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Introduction

This fourth symposium on Solar Hydrogen and Nanotechnology was again devoted to the conversion of abundant solar energy into hydrogen fuel, i.e. chemical energy.

This year's focus was on photoelectrolytic approaches, either as photo-electrochemical cells or as self supported catalysts. Here, the key issue is to develop materials that are able to absorb a significant portion of the solar spectrum while producing a strong enough bias for either water oxidation reduction or both reactions.

Several approaches to fabricate such materials including chemical vapor deposition, sol-gel processes, electrochemistry, vapor-liquid-solid growth, pyrolysis, photolithography, and conventional high temperature solid state synthesis were presented. Promising compounds include hematite, cuprous oxide, gallium nitride, zinc oxide, titania and titanates, tungsten oxide and nitride, silicon and silicon carbide, niobium oxide, and cadmium, indium, and copper chalcogenides. To enhance visible light absorption, heteroatom doping, and sensitization with ruthenium dyes and cadmium sulfide quantum dots were explored. New molecular approaches to generating water splitting catalysts including manganese oxide dusters and platinum completes as cocatalysts were also demonstrated.

Besides material composition, the particle morphology strongly affects the properties and functions of the catalyst, and hence needs to be controlled. Rod-like, sheet-like, and more complex structures with feature sires on the nano and microscale were demonstrated to have activity as photocatalysts. Several presentations described how rod-like nanostructures could be integrated into multi-component nanostructures for water splitting.

The characterization of solar war splitting catalysts was another focus area at the symposium. Besides general techniques, photoelectron spectroscopy, photo electrochemistry, electrochemical impedance spectroscopy, and time resolved optical spectroscopy were found especially useful for elucidating the compositions, properties, and function of water splitting catalysts and devices.

Overall, the development of methods for efficient solar energy to fuel conversion remains one of the great challenges in science. Prof. Kazunari Domen estimates that with photoelectrochemical cells, 5-10% conversion efficiency may be reachable within the next 5 years, whereas for self-supported photocatalysts 5% over 10 years maybe more realistic.

On the other hand, research on photochemical water splitting goes beyond direct applications, and will continue to have a positive impact on solar energy conversion in general, materials synthesis, characterization, and the development of new analytical techniques for years to come.

I'd like to thank Prof. T. Nejat Veziroglu from the International Journal for Hydrogen Energy and the Donors of The American Chemical Society Petroleum Research Fund, for partial support of this symposium.

Frank E. Osterloh