Tandem Semiconductor Microwires Slurries for Solar Hydrogen Generation

Saumya Gulati,[1] Matthew Mulvehill,[1] and **Joshua Spurgeon**[1]
[1]Conn Center for Renewable Energy Research, University of Louisville, Louisville, KY

Abstract

Meeting the industry goal of $2/kg for solar H_2 is a daunting task that will require novel, highly efficient systems which eliminate many of the components and balance-of-systems costs inherent with photovoltaics + electrolyzers. Technoeconomic models have consistently shown that a photoactive slurry reactor for water-splitting could offer the cheapest route to storing solar energy as hydrogen fuel. However, abundant challenges with this approach have thus far limited such particle-based reactors to prohibitively low efficiencies. This talk will highlight our progress toward the development of a tandem semiconductor particle system designed to address the weaknesses of slurry reactors and achieve a high solar-to-hydrogen (STH) efficiency for particle systems. A proof-of-concept tandem structure uses silicon microwires as the base of the particle, with a wider bandgap TiO_2 layer grown on top to gain the additional photovoltage necessary to split water. Semiconductor architecture development and performance will be discussed along with early modeling efforts. In-situ magnetic alignment of the particles has been demonstrated for possible improved tandem light management. In addition, slurry optical characterization and photoelectrochemical performance will be discussed as a function of slurry parameters including bubble flowrate, particle concentration, spectral conditions, and light management strategies. Slurry conditions for minimizing back reactions will be discussed as well.

Biography of Presenter

Dr. Joshua Spurgeon is the eOn Endowed Chair for Sustainability and the Theme Leader for Solar Fuels at the Conn Center for Renewable Energy Research at the University of Louisville and is focused on economically viable approaches to solar fuels. He received his PhD in Chemical Engineering from the California Institute of Technology in 2010 as a National Science Foundation Fellow. He then became a Research Scientist and Project Lead at the Joint Center for Artificial Photosynthesis (JCAP, 2011 – 2013), before leaving for the Conn Center in 2014. He was awarded an NSF CAREER grant to pursue research into tandem particles for solar hydrogen generation.