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**Evidence of p- to n-type inversion at CIGS grain boundaries: A depth-dependent surface electron microscopy study**[1] CALVIN CHAN, TAISUKE OHTA, Sandia National Laboratories, GARY KELLOGG, Sandia National Laboratories and Center for Integrated Nanotechnologies, LORELLE MANSFIELD, ROMMEL NOUFI, National Renewable Energy Laboratory — Chalcopyrite $Cu(In_{1-x}Ga_x)Se_2$ (CIGS) is an interesting photovoltaic material because it holds the laboratory record for thin-film solar power conversion efficiency ($\eta > 20\%$) despite its disordered microcrystalline structure. However, commercialization of this technology has been limited by structural and chemical variations in CIGS films. Many microscopic and spectroscopic studies have shown built-in electric potentials ($\Phi_{bi}$) at CIGS grain boundaries. This may assist with electron-hole separation, but the reported magnitude and statistical distribution of $\Phi_{bi}$ remains inconsistent between studies. In this work, photoemission and low-energy electron microscopies (PEEM and LEEM) were used to reconcile these reported differences. Highly surface sensitive PEEM measurements showed $\Phi_{bi} \sim 0.5$ V, which was consistent with most other reports. However, more bulk sensitive LEEM measurements showed $\Phi_{bi} \sim 1.5$ V, which strongly suggests p- to n-type inversion at CIGS grain boundaries. This formation of pn junctions at CIGS grain boundaries is likely responsible for the high performance of CIGS photovoltaics.

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Calvin Chan
Sandia National Laboratories

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