< 목 차 >

KIT Energy 소식

윤서한 학생, 이공계 여대학원생 美연수프로그램 선발

- 과기부의 '한국 이공계 여성대학원생 미국연수 프로그램', 전국 10명 선정
- '친환경 응용을 위한 기능성 나노구조 소재 개발' 과제로 선정

신소재공학부 석사과정 윤서한 학생(지도교수 박준용)이 '2023년도 한국 이공계 여성대학원생 미국 연수프로그램'에 선정됐다.

과학기술정보통신부에서 시행하는 한국 이공계 여성대학원생 미국 연수프로그램은 한·미 양국 간 인력교류를 통해 여성 신진 연구자들의 연구 활동 증진과 이공계 진출 촉진을 위한 목적으로 시행되고 있다.

윤서한 학생은 '친환경 응용을 위한 누에나방 실크 기반 기능성 나노구조 소재 개발'과제로 이번 연수 프로그램에 선발됐다. 앞으로 6개월 간 미국 Tufts 대학에 체류하며, 실크 분야의 세계적 권위자인 Fiorenzo Omenetto 교수와 우리 대학 박준용 교수의 공동지도 하에 연구를 수행하게 된다. 이 연구는 누에고치에서 추출된 실크 단백질과 첨단 반도체공정기술을 접목하여 천연물 기반의 고기능성 나노소재를 개발하는 것으로, 지속가능한(sustainable) 친환경 소재 분야에서 핵심적인 원천기술을 확보할 수 있을 것으로 기대된다.

윤서한 학생은 "국내외 우수 연구진과 관련 분야를 함께 연구하며 학문적 시야를 넓힐 수 있는 좋은 기회를 얻게 되어 기쁘고, 이번 연수를 통해 앞으로 한국을 대표하는 여성과학기술인으로 성장할 수 있도록 노력하겠다."고 말했다.

윤서한 학생은 지난해에도 제1저자로 참여한 연구논문이 복합재료 분야 최상위 국제학술지에 게재된 바 있으며, 현재 우리 대학에서 4단계 BK21사업의 에너지융합기술 혁신인재 양성사업단 연구 장학생으로 참여하고 있다.

한편, 한국 내 이공계 석사 또는 박사학위 과정생을 대상으로 선발하는 '2023 한국 이공계 여성대학원생 미국 연수프로그램'에는 총 10명이 선정됐으며, 이들은 6개월간의 공동 R&D프로젝트 참여를 통해 연구역량 증진과 해외 연구 네트워크 구축 기회를 제공받게 된다.

금오공과대학교 KIT People(2023.07.21.) https://www.kumoh.ac.kr/ko/sub01_05_02.do?mode=view&articleNo=453356

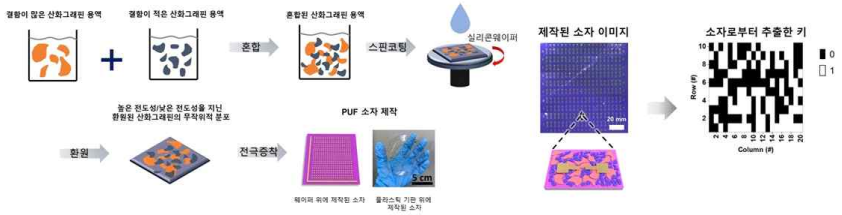
◈ 관련 기사 ◈

뉴시스	금오공대 윤서한 학생, 이공계 미국 연수 프로그램 선발	https://newsis.com/view/?id=NISX20230725_0002389570
베리타스알파	금오공대 윤서한 학생 이공계 여대학원생 美연수프로그램 선발	http://www.veritas-a.com/news/articleView.html?idxno=466008
데일리한국	금오공대 윤서한 학생, 이공계 여대학원생 미국 연수 프로그램 선발	https://daily.hankooki.com/news/articleView.html?idxno=981009
신아일보	금오공대 윤서한 학생, 이공계 여대학원생 미국 연수 프로그램 선발	http://www.shinailbo.co.kr/news/articleView.html?idxno=1735447
교수신문	국립금오공대 윤서한 학생, 이공계 여대학원생 美연수프로그램 선발	http://www.kyosu.net/news/articleView.html?idxno=107711
브레이크뉴스	금오공대 신소재공학부 윤서한 학생, 미국 연수프로그램 선발	https://www.breaknews.com/977849
대구신문	금오공대 윤서한 학생, 美 연수프로그램 선발	https://www.idaegu.co.kr/news/articleView.html?idxno=428216
영남일보	윤서한 국립금오공대 대학원생, 이공계 여대학원생 미국 연수프로그램 선발	https://www.yeongnam.com/web/view.php?key=20230723010002993
경북매일신문	윤서한씨, 이공계 여성대학원생 美연수프로그램 선발	http://www.kbmaeil.com/news/articleView.html?idxno=964654
경북도민일보	국립금오공대 윤서한 학생, 이공계 여대학원생 美연수프로그램 선발	http://www.hidomin.com/news/articleView.html?idxno=521598
경북신문	금오공대 윤서한씨, 과기부 美연수프로그램 선정	http://www.kbsm.net/news/view.php?idx=399525
전자신문	금오공대 대학원생, 과기부 이공계 여대학원생 미국 연수 프로그램 선발	https://www.etnews.com/20230721000164#
서울경제	금오공대생 미국연수프로그램에 선정	https://www.sedaily.com/NewsView/29S7TZ8OKL

KIT Energy 소식

신소재공학부 학부생 1저자 논문, 재료 분야 최고 수준 국제학술지 게재

- 신소재공학부 4학년 최선연 학생, '산화그래핀 기반 물리적 복제방지 보안기술' 개발



신소재공학부 4학년 최선연 학생(지도교수 김현호)이 제1저자로 참여한 논문이 재료 분야의 저명한 국제학술지에 게재됐다.

논문 제목은 'Unpredictably Disordered Distribution of Hetero-Blended Graphene Oxide Flakes with Non-Identical Resistance in Physical Unclonable Functions(예측할 수 없이 무질서하게 혼합된 서로 다른 저항을 가진 이종의 산화그래핀 플레이크의 물리적 복제방지 기능)'으로, SCI급 국제학술지인 'Advanced Functional Materials(상위 5%, IF 19.924)'온라인판에 8월 2일자로 게재됐다. 오프라인으로는 9월 중 게재될 예정이다.

최선연 학생은 동일한 반도체 제조 공정으로 제작되어도 재현성의 차이로 인해 예측할 수 없는 난수(Random Number)를 생성할 수 있는 '물리적 복제방지기술(physical unclonable functions, PUFs)'에 대한 연구를 진행했다. 물리적 복제방지 시스템(PUF)은 하드웨어를 기반으로 하는 보안기술로, 이는 기존 소프트웨어 방식의 보안시스템이 해킹에 취약한 단점을 근본적으로 해결할 수 있는 대안으로 최근 주목받고 있다.

이번 연구에서는 서로 다른 저항을 가진 이종의 산화그래핀을 혼합하여 코팅한 후, 환원을 해줌으로써 환원된 산화그래핀 조각들이 무작위로 존재하도록 했다. 영역별 전기전도도의 무작위성을 유도하여 물리적 복제방지 시스템을 구현한 것인데, 이는 용액기반의 간단한 공정으로 인해 대면적, 대량제조가 가능하다는 장점이 있다. 또한 상온에서 공정이 진행되기 때문에 플라스틱 기판 위에서도 제작할 수 있다.

최선연 학생은 "이번 연구는 해킹의 근본적인 문제를 해결할 수 있다는 점에서 유의미한 연구라고 생각한다."며, "앞으로도 다양한 이차원 물질에 대한 연구를 통해 우리나라의 과학발전에 기여할 수 있는 연구자로 성장하고 싶다."고 밝혔다.

지도교수인 김현호 교수는 "이번 논문은 산화그래핀을 물리적 복제방지 기술을 통해 최초로 응용한 새로운 개념의 연구로서 제조방법과 비용적인 측면에서 큰 효율성을 가지고 있기 때문에 산업적으로도 그 미래가치가 크다."고 밝혔다.

이번 연구는 신소재공학부 저차원나노소재 및 반도체소자 연구실(Low-Dimensional Materials & Semiconducting Devices Lab., 지도교수 김현호)에서 주도하여 가천대, 경북대, 한국전기연구원 등과의 공동연구를 통해 진행됐으며, 교육부 4단계 BK21사업, 한국연구재단 신진연구자지원사업, 대학중점연구소지원사업 등의 지원으로 수행됐다.

금오공과대학교 KIT People(2023.09.05.) https://www.kumoh.ac.kr/ko/sub01_05_02.do?mode=view&articleNo=461635

◈ 관련 기사 ◈

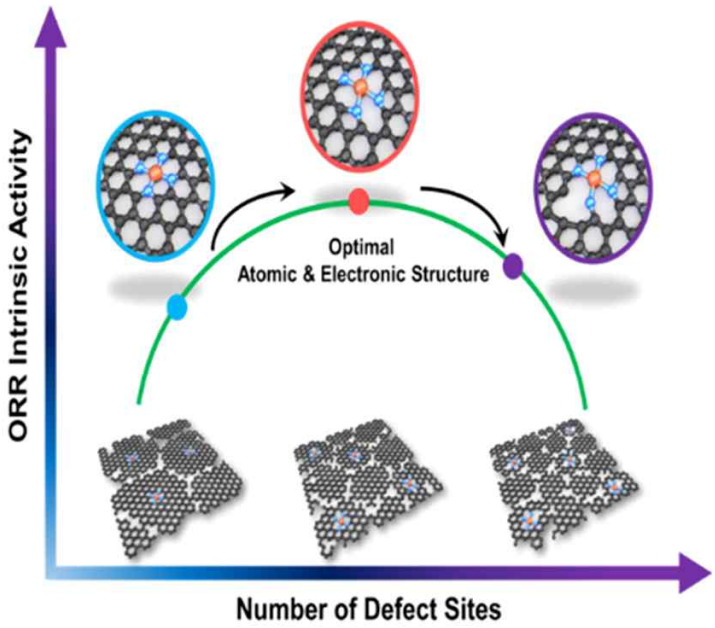
News1	금오공대 최선연 '복제방지 보안기술 연구논문' 국제학술지 게재	https://www.news1.kr/articles/5161506
경북일보	금오공대 최선연 학부생, 1저자 논문 저명 국제학술지 게재	http://www.kyongbuk.co.kr/news/articleView.html?idxno=2141486
경북매일신문	금오공대 학부생 국제학술지 논문 게재	http://www.kbmaeil.com/news/articleView.html?idxno=968428
한국대학신문	금오공대 학부생, 국제학술지 제1저자로 눈문 게재	https://news.unn.net/news/articleView.html?idxno=551979
데일리한국	금오공대 학부생 1저자 논문, 재료 분야 최고 수준 국제학술지 게재	https://daily.hankooki.com/news/articleView.html?idxno=996072
교수신문	국립금오공대 학부생 1저자 논문, 재료 분야 최고 수준 국제학술지 게재	http://www.kyosu.net/news/articleView.html?idxno=109160
경북도민일보	국립금오공대 학부생 1저자 논문, 재료 분야 최고 수준 국제학술지 게재	http://www.hidomin.com/news/articleView.html?idxno=525488
경상매일신문	국립금오공대 학부생 1저자 논문, 재료 분야 최고 수준 국제학술지 게재	http://www.ksmnews.co.kr/default/index_view_page.php?idx=443252&part_idx=263
베리타스알파	금오공대 학부생 1저자 논문 재료 분야 최고 수준 국제학술지 게재	http://www.veritas-a.com/news/articleView.html?idxno=471382

수소에너지

Advanced Materials
August 07, 2023 (온라인 게재) (Impact Factor : 29.4)

Insight into Defect Engineering of Atomically Dispersed Iron Electrocatalysts for High-Performance Proton Exchange Membrane Fuel Cell

Seung Yeop Yi, Eunho Choi, Ho Yeon Jang, Seonggyu Lee, Jinkyu Park, Daeeun Choi, Yeju Jang, Hojin Kang, Seoin Back-, Segeun Jang-, Jinwoo Lee-



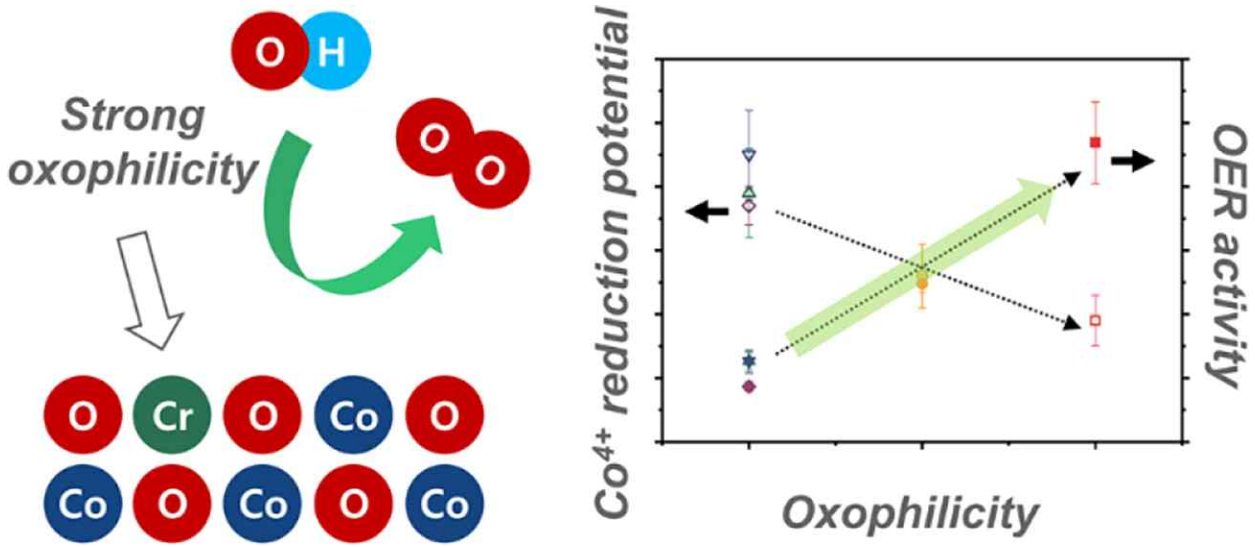
Atomically dispersed and nitrogen coordinated iron catalysts (Fe-NCs) demonstrate potential as alternatives to platinum-group metal (PGM) catalysts in oxygen reduction reaction (ORR). However, in the context of practical proton exchange membrane fuel cell (PEMFC) applications, the membrane electrode assembly (MEA) performances of Fe-NCs remain unsatisfactory. Herein, improved MEA performance is achieved by tuning the local environment of the Fe-NC catalysts through defect engineering. Zeolitic imidazolate framework (ZIF)-derived nitrogen-doped carbon with additional CO2 activation is employed to construct atomically dispersed iron sites with a controlled defect number. The Fe-NC species with the optimal number of defect sites exhibit excellent ORR performance with a high half-wave potential of 0.83 V in 0.5 M H2SO4. Variation in the number of defects allows for fine-tuning of the reaction intermediate binding energies by changing the contribution of the Fe d-orbitals, thereby optimizing the ORR activity. The MEA based on a defect-engineered Fe-NC catalyst is found to exhibit a remarkable peak power density of 1.1 W cm−2 in an H2/O2 fuel cell, and 0.67 W cm−2 in an H2/air fuel cell, rendering it one of the most active atomically dispersed catalyst materials at the MEA level.

수소에너지

Journal of Physical Chemistry C
Volume 127, Issue 15, August 10, 2023, p15062 (Impact Factor : 3.7)

Oxophilicity induced Surface Hydroxylation to Promote Oxygen Evolution in Selectively Substituted Spinel-type Cobalt Oxidesn

Seonggyu Lee*, Seongbeen Kim, Yeju Jang, Jaeho Byeon, Jinwoo Lee*



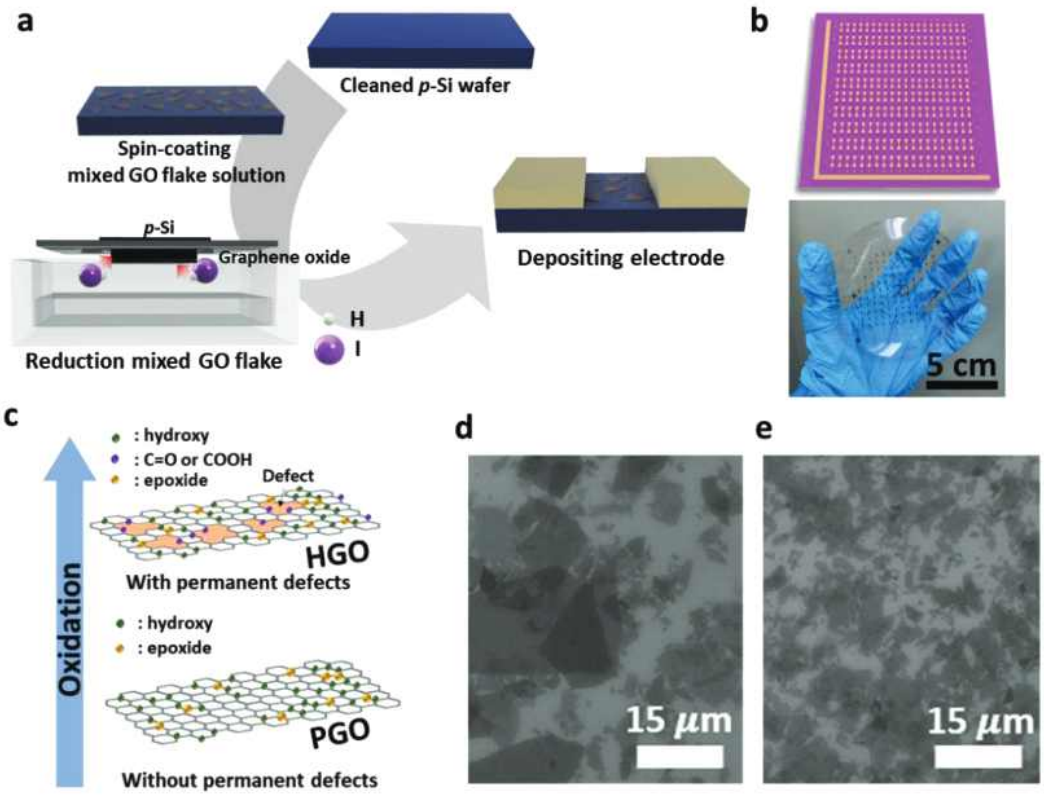
Highly active oxygen evolution reaction (OER) electrocatalysts based on abundant and less expensive transition metal oxides must be developed for the commercialization and wide application of water electrolyzers in large-scale energy storage systems. Among the non-precious metal group OER catalysts, spinel-type cobalt oxide has attracted attention owing to its superior theoretical/empirical activity and stability at relatively low costs, and the substitution of cobalt ions with other metal ions is also considered as a promising approach to improve the intrinsic activity of cobalt oxide. However, many studies have not considered the exact geometrical site occupancy and oxidation states of substituted metal ions. Therefore, the role and effect of substituted metal ions are still unclear, and it is difficult to identify the activity descriptor in OER, although such identification would be extremely important to guide the design of a highly active non-precious metal group OER catalyst. Herein, we report the origin of the enhanced OER activities of cobalt-based spinel-type metal oxides with precisely controlled substitution sites and oxidation states. One of the Co3+ ions in the octahedral sites was selectively substituted by Cr3+ and Mn3+ ions using the nanocasting method. The synthesized CrCo2O4 showed 5.4 times enhanced electrocatalytic OER mass activity at 1.6 VRHE compared to that of Co3O4, whereas MnCo2O4 showed mass activity similar to that of Co3O4. The more oxophilic property of Cr facilitates the adsorption of oxygen species on the surface, thereby increasing the surface hydroxylation and reducing the charge-transfer resistance, leading to increased electrocatalytic OER activity.

에너지변환

Advanced Functional Materials
Issue 2304432, August 2023 (온라인게재) (Impact Factor : 19.0)

Unpredictably Disordered Distribution of Hetero-Blended Graphene Oxide Flakes with Non-Identical Resistance in Physical Unclonable Functions

Subin Lee†, Seon Yeon Choi†, Byung Chul Jang†, Dong Hyun Lee†, Joon Young Cho, Joong Tark Han, Hocheon Yoo,* and Hyun Ho Kim*



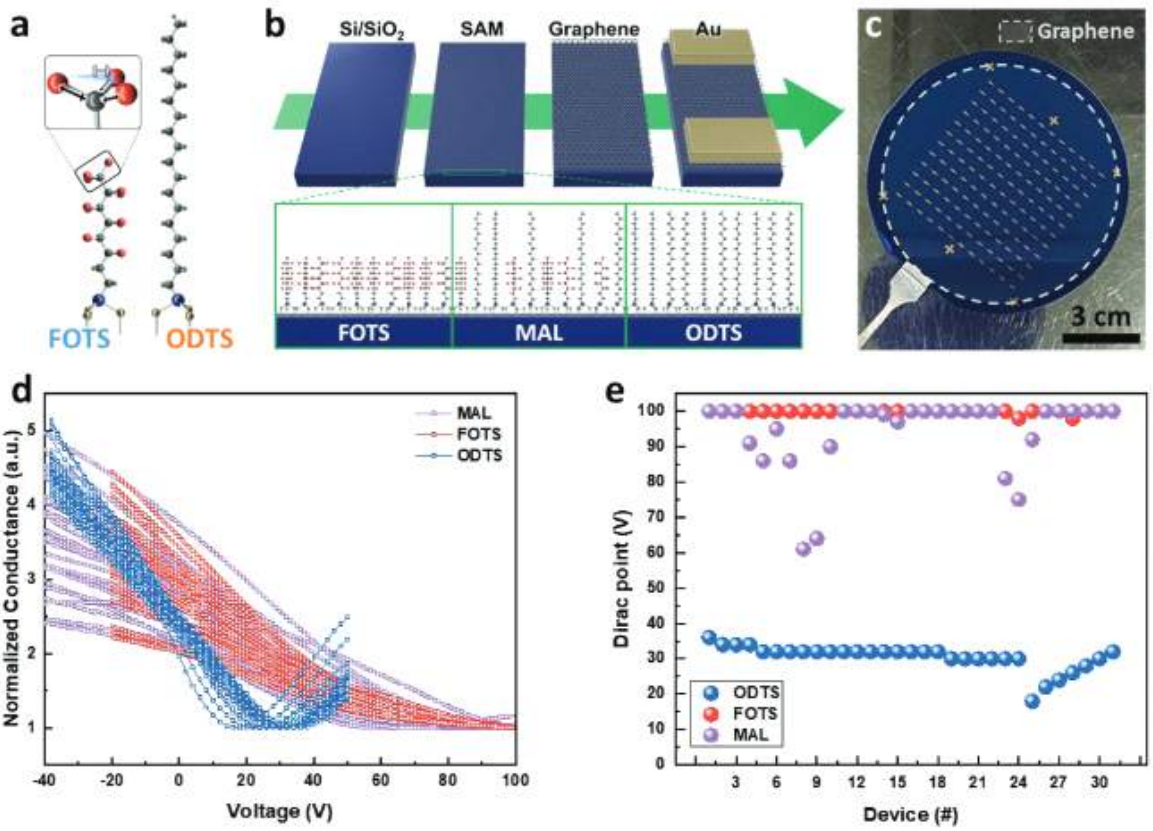
In this study, a new concept of physical unclonable functions (PUFs) isintroduced comprising reduced graphene oxide (GO) materials. To create adisordered conductivity distribution, two types of GO are used: HGO, areproduced by the conventional Hummers' method, and PGO, produced byBrodie's method with an additional unique purification procedure. It is foundthat PGO becomes graphene-like after room-temperature chemical reduction.These two reduced GOs have a distinct conductivity difference of up to 104times. By blending these two materials, a random mixture is created that cangenerate a highly unpredictable electrical signal, serving as an ideal securitykey with strong randomness and uniqueness. The optimized PUF device,based on this approach, demonstrates excellent performance in generatingsecure keys.

에너지변환

Advanced Science
Issue 2302604, August 2023 (온라인게재) (Impact Factor : 15.1)

Machine Learning Attacks-Resistant Security by Mixed-Assembled Layers-Inserted Graphene Physically Unclonable Function

Subin Lee†, Byung Chul Jang†, Minseo Kim†, Si Heon Lim†, Eunbee Ko, Hyun Ho Kim*, and Hocheon Yoo*



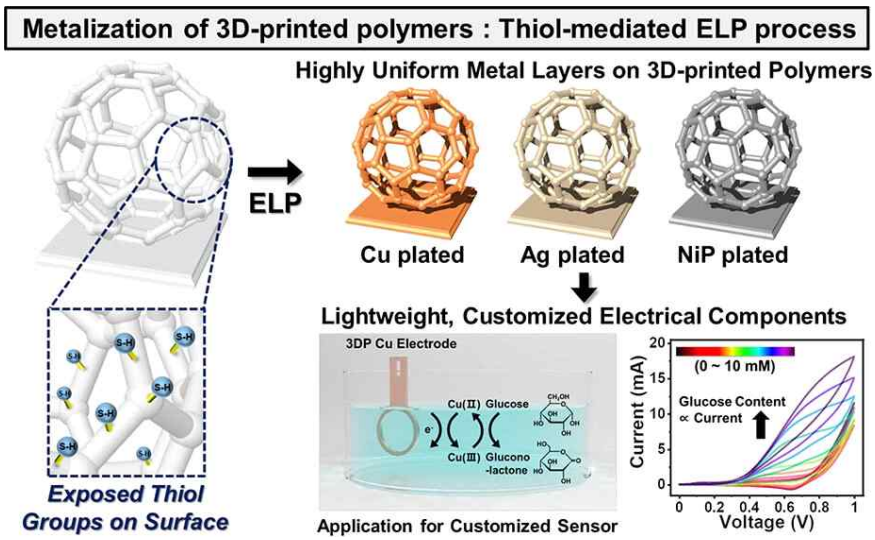
Mixed layers of octadecyltrichlorosilane (ODTS) and 1H,1H,2H,2H-perfluorooctyltriethoxysilane (FOTS) on an active layer of graphene are used to induce a disordered doping state and form a robust defense system against machine-learning attacks (ML attacks). The resulting security key is formed from a 12 × 12 array of currents produced at a low voltage of 100 mV. The uniformity and inter-Hamming distance (HD) of the security key are 50.0 ± 12.3% and 45.5 ± 16.7%, respectively, indicating higher security performance than other graphene-based security keys. Raman spectroscopy confirmed the uniqueness of the 10,000 points, with the degree of shift of the G peak distinguishing the number of carriers. The resulting defense system has a 10.33% ML attack accuracy, while a FOTS-inserted graphene device is easily predictable with a 44.81% ML attack accuracy.

태양에너지

ACS Applied Materials & Interfaces
Volume 15, July 2023, p31765 (Impact Factor : 9.5)

Straightforward Manufacturing of 3D-Printed Metallic Structures toward Customized3 Electrical Components

Dongmin Lee, So-Young Kim, Gwajeong Jeong, Woo Sung Lee, Wonho Lee*, and Hyunseung Yang*



Metalizing three-dimensional (3D)-printed polymers has been spotlighted in the field of manufacturing high-end and customized electrical components. Conventional metalization approaches that rely on the electroless plating (ELP) process typically require the use of noble metal-based catalysts or involve multistep processes, limiting their practical applications. Herein, we propose a straightforward yet effective approach to manufacture 3D-printed polymers with conductive metal layers through a thiol-mediated ELP process without involving an additional catalytic activation process. A photocurable ternary resin based on thiol-ene-acrylate monomers was precisely designed to induce excess thiol moieties on the surface of 3D-printed structures. These exposed thiol moieties served as active sites for metal ion complexion via strong metal-sulfur bonds, allowing the deposition of metal layers on the 3D-printed polymers through the ELP. Diverse metal layers, including Cu, Ag, and NiP, could be deposited onto virtually any 3D-printed structures with high uniformity and adhesion stability. To highlight the potential application of our approach, we fabricated fully functional glucose sensors through the deposition of the Cu layer on 3D-printed electrode models, and these sensors displayed excellent nonenzymatic glucose sensing performance. The proposed approach offers great insights for designing functional metallic structures and opens up new avenues for manufacturing lightweight, customized electrical components.

환경에너지

Ultrasonics Sonochemistry
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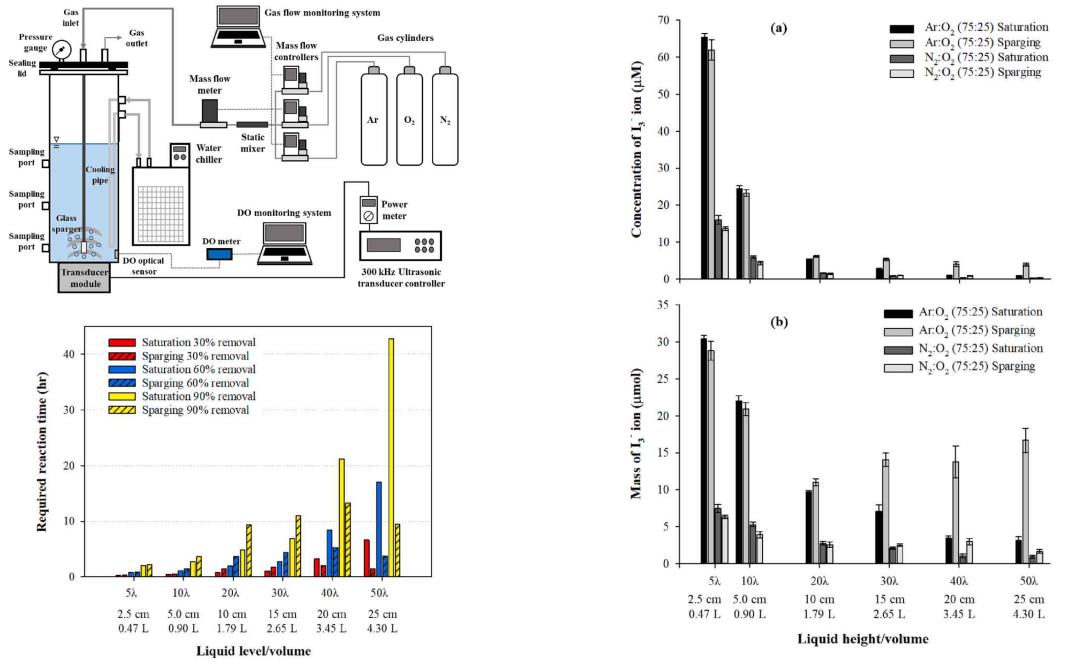
Effects of gas saturation and sparging on sonochemical oxidation activity under different liquid level and volume conditions in 300-kHz sonoreactors: Zeroth- and first-order reaction comparison using KI dosimetry and BPA degradation

Seongeun Lee, Younggyu Son*



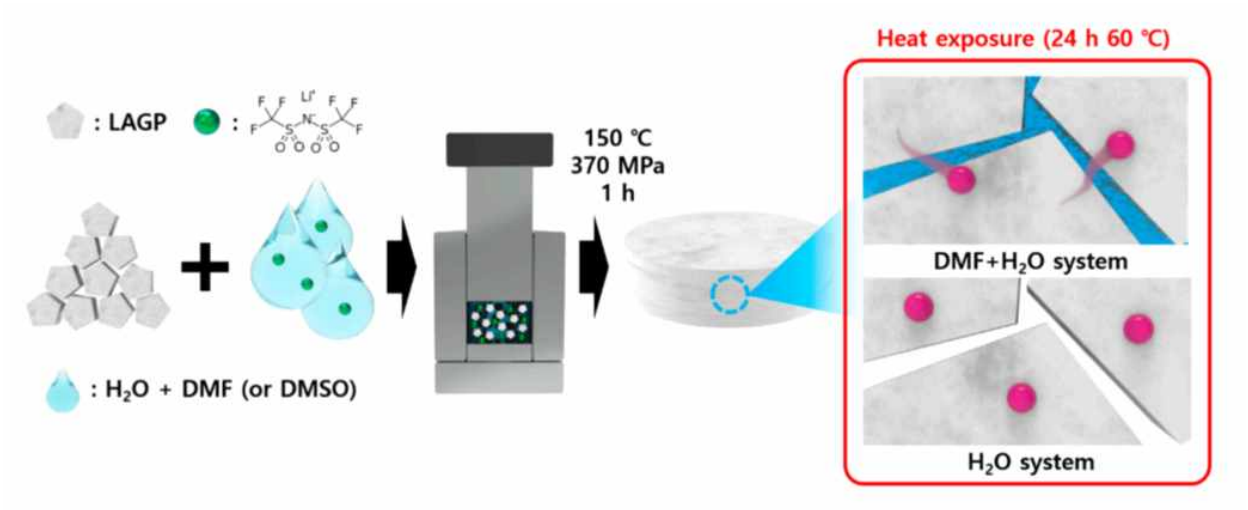
The sonochemical oxidation activity was investigated for gas saturation and gas sparging under various liquid levels and volumes in 300 kHz sonoreactors. The liquid levels and volumes ranged from 5λ (25 mm, 0.47 L) to 50λ (250 mm, 4.30 L) and two gas mixtures, Ar:O_2 (75:25) and N_2:O_2 (75:25), were used. Two types of reaction kinetics were observed to quantitatively analyze the sonochemical oxidation reactions: zero-order (KI dosimetry: C_0 = 60.2 mM) and first-order (Bisphenol A (BPA) degradation: C_0 = 0.043 mM). The masses of the sonochemical oxidation reactions were calculated and compared rather than the concentrations to more accurately compare the sonochemical oxidation activity under different liquid volume conditions. First, as the liquid level or volume increased for the zero-order reactions, the concentration of I_3^- ions representing the volume-averaged activity decreased substantially for gas saturation owing to the increase in liquid volume. However, gas sparging substantially enhanced sonochemical oxidation activity, and the mass of I_3^- ions representing the total activity remained constant as the liquid level increased from 20λ because of the improved liquid mixing and a shift in the sonochemical active zone. Second, as evidenced by the zero-order reactions, the concentration of BPA decreased considerably as the liquid level or volume increased in the first-order reactions. When gas sparging was used, higher reaction constants were obtained for both gas mixtures, ranging from 40λ to 50λ. However, a comparison of the sonochemical oxidation activity in terms of the degraded mass of BPA was inapplicable as the concentration of BPA decreased substantially and a lack of reactants occurred for the lower liquid level and volume conditions as the irradiation time elapsed. Instead, using the first-order reaction constant, a comparison of the required reaction times for a specific removal efficiency (30%, 60%, and 90%) was proposed. Gas sparging can substantially reduce the reaction time required for a liquid level of 40λ or higher.

에너지변환

Nanomaterials
Volume 13, August 2023, p2436 (Impact Factor : 5.3)

Thermally Stable Ceramic-Salt Electrolytes for Li Metal Batteries Produced from Cold Sintering Using DMF/Water Mixture Solvents

Sunwoo Kim, Yejin Gim, Wonho Lee*



The cold sintering process (CSP) for synthesizing oxide-based electrolytes, which uses water transient solvents and uniaxial pressure, is a promising alternative to the conventional high temperature sintering process due to its low temperature (<200 ˚C) and short processing time (<2 h). However, the formation of amorphous secondary phases in the intergranular regions, which results in poor ionic conductivity (σ), remains a challenge. In this study, we introduced high-boiling solvents of dimethylformamide (DMF, b.p.: 153 ˚C) and dimethyl sulfoxide (DMSO, b.p.: 189 ˚C) as transient solvents to develop composite electrolytes of Li1.5Al0.5Ge1.5(PO4)3 (LAGP) with bis(trifluoromethane)sulfonimide lithium salt (LiTFSI). Our results show that composite electrolytes processed with the DMF/water mixture (CSP LAGP-LiTFSI DMF/H2O) yield a high σ of 10−4 S cm−1 at room temperature and high relative densities of >87%. Furthermore, the composite electrolytes exhibit good thermal stability; the σ maintains its initial value after heat treatment. In contrast, the composite electrolytes processed with the DMSO/water mixture and water alone show thermal degradation. The CSP LAGP-LiTFSI DMF/H2O composite electrolytes exhibit long-term stability, showing no signs of short circuiting after 350 h at 0.1 mAh cm−2 in Li symmetric cells. Our work highlights the importance of selecting appropriate transient solvents for producing efficient and stable composite electrolytes using CSP.

에너지저장

Carbon Letters
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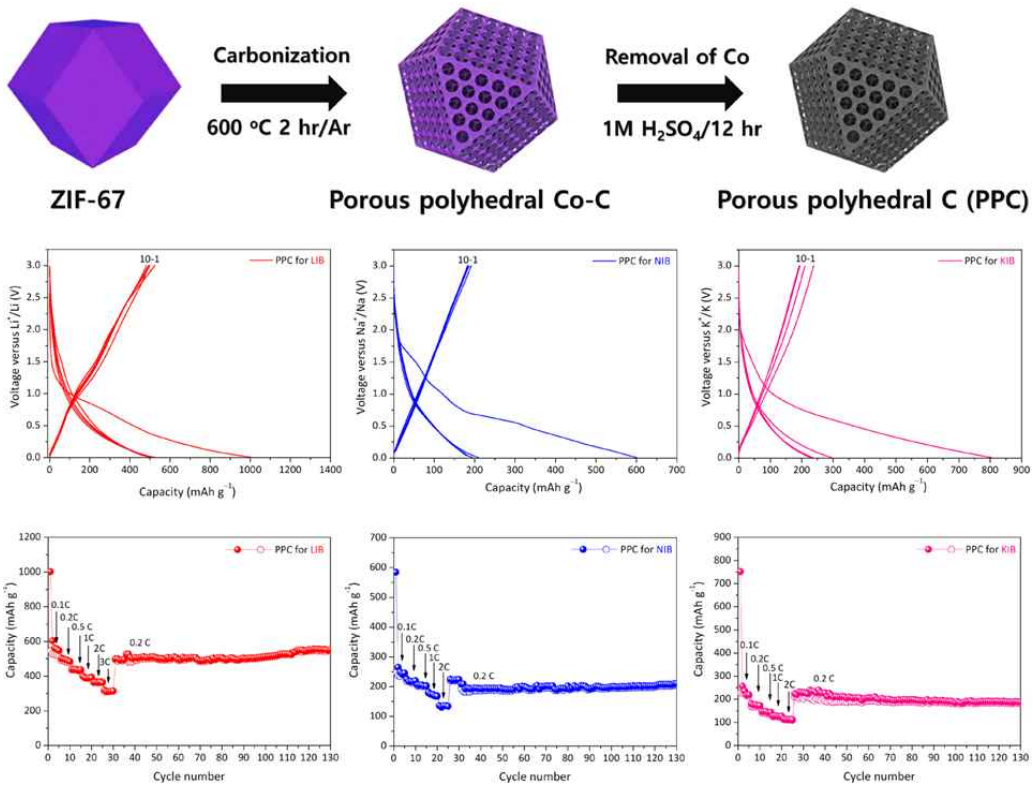
Porous polyhedral carbon matrix for high-performance Li/Na/K-ion battery anodes

Vinoth Ganesan, Young-Han Lee, Heechul Jung*, Cheol-Min Park*



A carbon matrix for high-capacity Li/Na/K-alloy-based anode materials is required because it can efectively accommodate the variation in the volume of Li/Na/K-alloy-based anode materials during cycling. Herein, a nanostructured porous polyhedral carbon (PPC) was synthesized via a simple two-step method consisting of carbonization and selective acid etching, and their electrochemical Li/Na/K-ion storage performance was investigated. The highly uniform PPC, with an average particle size of 800 nm, possesses a porous structure and large specifc surface area of 258.82 cm^2 g^{-1}. As anodes for Li/Na/K-ion batteries (LIBs/NIBs/KIBs), the PPC matrix exhibited large initial reversible capacity, fast rate capability (LIB:~320 mAh g^{-1} at 3C; NIB:~140 mAh g^{-1} at 2C; KIB:~110 mAh g^{-1} at 2C), better cyclic performance (LIB:~550 mAh g^{-1}; NIB:~210 mAh g^{-1}; KIB: ~ 190 mAh g^{-1} at 0.2C over 100 cycles), high ionic difusivity, and excellent structural robustness upon cycling, which demonstrates that the PPC matrix can be highly used as a carbon matrix for high-capacity alloy-based anode materials for LIBs/NIBs/KIBs.