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Optical transmission and photoconductivity of chemical bath-deposited CdS thin films for optoelectronic applications

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ABSTRACT

This paper presents a comprehensive study of the optical transmission, photoconductivity, and morphology of CdS thin films deposited via the chemical bath deposition (CBD) method. The films deposited for 60 min exhibit an optical energy band gap value of 2.42 eV and the highest optical transmission of 75 % in the wavelength range of 500–900 nm. For these films, the transmission electron microscopy imaging shows a distribution of particle sizes around 10 nm. The wavelength dependence of the photoconductivity, extracted from photo resistivity data, shows that the maximum photoconductivity occurs at 492 nm wavelength. This corresponds to an electrical energy band gap of 2.52 eV, which is greater than the optically measured energy gap of 2.42 eV. Based on these results, the electron-hole pair binding energy for CdS films is estimated as 100 meV. According to the electrical resistivity vs. temperature measurements, the activation energy is 1.26 eV which agrees with the electrical energy band gap of 2.52 eV. CdS films annealed under nitrogen gas at 200 °C for one hour exhibited an energy gap of 2.32 eV. These films displayed a conductivity of $60 \times 10^{-4} \text{ Scm}^{-1}$, a carrier concentration of $6.38 \times 10^{14} \text{ cm}^{-3}$, and a mobility of $7.46 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$. These impressive characteristics suggest the suitability of CBD-grown CdS films annealed at 200 °C in nitrogen gas, to be used as the window material in CdS/CdTe thin film solar cells and other optoelectronic applications.