A Comparative Study of CZTS Thin Films Deposited By Different Non Vacuum Techniques

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Abstract

Thin-film solar cells technology is one of the solutions for expensive silicon solar cells. The kesterite-structured Cu_2ZnSnS_4 (CZTS) semiconductor has been considered as a promising light-harvesting material and a great progress on CZTS based solar cells has been achieved during the past few years. For the fabrication of CZTS solar cells, vacuum and non-vacuum deposition techniques have been reported. Among these methods, non-vacuum techniques such as spray pyrolysis, spin coating, and electrodeposition are widely being used owing to their simplicity and the low cost. In this study, CZTS thin films were prepared on Florine doped tin oxide (FTO) by spray pyrolysis, spin coating, and electrodeposition methods and their properties were compared. The Cu–Zn–Sn (CZT) containing precursor solution for spray pyrolysis and spin coating was prepared by solution-based sol-gel method. In the spray pyrolysis method, the precursor solution was sprayed on to the heated FTO substrate at 150 ^{0}C using compressed Nitrogen as a carrier gas. In the spin coating method, the precursor solution was spin coated on the FTO at 2500 rpm and dried at 150^{0}C on the hot plate. The co-electrodeposited Cu-Zn-Sn film was grown by using a metallic precursor solution and the deposition was carried out potentiostatically using a 3-electrode cell with a platinum counter electrode and Ag/AgCl reference electrode. The stacked metals layer which prepared by three different technics were sulfurized by annealing in a sulfur-nitrogen environment for 15 minutes at 280 ^{0}C. The photoelectrochemical response during chopped illumination was studied comparatively for each deposition techniques. The electrodeposited films were observed to be shown well with good photocurrent response, compared with the CZTS films made by spray pyrolysis and spin coating techniques. All prepared CZTS films were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), UV- visible spectroscopy to obtained detail of the crystal structure, surface morphology, atomic composition and optical properties of the CZTS thin films respectively.

Keywords: CZTS, spray pyrolysis, spin coating, electrodeposition, thin film solar cell