SW12 : 유연 소재 연구회

SW12-1 | 고분자 전해질 연료전지 적용을 위한 수소 이온 교환막 개발

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Proton exchange membrane fuel cell (PEMFC) have been considered as one of the promising environmental-friendly technologies for sustainable energy conversion and power generation in automotive and stationary applications. Perfluorosulfonic acid (PFSA) ionomers such as Nafion and Aquivion have been most widely used as electrolytes due to their high proton conductivity and mechanical stability. However, they have significant shortcomings such as high cost, limited operating temperature and high fuel crossover.
We will present two ways to overcome these limitations of PFSA ionomers. First, the molecular modification of Nafion with controlled nanostructure has been achieved for realizing the enhancement of proton conduction and consequent increase of power generation of PEMFCs. Moreover, as alternative polymer electrolyte membranes, hydrocarbon-based polymers such as sulfonated poly(ether ether ketone) have been adopted for the reliable operation of PEMFCs. Polymer synthesis, molecular structure control and composite membranes with inorganic nanoparticles have been studied as a candidate for the next-generation membranes for fuel cells. We believe that these achievements can also be applied to other energy applications such as redox-flow batteries and polymer electrolyte batteries.

SW12-2 | 연료전지용 양성자 교환막 정렬 및 쌍극자 극성 양성자 수송 채널을 갖춘 일축 연신 Nafion/Poly(vinylidenefluoride) 혼합막

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Nafion and poly(vinylidene fluoride) (PVDF) blend membranes are introduced for realizing the controlled nanostructure of the membrane for high proton conduction. In particular, PVDF can align dipole polarization between fluorine and hydrogen atoms by mechanical stretching, forming beta-phase crystalline structure with all trans chain conformation. Moreover, the hydrophilic sulfonic acid groups of Nafion are successfully aligned in the in-plane direction by stretching conditions. Both of the aligned nanostructure of Nafion and dipole polarized molecular arrangement of the Nafion/PVDF blend membranes enhance the proton conduction through the membrane for operating proton exchange membrane fuel cells(PEMFCs). The controlled molecular structures and the membrane properties have been carefully investigated by atomic force microscopy and small angle X-ray scattering. Furthermore, the increased proton conductivity of the blend membranes gives rise to increasing the proton conduction at the interface between the membrane and cathode catalyst layer of the membrane electrode assembly with enhanced the electrochemical surface area for high power generation of PEMFCs.

SW12-3 | Biodegradable, Electro-Active Chitin Nanofiber Films for Flexible Piezoelectric Transducers

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Since the conventional fluorine-based electro-active polymers release toxic residues into the environment during their syntheses and decomposition processes, eco-friendly piezoelectric polymers are urgently demanded in the field of energy-related soft materials. Here, we introduce a regenerated fibers of chitin (Chiber), the 2nd most abundant biopolymer only after cellulose, and propose its utility as a nonwoven fiber separator for lithium metal batteries (LMBs) that exhibits an excellent electrolyte-uptaking capability and Li-dendrite-mitigating performance. Furthermore, we derive a high-performance biodegradable chitin polymer from squid pen material and demonstrate its utility as a flexible piezoelectric material. The readily controlled ferroelectric chitin film confers excellent piezoelectricity under external mechanical pressure, resulting in comparable performance with that of conventional fluorine-based piezoelectric polymers. Finally, the biodegradable chitin polymer can be successfully dissolved by chitinase enzyme within eight days without any toxic residues remained.

SW12-4 | Application of conductive polymer as silicon binders

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Silicon is attracting a lot of attention as the promising alternative to traditional graphite anode materials of the Lithium-ion battery because of high theoretical capacity(3579mAh / g). However, a significant volume change during cycling and low conductivity due to the semiconductor properties of silicon problems are preventing commercialization. Conductive polymer binders can do dual roles as both a binder and a conducting agent. This dual functionality not only increases the proportion of active materials in the electrode but also elevates the volumetric energy density of current Li-ion batteries. Also, it can promote homogeneous electron transfer within the whole electrode. In this study, we explore the potential of PEDOT:PSS and its treatment effect in silicon anode. To investigate this, electrochemical performance, GIWAS analysis for mechanism of conductivity enhancement was measured. Also, the actual cycling was observed by in-situ OM

SW12-5 | 생분해성 의료 장치를 위한 유연 소재

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Modern integrated circuit technology has an impressive ability to maintain stable operation with exceptional reliability, often without undergoing any physical or chemical changes. However, a new class of electronic materials offers the opposite outcome - transient devices that can dissolve, disintegrate, or disappear at specified times or rates. Water-soluble transient electronics present intriguing possibilities for bioresorbable medical implants, which can be tailored to dissolve based on an individual's body chemistry. In my talk, I will introduce fundamental concepts in chemistry, materials science, and assembly processes related to the development of bioresorbable medical devices. As an illustrative example, I will discuss soft bioresorbable materials for wireless electronic stimulators designed to treat temporary bradycardia.