Correlating the Bandgaps of Earth-Abundant Metal Oxides to Photocurrent Generation for Water Splitting Applications

McCleary, Jennifer

Providing sustainable energy globally is one of the greatest challenges of the 21st century. Health and climate risks associated with combustion of fossil fuels threaten global stability, development, and national security. The sun is the most abundant and cleanest source of energy, but its intermittence on earth requires conversion into stored fuels. Chemistry can meet this challenge by solar-driven water splitting with earth-abundant, efficient and robust photoelectrode and catalyst materials. Six earth-abundant mixed-metal oxide materials were prepared on FTO (fluorine-doped tin oxide)-glass and made into electrodes. The materials' bandgaps were obtained from Tauc analysis of diffuse reflectance spectra that were measured in a spectrophotometer with an integrating sphere. Photoelectrochemical performance was experimentally determined in aqueous electrolyte and under simulated sunlight illumination. Generated photocurrents were correlated with the materials' bandgaps and compared to a prediction of how efficiency depends on bandgap. With some exceptions, the data appeared to match the predicted correlation that photocurrent density peaks at an optimum bandgap of about 2.0 eV and decreases as bandgap increases or decreases from this value. Such a correlation will facilitate the discovery of new photoanode materials for solar water splitting as a viable alternative of energy to power the planet.

Awards Won:

Fourth Award of $500