OPTICAL PROPERTIES OF CADMIUM INDIUM TELLURIDE AS A FUNCTION OF MANGANESE DOPING PERCENTAGE

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Abstract

The optical properties for pure and Mn doped $CdIn_2Te_4$ thin films were studied as a function of Mn doping percentage. The estimated direct energy gap was in the range (1.06-0.96) eV for Mn concentration between (0.3-3.0) wt percent.

Introduction

Cadmium Indium Telluride is a semi-conducting compound with energy band gap 1.1eV and its structure is basically a chalcopyrite structure with half of one of the cations removed [1]. Some II-III_2-VI_4 ternary compounds such as $CdIn_2$ Te_4 have attracted attention recently both from fundamental and applied point of view. Cd-In-Te offers a system in which the optical band gap could be varied in a wide range of interest. Recently Ramirez et al. have reported a direct band gap for $CdIn_2Te_4$ thin films prepared by close spaced vapor transport technique [2,3]. The formation of ternary semi-conductor compounds from the Cd-In-Te ternary system has been investigated by melting of different concentrations of these elements [4]. The purpose of this paper is to describe the optical properties of chemically sprayed $CdIn_2Te_4$: Mn films.

Experimental Procedure

$CdIn_2Te_4$ films were prepared by spray pyrolysis method. Solution of $CdSO_4$, $InCl_3$ and TeO_2 were prepared by dissolving appropriate amounts of the high purity compounds in de-ionized water. Mn doped films were prepared by adding different weight percentage (0.3-3.0) wt% of Mn , by dissolving appropriate amount of $MnCl_2$ in De-ionized water and adding to the solution. The obtained solution is immediately sprayed with the help of a double nozzle sprayer onto heated substrate of glass plates. The sprayer setup and experimental details of preparation were described elsewhere [5]. The spraying rate was in the 3ml/min and the thickness of the prepared samples was in the range (0.16-0.20) μm. Optical absorption curves were taken on a Sp-800 pye Unicam spectrophotometer in the wave length range (300-1500) nm.

Results and Discussion

Typical absorption coefficient spectra for $CdIn_2Te_4$ films doped with different Mn weight percent are shown in Fig. (1). It can be seen that the absorption coefficient **α** is increasing with increasing the Mn concentration as shown in Fig (2).

The relation between **α** and incident photon energy **hν** for direct allowed band to band transition as used by Rajaram [6] is given by the following equation :

$$(\alpha h\nu)^2 = C(h\nu - E^d_g) \qquad h\nu > E^d_g$$

$$(Ah\nu)^2 = 0 \qquad h\nu < E^d_g,$$

where E^d_g is the direct energy gap and **C** is nearly constant independent of photon energy [7]. $(\alpha h\nu)^2$ has been plotted in Fig (3) for undoped and doped films. The extrapolation of the linear region of $(\alpha h\nu)^2 = 0$ gives the direct allowed band gaps. Table (1) presents the direct allowed band gaps E^d_g as a function of Mn doping percentage following the previous process. For pure $CdIn_2Te_4$ film the direct allowed band gap is (1.12±0.05) eV.

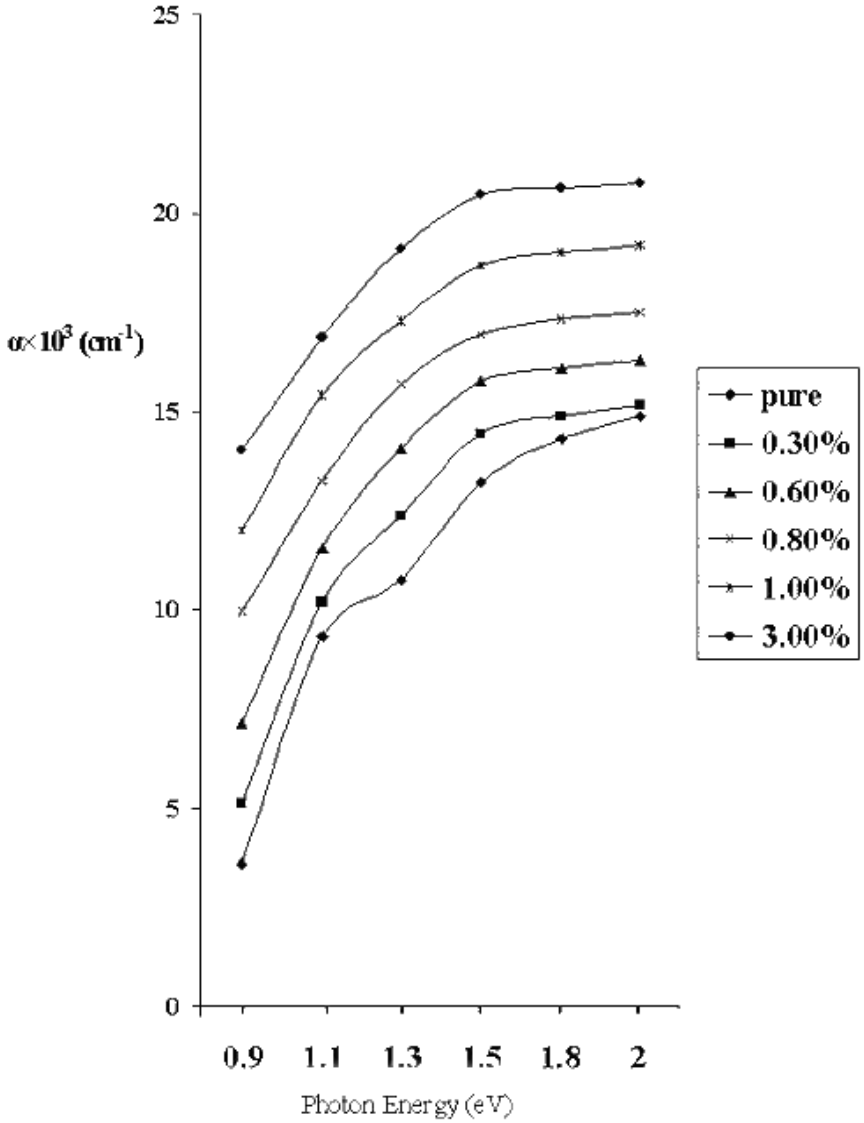

Fig. (1)-Absorption Coefficient α vs. Photon Energy for different Mn wt percent.

Mn.wt%	Pure	0.3%	0.6%	0.8%	1.0%	3.0%
E^d_g (eV)	1.12	1.06	1.025	0.98	0.97	0.96

Table (1)-The direct band gaps for different Mn doping percentage.

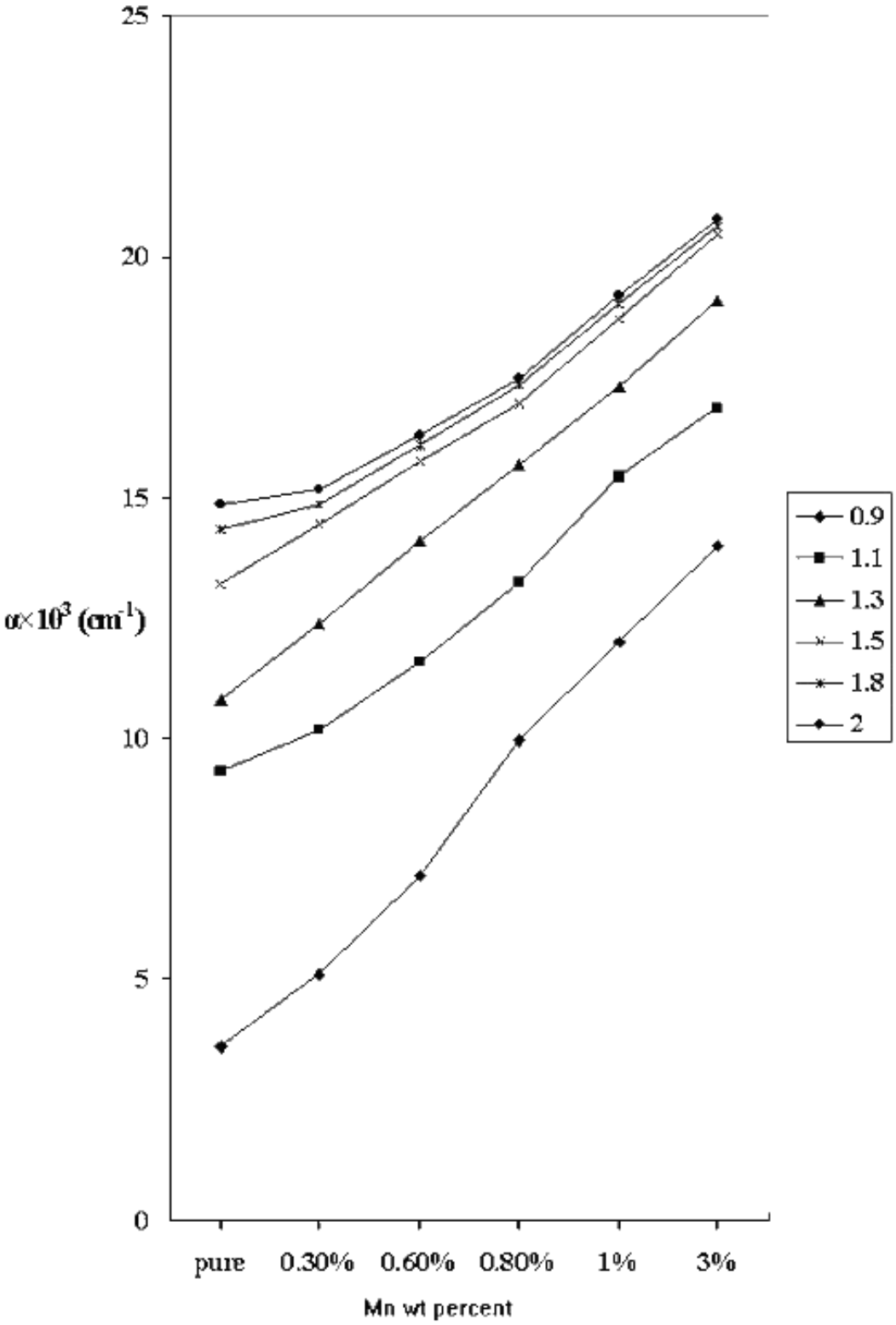

Fig. (2)-Absorption Coefficient α vs. Mn doping percentage for different photon energy.

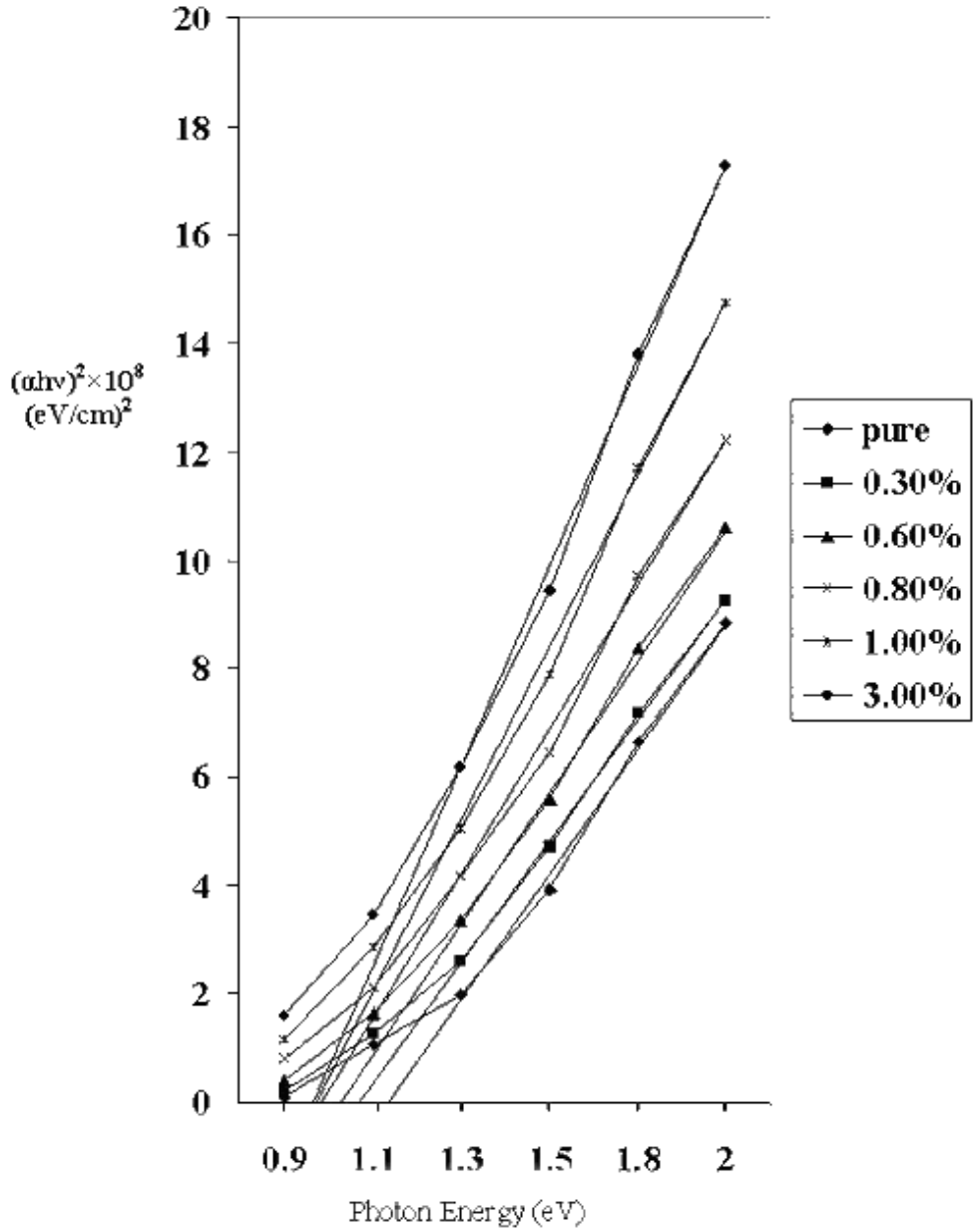

Fig. (3)- $(\alpha h\nu)^2$ vs. Photon Energy for different Mn doping wt percentage.

Conclusion Remarks

- The optical properties of $CdIn_2Te_4$: Mn films were investigated for doping concentration varied between (0-3) wt percent.
- The direct energy gaps were calculated as a function of doping concentration. It was found that the direct energy gaps decreased with increasing doping concentration.

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