Ph.D. Dissertation Defense

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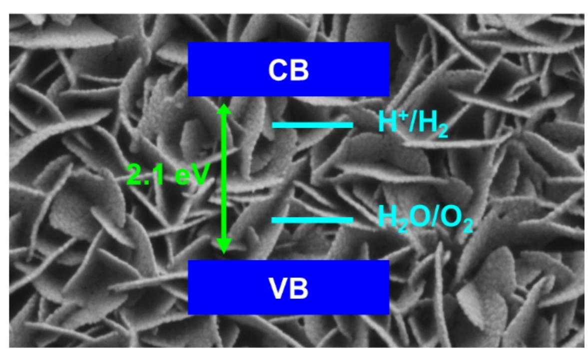
"Electrochemical synthesis of iron-based semiconducting electrodes for photoelectrochemical water splitting"

Transitioning the energy supply from fossil fuels to renewable sources, like solar energy, will be critical for future energy security. Solar energy, however, cannot be generated at all times of day, so effectively storing solar energy as a chemical fuel is imperative to its long-term success and acceptance. Using solar energy to photoelectrochemically split water allows solar energy to produce hydrogen gas, which then acts as a clean and renewable chemical fuel. High quality photoelectrodes that can absorb a large portion of the solar spectrum and split water in a stable manner are required.

The work presented herein describes electrochemical synthesis techniques to produce a variety of iron-based p-type oxide semiconductors. Specifically, development of minimally studied photocathodes, $LaFeO_3$ and related materials, gave bandgap energies of ~2.1 eV, which allow for absorption of a large portion of the visible solar spectrum. Analysis of $LaFeO_3$ showed photostability exceeding 15 hours without any sign of photodegradation. Incorporation of dopant atoms into both the La and Fe-sites caused a decrease in the bulk recombination processes that inhibited $LaFeO_3$ and an increase in performance of 228% for a model redox couple. Additionally, the discovery of a novel photocathode, $Ca_2Fe_2O_5$, was accompanied by extensive analysis of its physical and optical properties, as well as its chemical and photochemical stabilities. The studies reported here will be used for better understanding and directed research into the family of stable iron-based p-type oxides for photoelectrochemical water splitting.



October 16, 2018 at 1:00 pm in Room 9341