Electrodeposition of CIGS/CZTS Components from Aqueous Electrolytes

Salem S. Zahmi
Department of Chemical Engineering
Northeastern University
Boston, Massachusetts 02115, USA

Thin films for solar panels can be made more cost-effective if they can be produced by electrodeposition, and this exploratory work aims to develop an electrolyte to be used for a variety of photovoltaic devices, including Cu-In-Ga-Se (CIGS), Cu-In-S (CIS) and Cu- Zn- Sn – S (CZTS) materials, and any combination of them. As a first step a comparison of the electrodeposition of Sn, In and SnIn with and without Cu in a quiescent electrolyte with an excess of citrate were examined as a model component system. Deposits were fabricated under constant potential conditions, and the resulting composition and thickness were used to determine the partial current densities. The presence of Cu enhanced the partial current densities of Sn, and indirectly In. The reduction rate of In(III) was observed to be accelerated only when both Cu and Sn were present. $HAOH^{2-}$:AOH^{3-} ratio increases when Sn and In is codeposited together with/or without Cu. An increase of the surface roughness has been observed when there is an enhancement in the partial current density in the presence of Cu. Precipitations in CuSn and CuSnIn electrolytes have been observed after couple days of preparing the solutions.

Future work includes composite electrodeposition using Cu nanoparticles in a novel approach to electrodeposit CZTS and CIGS alloys and avoiding the redox reaction that causes Cu(II) to precipitate. This will be followed by adding Zn, Ga, and S/Se species into the electrolyte to create a single, one step process for these components. The resulting deposit composition and partial current densities will be examined when the bath pH, and bath

composition are varied. All experiments are proposed to be done using an upward facing rotating disk electrode.