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Influence of dipping cycles on physical, optical, and electrical properties of Cu_2NiSnS_4: Direct solution dip coating for photovoltaic applications

Krishnaiah Mokurala[*a, b], Sudhanshu Mallick[b], Parag Bhargava [b], Sebastian Siol[a], and Talysa R. Klein[a], Maikel F.A.M. van Hest[a]

[a] National Renewable Energy Laboratory, Golden, Colorado 80401, USA

[b] Indian Institute of Technology Bombay, Mumbai 400076, India,

Corresponding authors: Email Id: krishrama33@gmail.com,

Abstract: Direct solution coating technique has emerged as a promising economically viable process for earth abundant chalcogenide absorber materials for photovoltaic applications. Here, direct ethanol based dip coating of earth abundant Cu_2NiSnS_4 (CNTS) films on soda lime glass (SLG), molybdenum coated glass (Mo), and fluorine doped tin oxide coated glass (FTO) substrates is investigated. The structural and morphological properties of pre-annealed and sulfurized CNTS films coated on SLG, FTO, and Mo substrates are reported. The influence of dipping cycles on composition and optoelectronic properties of pre-annealed and sulfurized CNTS films deposited on SLG substrate is presented. Energy dispersive spectroscopy (EDS) and X-ray fluorescence (XRF) analysis reveal how changes in thickness and elemental composition affect morphology and optoelectronic properties. The obtained absorption coefficient, optical bandgap, resistivity and mobility of pre - annealed and sulfurized films are found to be 10^4 cm^{-1}, 1.5 eV, 0.48 Ωcm, 3.4 cm^2/Vs and 10^4 cm^{-1}, 1.29 eV, 0.14 Ωcm, 11.0 cm^2/Vs, respectively. These properties are well suited for photovoltaic applications and lead to the conclusion that the direct ethanol based dip coating can be an alternative economically viable process for the fabrication of earth abundant CNTS absorber layers for thin film solar cells.

Keywords: dip coating; dipping cycles; Cu_2NiSnS_4 ; annealing; optoelectronic properties; photo response