# CHEMICAL ENGINEERING

SEMINAR SERIES


## NATHAN LEWIS

**Monday, February 1, 2016**

George L. Argyros Professor of Chemistry
Division of Chemistry and Chemical Engineering
California Institute of Technology


# Sunlight-Driven Hydrogen Formation by Membrane-Supported Photoelectrochemical Water Splitting


**ABSTRACT:**. We are developing an artificial photosynthetic system that will utilize sunlight and water as the inputs and produce hydrogen and oxygen as the outputs. We are taking a modular, parallel development approach in which three distinct primary components-the photoanode, the photocathode, and the product-separating but ion-conducting membrane-are fabricated and optimized separately before assembly into a complete water-splitting system. The design principles incorporate two separate, photosensitive semiconductor/liquid junctions that will collectively generate the 1.7-1.9 V at open circuit necessary to support both the oxidation of $H_2O$ (or $OH^-$) and the reduction of $H^+$ (or $H_2O$). The photoanode and photocathode will consist of rod-like semiconductor components, with attached heterogeneous multi-electron transfer catalysts, which are needed to drive the oxidation or reduction reactions at low overpotentials. The high aspect-ratio semiconductor rod electrode architecture allows for the use of low cost, earth abundant materials without sacrificing energy conversion efficiency due to the orthogonalization of light absorption and charge-carrier collection. Additionally, the high surface-area design of the rod-based semiconductor array electrode inherently lowers the flux of charge carriers over the rod array surface relative to the projected geometric surface of the photoelectrode, thus lowering the photocurrent density at the solid/liquid junction and thereby relaxing the demands on the activity (and cost) of any electrocatalysts.


**RECEPTION 3:30 • LECTURE 4:00 – 5:00**
**PHYSICS ASTRONOMY BLDG. (PAA) A110**

CHEMICAL ENGINEERING
UNIVERSITY *of* WASHINGTON
*Knowledge and solutions for a changing world*

**ABSTRACT, CONTINUED:** A flexible composite polymer film will allow for electron and ion conduction between the photoanode and photocathode while simultaneously preventing mixing of the gaseous products. Separate polymeric materials will be used to make electrical contact between the anode and cathode, and also to provide structural support. Interspersed patches of an ion conducting polymer will maintain charge balance between the two half-cells.

**BIO:** Dr. Nathan S. Lewis is the George L. Argyros Professor of Chemistry at the California Institute of Technology. Professor Lewis is Principal Investigator of the Beckman Institute Molecular Materials Resource Center. His research interests include artificial photosynthesis and electronic noses. Nate continues to study ways to harness sunlight and generate chemical fuel by splitting water to generate hydrogen. He is developing the electronic nose, which consists of chemically sensitive conducting polymer film capable of detecting and quantifying a broad variety of analytes. Technical details focus on light-induced electron transfer reactions, both at surfaces and in transition metal complexes, surface chemistry and photochemistry of semiconductor/liquid interfaces, novel uses of conducting organic polymers and polymer/conductor composites, and development of sensor arrays that use pattern recognition algorithms to identify odorants, mimicking the mammalian olfaction process.
Excellence in Graduate Polymer Research Award.