Evaluation of Photoelectrochemical Properties of $AgInS_2$ coated with TiO_2 by Atomic Layer Deposition

Qian Cheng and Candace K. Chan
Materials Science & Engineering
School for Engineering of Matter, Transport and Energy
Arizona State University
501 E Tyler Mall, ECG 301
Tempe, AZ 85287

Chalcopyrite materials are promising materials for solar energy conversion due to their high solar-to-electric conversion efficiencies and good absorption coefficients. Due to the considerable overpotential for splitting water, silver-based chalcopyrites are more appropriate for photoelectrochemical hydrogen production considering their larger bandgaps ~ 1.8 eV. However, sulfides are usually unstable as photoanodes. Coatings of a thin metal oxide layer to prevent the contact of the photoanode with the electrolyte may help to improve the photodegradation. Thin films of $AgInS_2$ were prepared using spin coating and evaluated as photoanodes. Extrinsic dopants such as Sn and Cu were also studied. Illuminated open-circuit voltage, Mott-Schottky, and linear scanning voltammetry curves were performed to find the flatband potential and conduction type. After that, a uniform 2 nm TiO_2 layer was deposited by atomic layer deposition (ALD) onto the surface of the $AgInS_2$. The effect of deposition conditions, film thickness, and presence of Pt islands on the photocurrent and onset potential for the $AgInS_2$ photoanodes were evaluated. Long term stability results on the coated and un-coated $AgInS_2$ will be discussed.
The results from this work will help improve basic understanding of the properties of chalcopyrite materials in photoelectrochemical applications, as well as the effectiveness of TiO_2 protecting layers for reducing photocorrosion and degradation in sulfide photoelectrodes.