

Engaging Chemistry: Distinguished Lecture Series in Chemistry



## Visiting Speaker: Dr. Harry Gray

Arnold O. Beckman Professor of  
Chemistry and the Founding  
Director of the Beckman Institute

at the California Institute of  
Technology

### **“POWERING THE PLANET WITH SOLAR FUEL”**

Date: Wednesday, October 23, 2013

Time: 4:00-5:30 pm

Place: CCIS, Room L1-140,

University of Alberta, North Campus

<http://goo.gl/maps/4Nsn8>

Abstract: see reverse

#### **Also Presenting:**

### **“THE 21<sup>ST</sup> CENTURY SOLAR ARMY”**

Date: Tuesday, October 22, 2013, 7:30-9:30 pm

Place: Edmonton City Hall

<http://goo.gl/maps/GPh5l>

Sponsored by the 75<sup>th</sup> and 91<sup>st</sup> CSC Conference Funds, Faculty of Science  
at the University of Alberta, and Habitat Studios

## **“POWERING THE PLANET WITH SOLAR FUEL”**

**Abstract:** Molecular hydrogen has emerged as an attractive candidate for a clean, renewable fuel to meet the world's skyrocketing demand for energy. Hydrogenase enzymes that contain iron and nickel cofactors evolve H<sub>2</sub> catalytically from water with turnover frequencies as high as 9000 s<sup>-1</sup> at 30 °C. However, the relative instability of these enzymes under aerobic conditions has led to the search for robust inorganic catalysts that can produce hydrogen from water. Platinum is an excellent catalyst for proton reduction and hydrogen oxidation, but scarcity and high cost limit its widespread use. Our emphasis is on heterogeneous and homogeneous catalysts made from earth-abundant elements that could be part of scalable solar fuel devices. Promising heterogeneous catalysts include MoS<sub>2</sub> and Ni–Mo, which reduce protons in aqueous solutions with catalytic efficiencies near that of platinum. While homogeneous catalysts typically degrade faster than their heterogeneous counterparts, molecular systems are much easier to study mechanistically. Cobalt complexes enable electrocatalytic production of H<sub>2</sub> from solutions with high turnover frequencies, and kinetics investigations have established that the reactive intermediate is a Co(II)-hydride. The challenge of water oxidation in many ways eclipses that of proton reduction. The oxidation reaction involves the rearrangement of more protons and electrons, and fewer good catalysts for the reaction exist that are made of earth-abundant materials. We have found that 3 to 5 nm metal-oxide particles made by pulsed laser ablation of precursors in water are very active water oxidation catalysts. We hope to elucidate the electronic structures of these very small nanoparticles as part of a program with the goal of understanding their mechanisms.