Structural, Optical and Photoconductive Properties of Thermally Evaporated CdS_xTe_{1-x} Thin Films

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ABSTRACT

The formation of a CdS_xTe_{1-x} layer by the interdiffusion of S into the CdTe and of Te into CdS films occurs during the fabrication of CdS/CdTe thin film solar cells. The CdS_xTe_{1-x} layer is thought to be important because the real electrical junction is located in this interdiffused CdS_xTe_{1-x} region. Thus, it is important to have a full understanding of the physical properties of CdS_xTe_{1-x} alloy thin films. In this study, CdS_xTe_{1-x} thin films with composition $0 \leq x \leq 1$ were prepared by thermal evaporation method on glass substrate using powder of pure CdS and CdTe compounds pressed in pellet form as the source in a vacuum of 5.5 10^{-5} mbar. X-ray diffraction (XRD) revealed that the films exhibited a cubic zincblende structure with the preferred orientation of (111) plane when $x < 0.2$. However, when $x \geq 0.8$, they had a hexagonal wurtzite structure with the preferred orientation of (002) plane. For the composition $0.2 \leq x \leq 0.6$, the cubic and hexagonal phases coexisted in the system and the films became less preferentially oriented. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used to study the morphological features of the samples. The transmission spectra of the films were studied using a double beam spectrophotometer in the wavelength range of 300-900 nm. Optical band gap value of the films was determined from the transmittance spectra. The variation of band gap (E_g) with composition (x) of the films was in good agreement with the quadratic form, giving a bowing parameter of (b) =1.85 eV. From the transient photoconductivity measurements, persistent photoconductivity (PPC) behavior was observed. The decay current data fit better with multiple exponential functions, resulting in five slow decay times. The longest carrier lifetime of approximately 6,000 s was observed in the films with x = 0.8. Density of trap states corresponding to decay time was also evaluated from the decay current data.

Keywords: CdS_xTe_{1-x} Thin films, Thermal evaporation, XRD, Persistent photoconductivity