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Effect of film thickness on characteristic properties of thermally evaporated cadmium sulphide thin films

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Cadmium sulphide (CdS) thin films are regarded as one of the most promising materials for heterojunction solar cells. Due to its wide bandgap (~ 2.42 eV), CdS thin films have been used as the window material together with several semiconductors such as InP, CdTe, Cu_2S, and $CuInSe_2$. For the future development of photonic devices based on above materials comprehensive studies on CdS window layer throughout all aspects such as deposition technique, temperature, duration, and post-heat treatments, etc. are highly required. In this study, CdS thin films were deposited on the cleaned FTO glass substrates using vacuum thermal evaporation technique by varying the deposition duration to have different layer thicknesses. The temperature of the substrates and the chamber pressure were maintained at 175 °C and 2×10^{-5} torr respectively. The deposition was carried out using CdS powder (*Sigma-Aldrich*, 99.995%) containing in an alumina boat. Deposited samples were then annealed in vacuum (pressure 3×10^{-5} torr) at 300 °C for 30 minutes. The bandgap and optical transmittance of the deposited thin films were studied using UV-Visible spectrophotometry. The surface topology analysis of the deposited thin films was carried out using Atomic Force Microscopy (AFM). A photoelectrochemical cell of (CdS/0.1 mol L^{-1} $Na_2S_2O_3$/Pt) was used to investigate electrical properties such as short circuit current (J_{SC}), open circuit voltage (V_{OC}), carrier concentration, and majority carrier type of the semiconductor with the aid of I-V measurements and Mott–Schottky measurements. The structural and crystal properties such as preferred orientation, phase distribution, crystallite size, microstrain, and lattice parameters were studied by employing the grazing incident X-ray diffraction. The calculations were done using the profile fit, Rietveld refinement, and Pawley refinement techniques. All the results revealed that there exists a correlation between the film thickness and the above-considered properties of the CdS thin film. The highest bandgap of 2.43 eV and optimum J_{SC} and V_{OC} of 113 μA/cm^3 and 341 mV respectively were observed for the photoelectrochemical cell made by 210 nm thick CdS thin film.

Keywords: Cadmium sulphide, Film thickness, GIXRD, Thermal evaporation

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