MSE-Colloquium@NTU

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Materials for Solar Fuel Production

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About the Talk

A practical method to use sunlight to generate chemical fuels would be a carbon-neutral energy source which could dramatically change the landscape of global energy generation and storage. "Artificial photosynthesis" systems which convert sunlight to energy in the form of chemical bonds are an attractive approach to address this challenge. Here, devices which use sunlight to split water into hydrogen and oxygen will be discussed.

For such systems to be sustainable, they must produce more energy over their useful lifetime that was required to manufacture them. Life cycle assessments which consider the energy payback times at the cell level [1] and also at scale of a large scale hydrogen-generating facility [2] will be presented. These assessments emphasize the need to develop systems with lifetimes similar to those of silicon-based photovoltaics (10-20 years) in order to ensure a positive energy payback.

The most commonly used approach for integrated solar water splitting employs photocathodes (H_2 or hydrocarbon producing) and photoanodes (O_2 producing) linked in a tandem geometry. The surfaces of these photoelectrodes can be a failure point under sustained operation due to corrosion. We have found that the use of conformal oxide layers can greatly reduce corrosion rates. Moreover, it is possible to achieve both high performance and lifetime by the use of protection layers, which are also tuned for selective carrier contact. Examples of such a strategy will be shown for photocathodes [3-5] and for photoanodes [6].

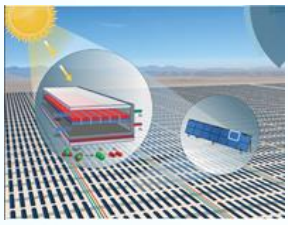

Fig. 1. Schematic of a 1 GW scale solar to H_2 generation plant
Adapted from [2].

References

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2. R. Sathre *et al*., *Energy Environ. Sci*. **7**, 3264 (2014).
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4. Y. Lin *et al*., *Nano Letters* **13**, 5615, 11 (2013).
5. Y. Lin *et al*., *J. Phys. Chem. C* **119**, 2308 (2015).
6. J. Yang *et al*., *J. Amer. Chem. Soc*. **136**, 6191 (2014)

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About the Speaker

Professor Joel W. Ager III is a Staff Scientist in the Materials Sciences Division at Lawrence Berkeley National Laboratory and an Adjunct Professor in the Materials Science and Engineering Department, UC Berkeley. He is a Principal Investigator in the Electronic Materials Program in the Singapore-Berkeley Research Initiative for Sustainable Energy (SinBeRISE) and a Project Leader in the Joint Center for Artificial Photosynthesis (JCAP). He graduated from Harvard College with an A.B in Chemistry and from the University of Colorado with a Ph.D. in Chemical Physics. After a post-doctoral fellowship at the University of Heidelberg, he joined Lawrence Berkeley National Laboratory in 1989. His research interests include the fundamental electronic and transport characteristics of photovoltaic materials, development of new photoanodes and photocathodes based on abundant elements for solar fuels production, and the development of new oxide and sulfide based transparent conductors. Professor Ager is invited frequently to speak at international conferences and has published over 260 papers in refereed journals.