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SEMINAR ANNOUNCEMENT

Fundamental Understanding of Photocatalysis Roles of Cocatalysts and Junctions

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Abstract

Since the 1970s, splitting water using solar energy has been a focus of great attention as a possible means for converting solar energy to chemical energy in the form of clean and renewable hydrogen fuel. Approaches to solar water splitting include photocatalytic water splitting with homogeneous or heterogeneous photocatalysts, photoelectrochemical or photoelectrocatalytic (PEC) water splitting with a PEC cell, and electrolysis of water with photovoltaic cells coupled to electrocatalysts. Though many materials are capable of photocatalytically producing hydrogen and/or oxygen, the overall energy conversion efficiency is still low and far from practical application. This is mainly due to the fact that the three crucial steps for the water splitting reaction: solar light harvesting, charge separation and transportation, and the catalytic reduction and oxidation reactions, are not efficient enough or simultaneously. Water splitting is a thermodynamically uphill reaction, requiring transfer of multiple electrons, making it one of the most challenging reactions in chemistry.

This lecture will describe the important roles of cocatalysts in photocatalytic and PEC water splitting reactions. For semiconductor-based photocatalytic and PEC systems, we show that loading proper cocatalysts, especially dual cocatalysts for reduction and oxidation, on semiconductors (as light harvesters) can significantly enhance the activities of photocatalytic and PEC water splitting reactions. Loading oxidation and/or reduction cocatalysts on semiconductors can facilitate oxidation and reduction reactions by providing the active sites/reaction sites while suppressing the charge recombination and reverse reactions. In a PEC water splitting system, the water oxidation and reduction reactions occur at opposite electrodes, so cocatalysts loaded on the electrode materials mainly act as active sites/reaction sites spatially separated as natural photosynthesis does. In both cases, the nature of the loaded cocatalysts and their interaction with the semiconductor through the interface/junction are important. The cocatalyst can provide trapping sites for the photogenerated charges and promote the charge separation, thus enhancing the quantum efficiency; the cocatalysts could improve the photostability of the catalysts by timely consuming of the photogenerated charges, particularly the holes; most importantly, the cocatalysts catalyze the reactions by lowering the activation energy.

Refreshments will be served before the seminar

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