

Studies on Radio Frequency Sputtered Copper Zinc Tin Sulphide Absorber Layers for Thin Film Solar Cells

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Abstract : Copper Zin tin sulphide ($\text{Cu}_2\text{ZnSnS}_4$ or CZTS) is found to be better alternative to Copper Indium gallium diselenide as absorber layers in thin film based solar cells due to the utilisation of earth-abundant materials in the midst of lower toxicity. In the present study, $\text{Cu}_2\text{ZnSnS}_4$ thin films were prepared on soda lime glass using (CuS, ZnS, SnS) targets and were deposited by three different stacking orders, using RF Magnetron sputtering. The substrate temperature was fixed at 300 °C during the depositions. CZTS thin films were characterized using X-ray diffraction, X-ray photoelectron spectroscopy, Raman spectroscopy and UV-Vis-NIR spectroscopy. All the samples exhibited X-ray peaks pertaining to (112) kesterite phase of CZTS, along with the presence of a predominant wurtzite CZTS phase. X-ray photoelectron spectroscopy revealed the presence of all the elements in all the samples. The change in stacking order clearly shows that it affects the structural and phase properties of the films. Relative atomic concentrations of Zn, Cu, Sn and S, which are determined by high-resolution XPS core level spectra integrated peak areas revealed that the CZTS films exhibit inhomogeneity in both stoichiometry and elemental composition. Raman spectroscopy studies on the film showed the presence of CZTS phase. The energy band gap of the CZTS thin films was found to be in the range of 1.5 eV to 1.6 eV. The films were then annealed at 450 °C for 5 hrs and it was found that the predominant nature of the X-ray peaks has transformed from Wurtzite to Kesterite phase which is highly desirable for absorber layers in thin film solar cells. The optimized CZTS layer was used as an absorber layer in thin film solar cells. ZnS and CdS were used as buffer layers which in turn prepared by Hot wall epitaxy technique. Gallium doped Zinc oxide was used as a transparent conducting oxide. The solar cell structure Glass/Mo/CZTS/CdS or ZnS/GZO has been fabricated, and solar cell parameters were measured.

Keywords : earth-abundant, Kesterite, RF sputtering, thin film solar cells

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