Optimization of three growth parameters for electrodeposition of CdS thin film semiconductor; pH, deposition temperature and deposition voltage in a stable electrolyte

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Cadmium sulfide has been identified as the most promising window material for fabrication of CdS/CdTe and CdS/$CuInGaSe_2$ thin film solar cells. Among vast variety of commercially available CdS fabrication methods electrodeposition (ED) is a viable technique due to its low cost and simplicity. This study focuses a procedure followed for optimization of the three growth parameters; pH of the bath solution, deposition temperature and deposition voltage for ED-CdS thin films with high photovoltaic activities utilizing $CdCl_2$ and $Na_2S_2O_3$ as cadmium and sulfur precursors respectively.

Based on the two initial leading experiments, feasible pH and deposition temperature ranges for a stable electrolyte which does not promote chemical bath formation of CdS were identified to be in the ranges of 1.5-2.0 and 50-70 °C respectively. Also, using cyclic voltammetry the feasible cathodic deposition voltage was identified to be in the range of 640-720 mV with respect to saturated calomel electrode. Consequently, the technique of the design of experiment (DOE) was carried out to establish random combinations of levels of the three electrodeposition parameters amid the previously identified parameter ranges for deposition of CdS layers via the ED technique. Finally, the electrical, optical, structural and morphological properties of the CdS thin films electrodeposited under different combinations of parameter values were investigated using photo-electrochemical cell study, optical absorption spectroscopy, x-ray diffraction method and scanning electron microscopy respectively.

The results indicated that, aqueous solutions in the pH range of 1.6 to 1.8 containing 0.10 M $CdCl_2$ and 0.01 M $Na_2S_2O_3$ at 55-65 °C can successfully be used for electrodeposition of thin film CdS semiconductor materials over a cathodic deposition voltage range of 650 to 680 mV with a deposition period of 20 to 40 min.

Key words: Electrodeposition, Cadmium Sulfide, Semiconductors, Solar energy materials

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