## SW10 : 재생전기화학적 에너지 변환 기술 연구회

### SW10-1 | 산화물 소재 기반 광전기화학 태양광 에너지 변환

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Solar-driven photo-to-chemical conversion presents a compelling avenue for sustainable energy harvesting and storage. Drawing inspiration from natural photosynthesis, researchers have ventured into utilizing photosensitive semiconductors to convert solar energy into chemical energy. The utilization of photoelectrochemical (PEC) cells for water splitting to produce hydrogen and other chemical reactions to produce value added chemicals stands as a robust approach in this endeavor. This invited talk delves into recent advances concerning metal oxide-based semiconductors in the context of photo-to-chemical energy conversion. Approaches involving novel surface modifications and energy state manipulations will be discussed, targeting the mitigation of recombination, enhancement of charge-carrier migration, and bolstering stability. Encompassing methodologies like morphology/nanostructure control, defect engineering, extrinsic doping, and interfacial engineering, these strategies hold the promise of elevating the efficacy of photo-to-chemical energy conversion. This presentation seeks to illuminate the progress in this dynamic field, shedding light on pathways toward efficient energy conversion with high sustainability.

### SW10-2 | 선택적 에틸렌/에탄올 생산을 위한 전기화학 이산화탄소 환원 촉매 개발

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Electrochemical $CO_2$ reduction reaction ($CO_2RR$) for value-added fuels/chemical feedstocks production, offers an avenue toward carbon neutrality. Steering $CO_2RR$ pathways by electrocatalysts are being studied; but it remains a challenge to optimize the selectivity and productivity of multi-carbon ($C_{2+}$) chemicals such as ethylene ($C_2H_4$) and ethanol ($C_2H_5OH$). Here, I will present our recent efforts to address these challenges by material design for $CO_2RR$ heterogeneous electrocatalysts. We discovered thermodynamic-based material design principle for selective redox reactions during catalyst fabrication. This enabled the interface design of Cu alloy catalysts over miscibility limit to control the selectivity between ethylene and ethanol in $CO_2RR$. Furthermore, we showcase molecularly enhanced heterogeneous electrocatalysts to enhance the production rate of ethylene by facilitating $CO_2$-to-*CO formation. In the concluding remarks, the future perspective in this field will be discussed.

### SW10-3 | 에탄올 완전 전기산화를 위한 중공 구조의 Pt-Rh 전기 촉매 내 나노 구속 및 물질 전달

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A major challenge of ethanol utilization in fuel cells relates to full oxidation of ethanol to $CO_2$ due to unique thermodynamic and kinetic challenges of ethanol's C-C bond cleavage step. Consequently, the Faradaic efficiency of full oxidation of ethanol to $CO_2$ is often limited to $^-$ near the electrocatalyst surface.

### SW10-4 | 고효율 클로르 알칼리 전기분해를 위한 코어-쉘 구조 혼합산화물 촉매 기반 액체 확산 전극

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Chlor-alkali electrolysis is a key industrial process for the production of chlorine gas, caustic soda, and hydrogen fuels. Here, we demonstrate that a Ti foam electrode, which has a diffusion layer of liquid reactant, deposited with a thin layer of core/shell-structured mixed metal oxide nanoparticles enables almost zero polarization in the range of hundreds of $mA/cm^2$ towards the chlorine evolution reaction (CER), using noble-metals 20 times lower than commercial electrode. The fast charge-transfer kinetics induce near-zero overpotential at low current densities, while the high mass transport rates aided by porous channels lead to unprecedentedly high CER performance. Under practical chlor-alkali process conditions, the mixed metal oxide electrode exhibited remarkable performance as a bifunctional electrode for CER and hydrogen evolution reaction (HER) with overpotential of 11 mV for HER.

### SW10-5 | 그린암모니아 합성을 위한 선택적 리튬 매개 질소 고정

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Ammonia is a promising sustainable energy carrier of renewable electricity, due to the ease of liquefication under moderate conditions and the high energy density of its liquid form. Ammonia is traditionally produced via the thermochemical Haber-Bosch process, which is an energy- and capital-intensive process because it requires high temperatures and pressures to achieve

industrial ammonia synthesis rates. In addition, the hydrogen used in this process is produced by steam reforming of natural gas, which releases substantial $CO_2$ emissions. Thus, replacing the thermochemical process with a sustainable electrochemical process is challenging in ammonia synthesis. In this regard, electrochemical nitrogen reduction via lithium-mediated process is considered the most promising technology for producing clean ammonia due to its high ammonia Faradaic efficiency, production rate, and reliability. In this presentation, I will present the lithium-mediated electrochemical nitrogen reduction process, including development of electrodes and electrochemical system for highly selective lithium fixation for green ammonia synthesis.