

Seminar

9:45 a.m. Tuesday, January 15, 2013 • 331 Smith Hall



Postdoctoral Scholar

Shane Ardo, Ph.D.

Department of Chemistry, California Institute of Technology

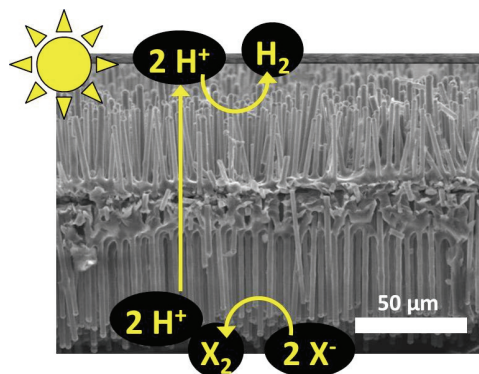
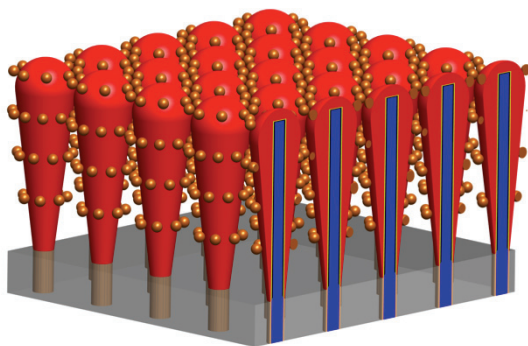
Demonstration of Artificial Photosynthesis with Peeled Silicon Microwire Arrays

Abstract

Sunlight can be harvested and converted into useful energy using semiconductor–liquid junction solar cells, which generate power through the transfer of electrons to molecules dissolved in solution. If two such interfacial electron-transfer events are efficiently coupled, stable chemical bonds can be formed, an important step to powering our planet with fuels derived from renewable energy. My talk will focus on three aspects of these systems.

First, engineering aspects will be discussed with a primary focus on transport phenomena (drift, diffusion, and convection), of electrons in conductive substrates, ions in solution, and ions and reaction products within separators. From the analyses, design criteria and guidelines will be established that account for the various performance tradeoffs in artificial-photosynthetic solar-fuel generators.

Second, a new silicon microwire-based tandem device architecture will be shown that generates enough photovoltage to drive solar water splitting. It consists of a periodic array of crystalline Si microwires each coated with WO_3 to form an array of monolithic tandem absorbers. Solar illumination generates > 2 V of potential toward water splitting (left figure).



Third, three free-standing Nafion-embedded silicon-microwire-array devices will be presented, which photogenerate H_2 and I_3^- from aqueous HI solutions via sunlight-driven artificial photosynthesis (right figure). Pt electrocatalysts are deposited on the Si microwires to catalyze light-driven hydrogen evolution and iodide oxidation. Open-circuit photovoltages measured for each type of wire array are $\sim 80 - 90\%$ of those obtainable from planar Si devices. Corrosion of Si is attenuated through methylation of Si atop sites via a two-step chlorination–alkylation surface chemistry procedure. These systems are sustainable because the HI fuel precursor is inorganic, thus not capable of liberating CO_2 , and HI can be regenerated in a flow battery/fuel cell as $\text{H}_2 + \text{I}_2$.

Host: Aaron Massari

Refreshments will be served prior to the seminar.