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Polymer chromophore-catalyst assembly for solar fuel generation

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Statement of the Problem: The polymer industry and its products are Dye-sensitized photoelectrochemical cells (DSPECs) convert energy from the sun directly into fuel. The DSPEC approach is a hybrid based on molecular light absorption and excited state electron or hole injection into the conduction or valence bands of high band gap semiconductors. Toward fabricating DSPEC devices, we have reported polymer-based ruthenium(II) polypyridyl chromophore-catalyst assemblies on TiO2 by using a Layer-by-Layer (LbL) self-assembly process for light driven water oxidation. The photophysical and electrochemical properties of the polychromophore-catalyst assembly were characterized in a solution and at the semiconductor interface and the energy/electron transfer processes were investigated in the polymer assembly. Importantly, photocurrent measurements of the polyelectrolyte LbL films formed on mesoporous semiconductor substrates demonstrate a clear anodic photocurrent response, coupled with the observation of O2. Also, we developed LbL polyelectrolyte assemblies consisting of an anionic π-conjugated poly(isoindigo-co-thiophene) (Pilt) and polyacrylic acid stabilized Pt nanoparticles (PAA-Pt) as proton reduction catalyst, co-deposited with poly(diallyldimethylammonium chloride) (PDDA) as an inert polycation. LbL self-assembly occurs by the alternate exposure of a metal oxide substrate to solutions of oppositely charged polyelectrolytes. UV-visible absorption spectroscopy reveal that multilayer deposition progressively increases the film thickness on ITO substrates. A photocurrent measurement of ITO//(PDDA/Pilt)10(PDDA/PAA-Pt)10 under AM 1.5 illumination and applied bias - 0.4 V shows a photocurrent response. This result provides new guidance for the LbL self-assembly of polychromophores/catalysts for light driven solar-fuels photoelectrochemical systems.

Biography

Gyu Leem earned his B.S. in chemical engineering from the Hanyang University and PhD in Chemistry from the University of Houston in 2008. After completing his PhD. he spent three years working as a principal scientist at LG R&D in South Korea. He was responsible for the design and synthesis of high-performance water absorbing polymer materials for baby diapers. In 2012, he moved to the University of Florida and performed postdoctoral research with Professor Kirk S. Schanze as a part of University of North Carolina Energy Frontier Research Center: Center for Solar Fuels, an Energy Frontier Research Center. He is currently appointed assistant professor of research at the chemistry department at the University of Texas at San Antonio in 2017. His research is focusing on water oxidation, carbon dioxide reduction and DSPEC water splitting and proton reduction.

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