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Low-Surface Roughness and High Optical Quality CdS Thin Film Deposited on Heated Substrate Using Room-Temperature Chemical Solution

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Abstract : The high production cost of the conventional solar cells requires the search for economic methods suitable for solar energy conversion. Cadmium Sulfide (CdS) is one of the most important semiconductors used in photovoltaics, especially in large area solar cells; and can be prepared in a thin film form by a wide variety of deposition techniques. The preparation techniques include vacuum evaporation, sputtering and molecular beam epitaxy. Other techniques, based on chemical solutions, are also used for depositing CdS films with dramatically low-cost compared to other vacuum-based methods. Although this technique is widely used during the last decades, due to simplicity and low-deposition temperature (~100°C), there is still a strong need for more information on the growth process and its relation with the quality of the deposited films. Here, we report on deposition of high-quality CdS thin films; with low-surface roughness (< 3.0 nm) and sharp optical absorption edge; on low-temperature glass substrates (70°C) using a new method based on the room-temperature chemical solution. In this method, a mixture solution of cadmium acetate and thiourea at room temperature was used under special growth conditions for deposition of CdS films. X-ray diffraction (XRD) measurements were used to examine the crystal structure properties of the deposited CdS films. In addition, UV-VIS transmittance and low-temperature (4K) photoluminescence (PL) measurements were performed for quantifying optical properties of the deposited films. The deposited films show high optical quality as confirmed by observation of both, sharp edge in the transmittance spectra and strong PL intensity at room temperature. Furthermore, we found a strong effect of the growth conditions on the optical band gap of the deposited films; where remarkable red-shift in the absorption edge with temperature is clearly seen in both transmission and PL spectra. Such tuning of both optical band gap of the deposited CdS films can be utilized for tuning the electronic bands' alignments between CdS and other light-harvesting materials, like CuInGaSe or CdTe, for potential improvement in the efficiency of solar cells devices based on these heterostructures.

Keywords : chemical deposition, CdS, optical properties, surface, thin film
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