Stable Solar-Driven Water Oxidation to $\text{O}_2(\text{g})$ By Multifunctional Electrocatalysts Coated Small Band Gap Semiconductors

Ke Sun^a and Nathan S. Lewis^a

Author Affiliations

Abstract

Technologically important small band gap (<2 eV) semiconductors must be stabilized against corrosion or passivation in aqueous electrolytes before they can be used as photoelectrodes that directly produce fuels from sunlight. In addition, incorporation of electrocatalysts on the surface of the photoelectrodes is required for efficient oxidation of H_2O to $\text{O}_2(\text{g})$ and reduction of H_2O or CO_2 to fuels. Stabilization of technologically important semiconductors against photocorrosion and photopassivation would have a significant impact on photoelectrochemical energy conversion, and could enable the development of a new generation of robust integrated devices for efficient solar-driven water splitting and solar-driven CO_2 reduction. Previous efforts have been extensively dedicated on elongating the lifetime of semiconductors under harsh fuel forming reaction conditions especially during the water oxidation half reaction. To date, the energy conversion performances and stability were limited on these systems, obscuring the realization of integrated solar fuel devices. In this work, we presented our recent effort on preparation of a multifunctional coating using Ni oxide, which provides multiple important functions on semiconductor photoelectrodes surfaces, including chemical/corrosion protection, electrically conducting, optical transparent/antireflective, and inherent electrocatalytic activity. The combination of the extraordinary film properties has resulted benchmark performances and stability on Si photoanodes, as well as other group II–VI and group III–V semiconductors that have never been able to be protected in relevant water oxidation conditions before. Results presented here indicated a viable strategy that is a promising approach to achieve the long-term stability of semiconducting photoanodes for use in solar fuel applications.