Optical and electrical study of indium tin oxide transparent back contact for wide bandgap $Cu(In,Ga)S_2$/Si tandem solar cells

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The potential for high efficiency in $Cu(In,Ga)S_2$ (CIGS) tandem configurations with commercial silicon solar cells makes it a subject of significant interest. Given the variable bandgap energy of CIGS, ranging from 1.5 eV ($CuInS_2$) to 2.4 eV ($CuGaS_2$), it offers substantial flexibility when paired with a 1.12 eV bandgap silicon bottom cell. An optimal energy bandgap of 1.7 eV for the top cell is identified to attain peak efficiency. An essential component to achieving this potential is the transparent back contact (TBC) that also needs to be low resistivity. This study delves into the application of indium tin oxide (ITO)—a transparent conductive oxide (TCO) that already showed promising results with chalcogenides—as the TBC for mono-junction CIGS solar cells, emphasizing its promising optical compatibility.

Our investigations focused on characterizing the interfacial properties of ITO and CIGS. We systematically assessed the effects of CIGS deposition on the ITO layer by evaluating its optical and electrical properties before and after deposition. Co-evaporation depositions were conducted at 580°C, targeting a 15% $\frac{Ga}{Ga+In}$ (GGI) on a 370 nm thick ITO layer sourced from SOLEMS company. 3-stage and CuPRO deposition process were both used in this study.

To derive insights into the material properties and interactions, we employed transmittance, reflectance, four-point probe, Hall effect, Raman, XRD, and photoluminescence techniques.