RTI Prominent Publication Summary

Photoassisted Overall Water Splitting in a Visible Light-Absorbing Dye-Sensitized Photoelectrochemical Cell

Youngblood, W.J., Lee, S.-H., Kobayashi, Y., Hernandez-Pagan, E.A., **Hoertz, P.G.**, Moore, T.A., Moore, A.L., Gust, D., and Mallouk, T.E. (2009). Photoassisted overall water splitting in a visible light-absorbing dye-sensitized photoelectrochemical cell. *Journal of the American Chemical Society* 131 (3):926–927.


Paul Hoertz

This paper describes the first demonstration of overall photochemical water splitting/solar fuel production using a low-cost dye-sensitized photoelectrochemical cell (DS-PEC) based on titanium dioxide (TiO_2) nanocrystalline films. Low-cost solar hydrogen production provides an attractive renewable approach to the synthesis of storable liquid fuels for transportation.

In this study, monodisperse, ~2 nm iridium oxide (IrO_2) nanoparticle water oxidation catalysts sensitized with bifunctional ruthenium (II) polypyridyl visible light chromophores were incorporated into mesoporous TiO_2 nanocrystalline films to prepare the photoanode. The ruthenium (II) chromophores serve as light absorber, catalyst particle stabilizer, and molecular bridge between the semiconductor and catalyst nanoparticles, ultimately creating a surface-bound molecular triad assembly that allows for photoinduced vectorial electron transfer. Under simulated sunlight conditions and a slight applied bias, steady state anodic currents were observed, consistent with electron flow from the photoanode to cathode. Evolution of oxygen at the photoanode and hydrogen at the platinum counterelectrode was verified by gas chromatography. The efficiency of the DS-PEC device using single wavelength irradiation was determined to be ~0.9%.

This work has provided the basis for DS-PEC water-splitting/solar fuels research using similar approaches in laboratories around the globe. The key advancements associated with this work include the following:

1) First demonstration of rationally designed nanoparticle-based chromophore-catalyst assemblies and incorporation into a functional water splitting device,

2) First demonstration of controlling the size of water oxidation catalysts down to 2 nm using either organic capping ligands or sensitizer-based stabilizers, and

3) First demonstration of photochemical hydrogen and oxygen evolution from a dye-sensitized photoelectrochemical cell using visible light.

Link:
http://pubs.acs.org/doi/abs/10.1021/ja809108y?prevSearch=Paul%2BHoertz%2BMallouk&searchHistoryKey