



Use of the Electrodeposition Technique for Growing n-type CdS and p-type CdTe Semiconductor Thin Films for Fabrication of Solar Cells with Improved Performances

by

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Abstract

Photovoltaic (PV) research efforts are currently devoted to production of low cost and high-efficiency solar cells. Among the different techniques, electrodeposition is one of the most suitable low cost methods, because the material can be deposited on the desired area of the substrate thus providing a film of reproducible quality.

The aim of this work is to study the electrochemical experimental conditions required to grow CdS and CdTe thin film semiconductors and fabricating the glass/FTO/CdS/CdTe/Cu/Au solar cell device with higher performances at a relatively low cost. n-type CdS and p-type CdTe thin films were electrodeposited on fluorine doped tin oxide (FTO) substrates using three electrode system where high purity graphite rods was used as counter electrode and Ag/AgCl double junction electrode or saturated calomel electrode (SCE) was used as the reference electrode. Electrochemical deposition method through the influence of the concentration of precursor species, deposition potential, deposition temperature, deposition time and pH offers excellent control over the properties of thin film CdS and CdTe layers using a potentiostatic approach. CdS thin films were prepared by electrodeposition technique from an aqueous solution of CdCl₂ as cadmium precursor and Na₂S₂O₃ or (NH₄)₂S₂O₃ or (NH₂)₂CS as the sulfur precursor. CdTe films were grown by potentiostatic electrodeposition from acidic solutions containing CdSO₄, CdCl₂ and TeO₂. The deposition mechanisms were investigated by cyclic voltammetry. Post deposition heat treatment on CdS and CdTe thin films enhanced the optical, electrical and morphological properties of grown materials.

The electrodeposited thin films were characterized using photoelectrochemical (PEC) studies, UV-Vis spectrophotometry, X-ray diffraction (XRD), scanning electron microscopy (SEM) and Raman spectroscopy. The key processing step CdCl₂/heat treatment was done on glass/FTO/CdS/CdTe structures before making the Cu/Au back contact of solar cell. The completed glass/TCO/CdS/CdTe/Cu/Au solar cell devices were characterized using current-voltage (I-V) measurements and the solar cell parameters, open circuit voltage (V_{oc}), short circuit current density (J_{sc}), fill factor (FF) and efficiency (η) were estimated. The highest efficiency observed for the laboratory scale device was of ~2.1%.

Key words: solar cell, electrodeposition, CdS, CdTe, thin films