SS12A : 극한물성 소재 초고부가 부품 KIURI 연구단

SS12A-1 | 나노갭 결함제어를 통한 ZnO 시트의 가스센서 특성 극대화

이승용[1], 김민영[1], 박철오[1], *이규형[1], 최명식[2]
[1]연세대학교, [2]경북대학교

Nanoscale defect structures on material surfaces introduce diverse chemical physics and have received sub stantial attention. However, nano structure distortions due to low stability and poor reproducibility have indi cated the limitation for further electro-device applications using defect control. In this study, the higher activated electron transfer from the nanogaps (NGs) enhances the sensitivity and accelerated depletion region purifying the porous- ZnO (P-ZnO) sheets for NO 2 gas-sensor applications. ~2.2 nm width of NGs on the (1010) orientated P-ZnO sheets and 12% higher surface oxygen vacancies (V O) are formed by using Li-ion implantation via the lithiation process. This intrinsic electron-doped ZnO by NGs shows a reduced work function (φ) and an elevated Fermi level (E F) compared to pristine ZnO. Therefore, the reaction between NO 2 gas and ZnO significantly ac celerates owing to the activated electron transfer that carries ultrafast recovery time (~16 s), and a low limit of detection (~4 ppb) at 150 ℃ are obtained for the NG-P-ZnO sheet-based gas sensor. The generation of NGs on the surface via Li-ion implantation with reliable stability provides a new strategy to improve the electrochemical reactivity of semiconducting metal oxides beyond that obtained using conventional material engineering ap proaches, such as size, shape, and dimension control.

SS12A-2 | Sustainable highly charged materials and the application to triboelectric sensors

*HAN Gihyeon[1]
[1]Yonsei University

Recently, a new energy generating device called triboelectric nanogenerator (TENG) has been reported and proved to be a simple and powerful technology for efficiently converting various mechanical energies around us. Since 2012, TENG has been reported to be used in various fields, showing excellent output performance by various structures and new materials. In particular, it is actively applied as a sensor due to its advantages such as high sensitivity, fast response, self-powered characteristics, low-cost manufacturing, and high applicability. Here, several applications of TENG as a sensor are reported. Light-stimulated triboelectric generation coupled with the plasmonic effect occurring between TiO_2 and Au during instantaneous friction is described. The output voltage of the triboelectric nanogenerator increases under UV illumination and decreases under visible light, eventually reaching zero at a light intensity of 480 mW/cm. Based on electron thermionic emission, two models are proposed to influence the charge transfer between TiO_2 and Au. They are transformation of TiO_2 by ultraviolet light and hot electron generation of Au by visible light. This will provide new avenues for photodetectors and energy harvesting devices in a variety of environments. In addition, a highly sensitive triboelectric bending sensor with non-contact mode operation that is less sensitive to strain is demonstrated by designing multiple triangular prisms on both sides of a polydimethylsiloxane (PDMS) film. The sensor can detect bending in strained conditions (up to 20%) as well as in the bending direction with very high linear sensitivity (~0.12/degree) up to 120° due to the electrostatic induction effect between Al and poly (glycerol sebacate) methacrylate. Increasing the bending angle further to 135° significantly increases the sensitivity to 0.16/degree due to contact electrification between the two. Sensors were attached to the proximal interphalangeal and upper and lower parts of the wrist to demonstrate a directional bending sensor with enhanced sensitivity. Lastly, sustainable charged polyurethane (TPU)-SiO_2 and PDMS-polytetrafluoroethylene (PTFE) composites with amphiphobic surfaces are reported regarding harsh environment tolerance and robust contactless mode triboelectric nanogenerators. The SiO_2 and PTFE particles are well-distributed in composites with ethanol and n-hexane as dispersing agents, respectively. The surface of the PDMS-PTFE composite is then etched and fluorinated, resulted in the amphiphobic surfaces. As a practical non-contact mode application, a speed sensor fabricated using two composites can stably detect a low vehicle speed less than 3.75 km/h when exposed to high humidity (~ 99 %) and various chemical oils. Over 50 % of initial output voltage are still generated after 2 weeks with no more decrease after 5 days, indicating high charge retention characteristic of the composites.

SS12A-3 | Solution-Processed High Transparency Ultrathin Films with Efficient Broadband Radiation and Diffuse Reflection

PARK JaeJung[1], *KIM Jung-Hyun[1]
[1]Yonsei University

Increasing global temperatures and the subsequent increase in energy consumption for temperature regulation hinder the search for efficient and cost-effective methods to reduce internal temperatures. Herein, we report a novel approach to passively reduce internal temperatures while maintaining transparency using a water-dispersed organic-inorganic hybrid film based on transparent and infrared emitting polymers (S-TIEP). The S-TIEP film was fabricated using a one-pot process, wherein self-assembly via phase separation gave rise to a transparent diffuse reflection layer and an absorption layer. With a transmittance of 80% and a weighted average heat shielding efficiency of 81%, the S-TIEP film demonstrates internal temperature reduction under solar irradiance conditions. The solution-based film fabrication method is scalable and eliminates the need for toxic solvents. Furthermore, external temperature experiments in a greenhouse dome demonstrated the effectiveness of the S-TIEP film compared to conventional materials, such as bare polyethylene terephthalate and cesium tungsten oxide. Our findings highlight the potential of solution-processed, high transparency ultrathin films as a promising energy-saving solution, with implications for various industries requiring temperature regulation and transparency.

SS12A-4 | Control of Fuel Cell Electrode Catalyst Layer Using Magnetic Fields

*JI Yunseong[1], KIM Sungmin[2], WOO Seonghyeon[2], *YIM Sung-Dae[2]
[1]Yonsei university, [2]Korea Institute of Energy Research

Polymer electrolyte membrane fuel cells (PEMFCs) are environmentally friendly and highly efficient energy conversion technologies that utilize oxygen and hydrogen gas to produce electricity. They are commonly used in power generation systems for automobiles, homes, and buildings. The electrode in PEMFCs performs electrochemical reactions that convert the chemical energy of reactants into electrical energy. Electrodes are typically manufactured by dispersing a mixture of platinum, carbon, and ionomer in a liquid. Due to the different properties of each material, the behavior of particles in the solution varies based on factors such as dispersion methods and characteristics of the dispersing medium, which in turn affects the final form of the electrode. The characteristics of the electrode layer influence the transport of reactants, which in turn affects the power output of the fuel cell. Therefore, research is being conducted to improve the power output characteristics of fuel cells through control of the arrangement to structure of electrode materials. In this study, we utilized a magnetic field to adjust the characteristics of the electrode and investigated their effects. We manufactured a catalyst dispersion solution for fuel cells using a solvent mixture of water and normal propyl alcohol, along with a perfluorosulfonic acid ionomer. Under conditions for magnetic control, we arranged particles to be aligned with magnetic force lines to manufacture electrodes and examined the resulting electrode shapes and improved high-power characteristics.

SS12A-5 | 자가 치유 및 투명 열전 복합필름

*김병관[1]
[1]충남대학교

A self-healable and transparent thermoelectric composite film consisted of bisulfate was demonstrated to exhibit a high negative ionic Seebeck coefficient and ionic power factor at 80% relative humidity and room temperature. Electronic channel inside of hydrogel was composed of ionic poly(2-acrylamido-2-methyl-1-propanesulfonic acid) doped poly (3,4-ethylenedioxythiophene) and bisulfate transport was induced ionic channel formation based on thermally diffusive anion carrier in the hydrogel, to realize a soft conductor. An anion detective coumarin-based chromophore was applied to visualize bisulfate transport obeyed by the Soret effect. A flexible band-type thermoelectric harvester module with 20 legs was fabricated to afford a thermovoltage of −2.75 V at a temperature gradient of 5.5 K, and the harvested energy was used to operate a light-emitting diode for the first time in an organic thermoelectric module with a small temperature gradient (〈10 K). Moreover, color tuning of band-type thermoelectric module was demonstrated to show multifunctional application of the transparent hydrogel.