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Electrodeposition of well-adhered CdTe thin films for solar cell applications

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Among the second generation thin film photovoltaics, CdS/CdTe based solar cell device is one of the leading contenders for large scale commercialization. Since the CdTe is the crucial absorber material of the foregoing device, it is essential to maintain a well-adhered CdTe layer to obtain high photovoltaic activities. If not, loosened CdTe layers with numerous pinholes can reduce the electrical, optical, structural and morphological properties of the material and hence extinguish the entire activities of CdS/CdTe solar cells.

In the present study, an electrodeposition procedure was developed to fabricate well-adherent CdTe layers to the substrate using the typical three electrode electrolytic cell. A fluorine doped tin oxide conducting glass substrate (7Ω/sq.) with dimensions of (1×3) cm^2 was used as the working electrode in the cell. A saturated calomel electrode and a high purity graphite rod served as reference and counter electrodes respectively. All the electrodepositions were carried out using an aqueous solution containing 1.0 mol/L $CdSO_4$, 1.0 mmol/L TeO_2 and 5.5 mmol/L $CdCl_2$. Based on the cyclic voltammetry studies and the stoichiometry of the proposed chemical reaction which forms CdTe material, the possible cathodic deposition potential (CDP) and pH ranges were identified to be in the ranges of 550-710 mV and 1.4-2.4 respectively. Henceforth, CdTe layers were electrodeposited at above mentioned conditions at temperature of 65 °C and subsequently annealed in air at 400 °C for 10 min**.** Thereafter, by considering the physical appearance of deposited CdTe layers and their adhesiveness upon a high pressure N_2 flow, the feasible values for CDP and pH were found to be in the ranges of 590-660 mV and 2.0-2.4 respectively. To further fine-tune the values for CDP and pH, a series of CdTe layers were deposited at above feasible growth conditions and inspected for their electrical, optical, structural and morphological properties using the methods of photo-electrochemical cell, optical absorption spectroscopy, X-ray diffraction and scanning electron microscopy respectively. Results revealed that, the optimum CDP is in the range of 620-660 mV and pH is in the range of 2.1-2.3 to exhibit good photovoltaic qualities.

Keywords: Electrodeposition, Cadmium telluride, Well-adhesive, Solar cells