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Priyanka U. Londhe, Ashwini B. Rohom, Nandu B. Chaure



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# Selenization of electrochemically synthesized Copper-Indium layers from non-aqueous solution for solar cell application

Priyanka U. Londhe, Ashwini B. Rohom, Nandu B. Chauré\*

<sup>1</sup>Department of Physics, Savitribai Phule Pune University (formerly University of Pune), Pune-411007, INDIA

\*Email ID: [n.chaure@physics.unipune.ac.in](mailto:n.chaure@physics.unipune.ac.in)

## Abstract

A simple two-step, electrodeposition of copper-indium (Cu-In) intermetallic alloy thin films followed by selenization process was employed for the synthesis and development of CuInSe<sub>2</sub> (CIS) thin film solar cells (TFSC). The co-deposition of Cu and In in ethylene glycol at 130°C was studied using the cyclic voltammetry (CV) to obtain a stable Cu-In phase. A wide window of deposition potentials from -0.7 V to -1.5 V versus Ag/AgCl reference electrode was optimized. Three different potentials, -0.7 V, -1.0 V and -1.3 V are chosen to deposit the Cu-In intermetallic alloy thin films, which were further selenized in controlled selenium ambient at 400 °C. The selenization effect is studied extensively on structural, morphological, optical and compositional properties of selenized Cu-In (CIS) thin films. Polycrystalline CIS layers with tetragonal crystal structure are obtained upon selenization of Cu-In thin films. Three prominent reflections of CIS, (112), (204/220) and (312/116) are exhibited in all selenized Cu-In layers. Additional secondary phases of Cu<sub>x</sub>Se<sub>1-x</sub> are attributed for the layers grown at -0.7 and -1.0 V. Compact and void-free surface morphology with particle size ~1 to 2 μm was observed for all selenized samples. The selenized Cu-In layer sample deposited at -1.3 V measure ~ 1.06 eV energy band gap with polycrystalline tetragonal chalcopyrite crystal structure of CIS. The photoelectrochemical measurement confirms the growth of p-type material. A selenized Cu-In layer deposited at -1.3 V with CdS window layer measured power conversion efficiency 5.44 %.

**Keywords:** Electrodeposition, nucleation, selenization, CuInSe<sub>2</sub>, thin film solar cells,

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