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Challenges in developing sustainable resources: Electrochemical catalysis

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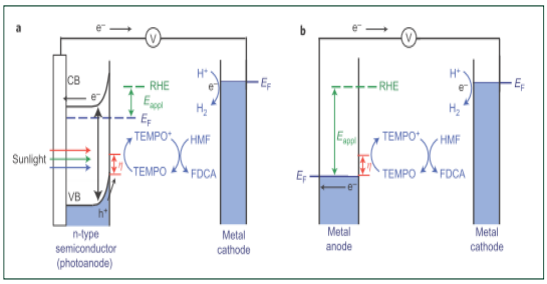

For decades, scientists have been working to harness the energy from sunlight to drive chemical reactions to form fuels such as hydrogen, which provide a way to store solar energy for future use. Toward this end, many researchers have been working to develop functional, efficient and economical methods to split water into hydrogen, a clean fuel and oxygen using Photo Electro-Chemical solar cells (PEC). Although splitting water using an electrochemical cell requires an electrical energy input, a PEC can harness solar energy to drive the water-splitting reaction. In a typical hydrogen-producing PEC, water reduction at the cathode (producing hydrogen) is accompanied by water oxidation at the anode (producing oxygen). Unfortunately, the rate of the water oxidation reaction is very slow, which limits the rate of the overall reaction and the efficiency of the solar-to-hydrogen conversion. We developed a novel PEC setup with a new anode reaction. This anode reaction requires less energy and is faster than water oxidation while producing an industrially important chemical product. The anode reaction they employed in their study is the oxidation of 5-Hydroxymethylfurfural (HMF) to 2,5-Furandicarboxylic Acid (FDCA). FDCA is an important molecule for the production of biomass-based polymers. Biomass conversion can offer a viable pathway to generate chemicals used in industrial processes without using petroleum products. We developed an efficient electrochemical method to oxidize HMF to FDCA at room temperature and ambient pressure using water as the oxygen source. By doing so, we demonstrated the utility of solar energy for biomass conversion as well as the feasibility of using an oxidative biomass conversion reaction as an anode reaction in a hydrogen-forming PEC.

Recent Publications

1. Kang D, Kim T W, Kubota S R, Cardiel A C, Cha H G, Choi K (2015) Electrochemical synthesis of photo electrodes and catalysts for use in solar water splitting. *Chemical Reviews*; 115: 12839-12887.

2. Cha H G, Choi K (2015) Combined biomass valorization and hydrogen production in a photo electro-chemical cell. *Nature Chemistry*; 7: 328-333.

Biography

Hyun Gil Cha has his expertise in electrochemical or photo electro-chemical reaction of biomass for producing valuable chemical. He has completed his PhD degree in the Department of Chemistry at Sogang University, South Korea in 2011. He has then worked as a Postdoctoral Researcher at the University of Wisconsin-Madison, USA, during 2013-2015. He is currently a Senior Researcher in Korea Research Institute of Chemical Technology (KRICT). His research interests include the development of environmentally friendly metal oxide-based nanocomposites for use in biomass conversion, photocatalysts, heavy metal adsorbents in water and lithium battery.

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