Preparation and Enhancement of CdS/ZnS Thin Films for Photovoltaic Purposes

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Abstract:

Polycrystalline CdS/ZnS thin films were prepared by chemical bath deposition (CBD) technique on fluorine-doped tin oxide (FTO) coated glass substrates. Enhancement of deposited CdS/ZnS thin film characteristics at solid/liquid interface in photoelectrochemical (PEC) systems was investigated. Deposited CdS/ZnS thin films were exposed to different treatment methods and different experimental conditions. The films were heated to desired temperatures (300ºC, 400ºC) under air. Cooling of heated films to room temperature was achieved by either slow cooling or quenching. Etching of film surface was conducted using dilute HCl solution. The effect of such treatment on the film photoelectrochemical characteristics was measured by monitoring different parameters, such as: open-circuit voltage (Voc), short-circuit current density (Jsc), dark current density-potential (J-V) plots, photo J-V plots, conversion efficiency (η), fill factor (FF), Scanning electron microscopy (SEM), X-ray diffraction, together with electronic absorption and photoluminescence (PL) emission spectra. The characteristics of CdS/ZnS thin films in PEC systems were enhanced by controlling different experimental conditions, controlling preheating temperatures and controlling cooling rates. The dark- and photo-current densities vs. potential plots were improved by annealing. Cell efficiency, fill factor, short-circuit current densities (Jsc) and SEM results were enhanced for the annealed CdS/ZnS films. The best annealing temperature for CdS/ZnS films was found to be 300ºC at which the photo J-V plots and cell efficincy were improved significantly. Slowly cooled electrodes from temperature 300ºC, gave better dark and photo current density vs. potential plots with higher efficiency than their quenched counterparts. SEM measurements were consistent with these findings, and showed better surfaces for slowly cooled CdS/ZnS thin film electrodes. Maximum values of conversion efficiencies were obtained by slow cooling of preheated CdS/ZnS electrodes cooled from temperature 300ºC compared to that of electrodes cooled from 400ºC. The effect of coating the CdS/ZnS electrodes with MnP/polysiloxane was also studied. The (Jsc) values of coated CdS/ZnS films (with certain Zn ratios) were significantly enhanced. The MnP/polysiloxane coating introduces a charge-transfer mediator species that enhances current and electrode stability.

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