TE-002 <Invited Talk>

Photoelectrochemical Water Oxidation and CO_2 Conversion for Artificial Photosynthesis

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As the costs of carbon-footprinetd fuels grow continuously and simultaneously atmospheric carbon dioxide concentration increases, solar fuels are receiving growing attention as alternative clean energy carriers. These fuels include molecular hydrogen and hydrogen peroxide produced from water, and hydrocarbons converted from carbon dioxide. For high efficiency solar fuel production, not only light absorbers (oxide semiconductors, Si, inorganic complexes, etc) should absorb most sunlight, but also charge separation and interfacial charge transfers need to occur efficiently. With this in mind, this talk will introduce the fundamentals of solar fuel production and artificial photosynthesis, and then discuss in detail on photoelectrochemical (PEC) water splitting and CO2 conversion. This talk largely divides into two section: PEC water oxidation and PEC CO2 reduction. The former is very important for proton-coupled electron transfer to CO2. For this oxidation, a variety of oxide semiconductors have been tested including TiO2, ZnO, WO3, BiVO4, and Fe2O3. Although they are essentially capable of oxidizing water into molecular oxygen, the efficiency is very low primarily because of high overpotentials and slow kinetics. This challenge has been overcome by coupling with oxygen evolving catalysts (OECs) and/or doping donor elements. In the latter, surface-modified p-Si electrodes are fabricated to absorb visible light and catalyze the CO2 reduction. For modification, metal nanoparticles are electrodeposited on the p-Si and their PEC performance is compared.

Keywords: Semiconductor, photocatalytic, water splitting, proton-coupled electron transfer