업단

Innovative Education & Research Center for Energy Convergence Science and Technology

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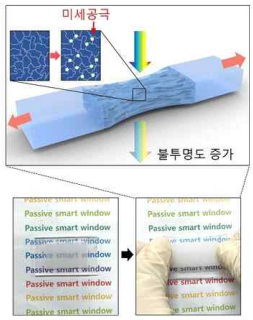
- 신소재공학부 윤서한 학생, '무전력 스마트 윈도우용 핵심 소재 제조기술' 다뤄
- 차세대 스마트 윈도우, 웨어러블 전자소자 등에 응용 가능성 높아





신소재공학부 윤서한 학생(석사과정, 지도교수 박준용)이 학부 4학년 재학 당시 제1저자로 참여한 연구논문이 복합재료 분야 최상위 국제학술지에 게재됐다.

윤서한 학생은 반도체공정을 기반으로 한 첨단 나노공정기술의 도입을 통해 단순한 기계적 변형에 의해 투광성이 제어되는 신개념 광학소재를 개발했다. 연구 결과는 복합재료 분야 SCI급 국제학술지인 '복합재료 파트 B:엔지니어링(Composites Part B: Engineering, IF: 9.078, JCR 기준 상위 0.56%)' 5월호에 게재될 예정이며, 4월 5일자 온라인판에 먼저 게재됐다. 논문명은'Stretchable translucent nanocomposite membranes with 3D heterogeneous interfaces derived from sugar templates for mechano-responsive optical applications'이다.

이종 계면이 내재된 유연 나노복합소재는 소재를 잡아당기거나 굽힐 때 내부에서 발생하는 수많은 미세공극에 의한 광 산란으로 불투명도가 조절될 수 있다. 이에 제로 에너지 빌딩을 구현하기 위한 무전력 스마트 윈도우용 핵심 소재로 각광받고 있지만, 소재를 제조하는 과정이 복잡하고 값비싼 문제점이 있었다. 윤서한 학생은 일상생활에서 쉽게 쓰이는 각설탕과 첨단 반도체공정을 접목하는 새로운 접근으로, 단순한 기계적 변형에 의해 불투명도가 가역적으로 조절될 수 있는 유연 나노복합소재 제조에 성공했으며, 나아가 무전력 스마트 윈도우 및 광학적 변형 센서로 응용할 수 있는 가능성을 입증했다.

윤서한 학생은 지난해 학부 4학년 재학 당시 제1저자로 이번 연구를 주도했으며, 올해 3월 대학원에 진학하여 4단계 BK21 사업의 에너지융합기술 혁신인재 양성사업단 연구장학생으로 참여하고 있다.

윤서한 학생은 "평소 나노구조에 의해 발현되는 유익하고 독특한 물성에 대한 관심이 많아 나노 소재기술 분야에 흥미를 가졌는데, 이번 논문을 통해 신소재를 직접 연구 개발하는 것에 더욱 재미를 느끼게 됐다"며, "석사과정 동안 나노구조에 의한 새로운 메커니즘을 탐구하고, 원천공정 및 소재를 개발하는 연구를 통해 사회에 기여할 수 있는 연구자로 성장하고싶다"고 밝혔다.

지도교수인 박준용 신소재공학부 교수는 "이번 연구는 저전력 스마트 윈도우, 변형 센서, 웨어러블 전자소재 등에 핵심적으로 활용 가능한 신축성 나노복합소재를 손쉽고 저렴한 비용으로 제조할 수 있는 방안을 제시했다는 측면에서 의미가 있다"며, "특히 학부생이 제1저자로 주도한 연구결과가 JCR 기준 복합재료 분야 1등 저널에 게재된 것은 주목할 만한 성과"라고 밝혔다.

이번 연구는 신소재공학부 나노구조재료 및 소자 연구실(Nanostructured Materials and Devices Lab, 지도교수 박준용)에서 진행됐으며, 교육부 4단계 BK21사업, 한국연구재단 신진연구자지원사업, 국토교통부 국토교통기술촉진연구사업, 한국과학창의재단 학부생연구프로그램(URP) 지원으로 수행됐다.

금오공과대학교 KIT People(2022.04.18.) https://www.kumoh.ac.kr/ko/sub01_05_02.do?mode=view&articleNo=361805

◈ 관련 기사 ◈

NEWSIS	금오공대 학부생 논문, 복합재료 국제학술지에 실렸다	https://newsis.com/view/?id=NISX20220419_0001838621&cID=10810
데일리한국	금오공대 학부생 1저자 논문, 복합재료 분야 최상위 국제학술지 게재	http://daily.hankooki.com/news/articleView.html?idxno=813726
Break News	금오공대 윤서한 학생 연구논문, 복합재료 분야 최상위 국제학술지 게재	https://www.breaknews.com/888420
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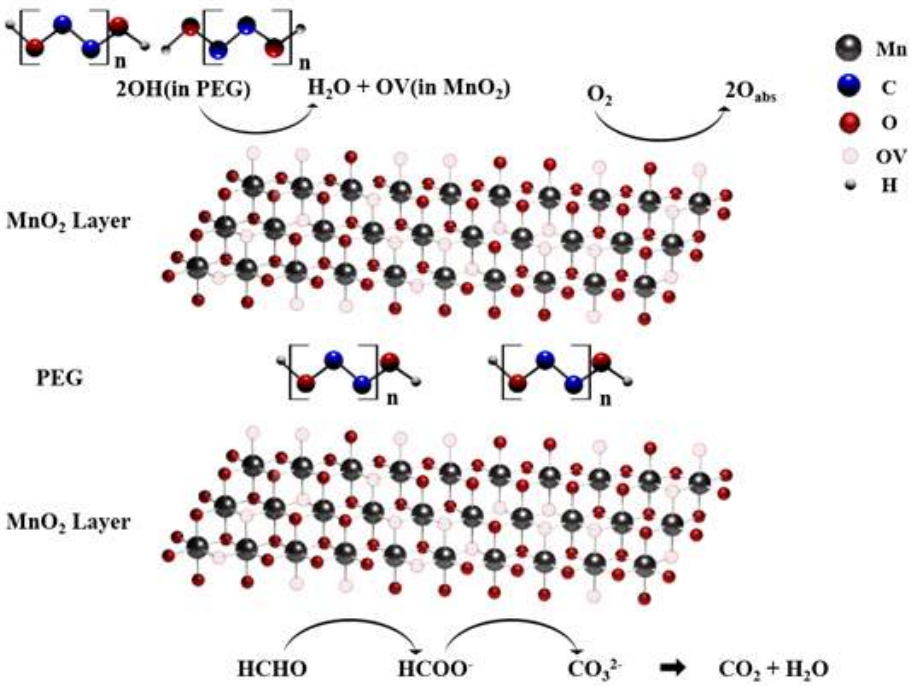
경북일보	금오공대, 학부생 1저자 논문 '복합재료 분야 최상위 국제학술지' 게재	http://www.kyongbuk.co.kr/news/articleView.html?idxno=2099653
교수신문	금오공대 학부생 1저자 논문, 복합재료 분야 최상위 국제학술지 게재	http://www.kyosu.net/news/articleView.html?idxno=87641

환경에너지

Applied Surface Science
Volume 598, May 2022, p153773 (Impact Factor : 7.392)

Oxidative decomposition with PEG-MnO_2 catalyst for removal of formaldehyde: Chemical aspects on HCHO oxidation mechanism

Seong-Bin Do, Sung-Eun Lee, Tae-Oh Kim*



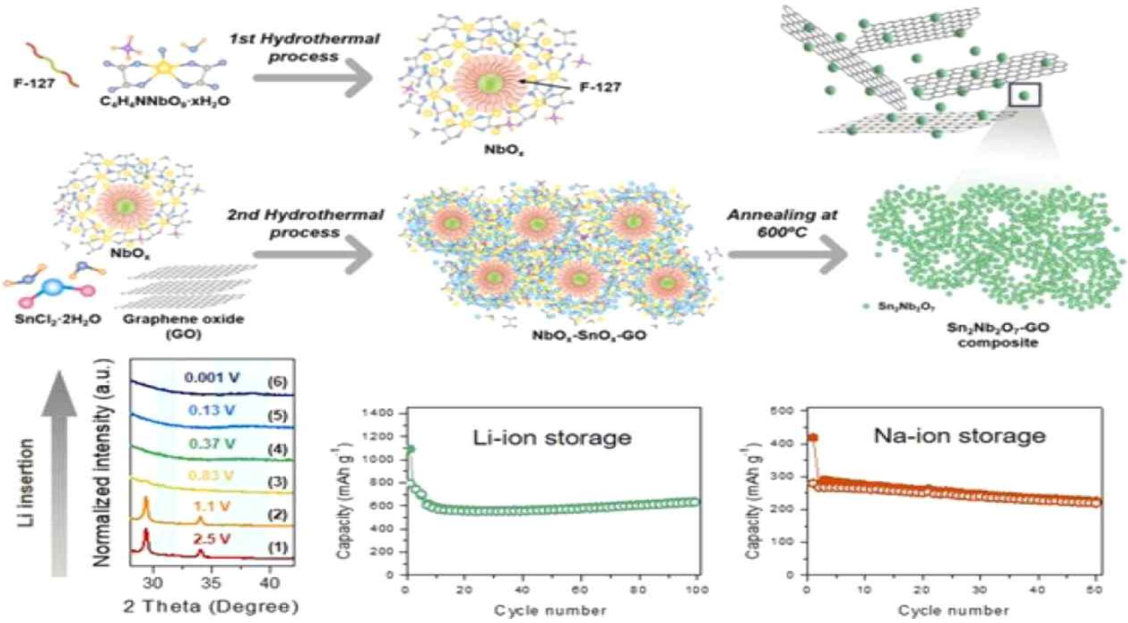
Formaldehyde (HCHO) is a representative indoor pollutant that can adversely affect human health, and research on HCHO removal at room temperature is actively needed. In this study, a carbon-based material, Polyethylene glycol #20000(PEG #20000), is used to prepare PEG-MnO_2 by doping on MnO_2. Glucose-doped MnO_2 (G-MnO_2) and birnessite-doped MnO_2 (δ-MnO_2) are utilized to compare removal efficiencies with PEG-MnO_2. The efficiency of PEG-MnO_2 is measured to be 96.8 % under the conditions of 60 % relative humidity and GHSV of 240 $L \cdot g_{cat}^{-1} \cdot h^{-1}$. In addition, PEG-$MnO_2$ catalysts demonstrated longer stability by maintaining a constant efficiency for 720min. The superior performance of PEG-MnO_2 is due to the formation of oxygen vacancies after PEG-doping which promote the oxidation of HCHO. Therefore, PEG-MnO_2 is expected to attract attention as a catalyst for HCHO removal at room temperature because it is easy to synthesize and has superb catalytic performance.

에너지저장

Journal of Alloys and Compounds
Volume 910, July 2022, 164943 (Impact Factor : 6.371)

Surfactant-derived porous $Sn_2Nb_2O_7$-graphene oxide composite as Li- and Na-ion storage materials

Yunjung Kim, Kyungbae Kim, Hyungeun Seo, Sung-Min Lee, Cheol-Min Park*, Jae-Hun Kim*



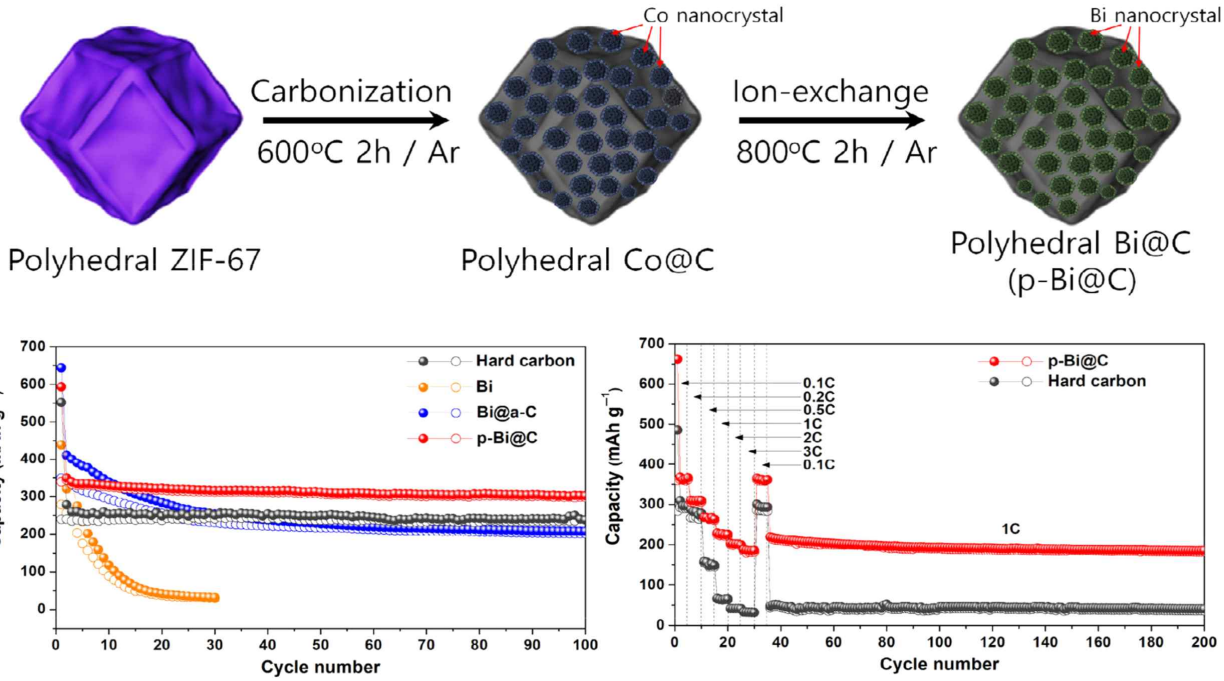
Tin-based materials, which are one of the materials that store Li-ion through an alloying reaction, have been actively studied as anode materials for Li-ion and Na-ion batteries thanks to their high capacity, high electrical conductivity, and low cost. In this paper, we propose a porous $Sn_2Nb_2O_7$-graphene oxide (GO) composite material that is prepared by a two-step hydrothermal and pyrolysis process. The ternary $Sn_2Nb_2O_7$ material decomposes into Sn and niobium oxide during the first Li or Na insertion reactions and the niobium oxide acts as a buffer medium to alleviate the volume changes of Sn, as well as a Li/Na storage material through intercalation. Furthermore, a porous structure combined with GO w as introduced into the composite, which increased the cycling stability of the electrode. The synthesized material was characterized by X-ray diffraction (XRD), electron microscopy, and X-ray photoelectron spectroscopy. The electrochemical reaction mechanism with Li was thoroughly investigated by ex situ XRD analysis. The electrochemical test results demonstrated that the composite electrode has great potential as both Li-ion and Na-ion anodes because of its high reversible capacity and initial Coulombic efficiency, as well as enhanced cycling and rate performance. The electrochemical performance can be attributed to the incorporation of a porous structure and GO.

에너지저장

International Journal of Energy Research
Volume 46, June 2022, 9486-9497 (Impact Factor : 4.672)

Bismuth and its nanocomposite: Reaction mechanism and rational nanocomposite fabrication process for superior sodium-ion battery anodes

Ki-Hun Nam‡, Vinoth Ganesan‡, Do-Hyeon Kim, Jeong-Hee Choi*, Cheol-Min Park*
; ‡equally contributed



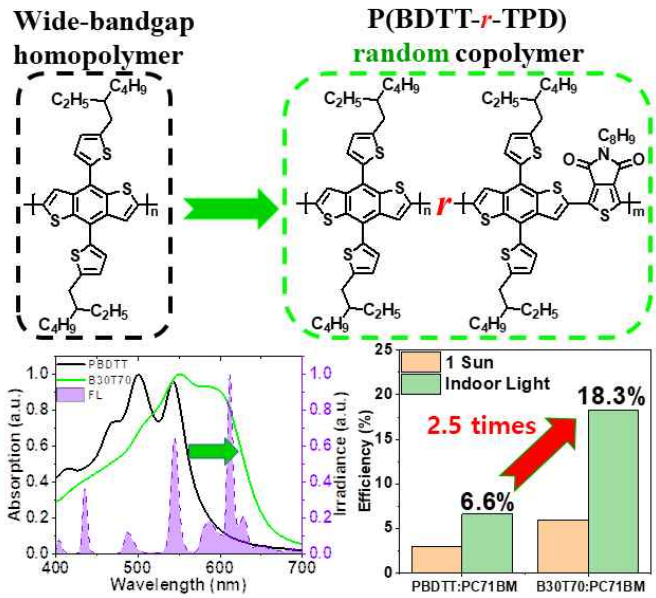
Bismuth has garnered attention as a promising anode material for Na-ion batteries (NIBs) because of its high volumetric capacity and appropriate operating potential. However, the large and repeated volume variations of the Bi anode during sodiation/desodiation lead to a poor electrochemical performance; thus, a rational design for Bi-based materials is essential for their application to NIB anodes. First, the Na reaction pathway of Bi was analyzed using various cutting-edge ex situ analysis tools. Subsequently, two different types of Bi-based nanocomposite materials were prepared to enhance the Na storage performance of Bi: one is an amorphous carbon (a-C)-modified Bi nanocomposite (Bi@a-C) fabricated via mechanical treatment and the other is a metal-organic framework (MOF)-derived polyhedral Bi nanocomposite (p-Bi@C) fabricated via chemical treatment. The Na storage performance of p-Bi@C is much higher than that of Bi@a-C because of the homogeneous anchoring effect of Bi nanocrystals in the MOF-derived polyhedral C matrices, which have robust and high Na-ion conduction. The p-Bi@C delivered a highly reversible capacity (302 mAh g^{-1} over 100 cycles) and high rate capability (205 mAh g^{-1} at 2C). Therefore, this study provides a rational design of Bi-based nanocomposite materials for application to high-performance NIB anodes.

태양에너지

Macromolecular Rapid Communications
May 07, p2200279 (Impact Factor : 5.006)

Revisiting the Classical Wide-Bandgap Homo and Random Copolymers for Indoor Artificial Light Photovoltaics

Jeonga Kim, Muhammad Ahsan Saeed, Sung Hyun Kim, Dongmin Lee, Yongchan Jang, Jin Su Park, Donggu Lee, Changyeon Lee, Bumjoon J. Kim, Han Young Woo, Jae Won Shim*, Wonho Lee*



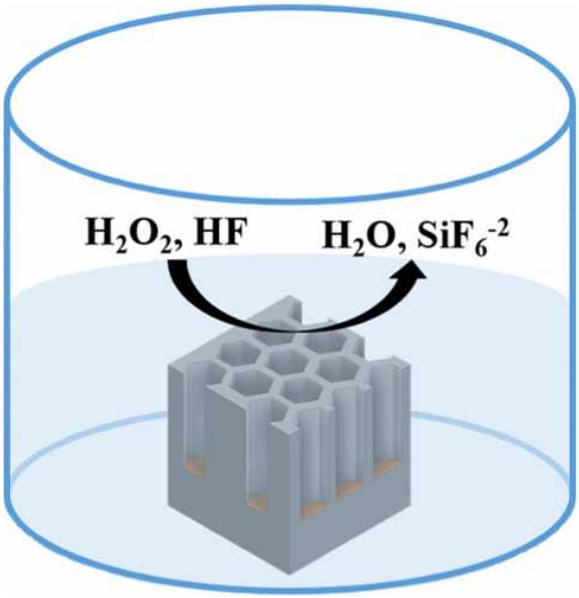
Organic indoor photovoltaics (IPVs) are attractive energy harvesting devices for low-power consumption electronic devices and the Internet of Things (IoTs) owing to their properties such as lightweight, semi-transparency, multi-coloring capability, and flexibility. It is important to match the absorption range of photoactive materials with the emission spectra of indoor light sources that have a visible range of 400-700 nm for IPVs to provide sustainable, high-power density. To this end, we synthesize benzo[1,2-b:4,5-b′]dithiophene-based homopolymer (PBDTT) as a polymer donors, which is a classical material that has a wide bandgap with a deep highest occupied molecular orbitals (HOMO) level, and a series of random copolymers by incorporating thieno[3,4-c]pyrrole-4,6,-dione (TPD) as a weak electron acceptor unit in PBDTT. We vary the composition of the TPD unit to fine tune the absorption range of the polymers; the polymer containing 30% TPD (B30T70) perfectly covers the entire range of indoor lamps such as LED and FL. Consequently, B30T70 shows a dramatic enhancement of the power conversion efficiency (PCE) from 1-sun (PCE: 6.0%) to the indoor environment (PCE: 18.3%) when fabricating organic IPVs by blending with $PC_{71}BM$. We suggest simple, easy molecular design guidelines to develop photoactive materials for efficient organic IPVs.

수소에너지

ACS Omega
Volume 7, Number 19, May 2, p.16665-16669 (Impact Factor : 4.132)

Deep Etching of Silicon Based on Metal-Assisted Chemical Etching

Anafi Nur'aini and Ilwhan Oh*



A deep etching method for silicon "micro"structures was successfully developed. This wet etching process is based on metal-assisted chemical etching (MACE), which was previously mainly utilized to etch the features that have lateral dimensions of "nanometers." In this novel MACE, the critical improvement was to promote the "out-of-plane" mass transfer at the metal/Si interface with an ultrathin metal film. This enabled us to etch micrometer-wide holes, which was previously challenging due to the mass transport limitation. In addition, it was found that when ethanol was used as a solvent instead of water, the formation of porous defects was suppressed. Under the optimized etch conditions, deep (>200 μm) and vertical (>88°) holes could be carved out at a fast etch rate (>0.4 μm/min). This novel deep MACE will find utility in applications such as microelectromechanical systems (MEMS) devices or biosensors.