Physica B 405 (2010) 3384–3390

Contents lists available at ScienceDirect

Physica B

journal homepage: www.elsevier.com/locate/physb

Structural, optical and electrical properties of cadmium-doped lead chalcogenide (PbSe) thin films

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ARTICLE INFO

Article history:
Received 26 April 2010
Received in revised form
4 May 2010
Accepted 6 May 2010

Keywords:
Lead chalcogenide thin films
Optical constants
X-ray diffraction
DC conductivity

ABSTRACT

$(PbSe)_{100-x}Cd_x$ thin films of thickness 3000 Å with variable concentrations of Cd (x=5, 10, 15 and 20) were prepared by thermal evaporation on glass substrates at room temperature at a base pressure of 10^{-6} Torr. The structural, optical and electrical properties of these films were studied. X-ray diffraction patterns were used to determine the crystal structure of the films. Films were of polycrystalline texture over the whole range of study. Optical constants of all films were determined by absorbance and reflection measurements in a wavelength range 400–1200 nm. Analysis of the optical absorption data showed that the rule of direct transitions predominates. The values of the absorption coefficient (α), extinction coefficient (k) and imaginary part of the dielectric constant were found to increase with increasing Cd content in lead chalcogenides while the refractive index (n) and real part of dielectric constant were increased with increasing Cd concentration up to 15% and then they decreased with 20% of Cd content in PbSe. These results were interpreted in terms of the change in concentration of localized states due to the shift in Fermi level. The dc conductivities and activation energies of the films were measured in the temperature range 298–398 K. It was observed that the dc conductivity increases at all temperatures with the increase of Cd content in lead chalcogenide system. The experimental data suggests that the conduction is due to the thermally assisted tunneling of the carriers in the localized states near the band edges. The activation energy and optical band gap were found to decrease with increasing Cd concentration in lead chalcogenide.