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Temperature Dependence of Optical Band Gap and Thickness of II-VI Solid Solution of Znte Thin Films by Spray Pyrolysis

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Abstract: *Spray pyrolysis is a simple, inexpensive method. Thin films of ZnTe were prepared by spraying the mixture of aqueous solution of zinc chloride and tellurium tetrachloride of 0.02 M of each. The temperature of the substrate was varied from 300^{0}C to 375^{0}C in the interval of 25^{0}C. The optical band gap of ZnTe thin films were obtained as 2.27 eV at optimised temperature 350^{0}C. From the transmission curve it was observed that onset of decrease of transmission toward the lower wavelength size as temperature increase, gives the value of band gap and it is varies from 2.32 eV to 2.27 eV. This indicates the increase of grain size of the films. This shows that formation of polycrystalline thin fims semiconductor. ZnTethin films shows the direct allowed transition.*

Keywords: *ZnTe thin films, spray pyrolysis, optical study.*

I. Introduction

II-VI group of compound is a most important due to their various application in upto electronic devices. ZnTe is a ternary chalcopyrite semiconductor have received intensive attention since their band gap energy lies close to the range of maximum theoretically attainable energy conversion efficiency. II-VI group of compound particularly ZnTe are attracting of attention due to their potential application in producing photovoltaic devices and wide use in the infra-red devices. In addition, they also possess some unusual and possible unique properties such as high dielectric constant and high carrier mobility as well as a narrows fundamental gap. The photoelectric properties of ZnTe thin films are greatly influenced by both native and foreign imperfection. Foreign atom are generally contaminated in the lattice during the film preparation and optical properties of semiconductor films, without causing a major change in the crystal structures.

There are several method to prepare ZnTe thin films such as, r.f. sputtering flash evaporation, vacuum evaporation chemical bath deposition , anodic and cathodic deposition, solution growth technique and spray pyrolysis (1-3) we have chosen spray pyrolysis because it is cheap, simple, inexpensive easy to handle and ruftuf method. In the present study, we have discuss the preparation of ZnTe thin films and studied the effect of temperature on optical band gap and the thickness of the films.

II. Experimental Methods

Aqueous solution of zinc chloride and tellurium tetrachloride of 0.02 M of each were prepared in double distilled water. These solution mixed in the proportion of 1:2.2 by volume. This mixed liquid spray on the preheated glass substrate. The glass sprayer was move mechanically to and fro to avoid the formation of the droplets on the substrate and insure the instant evaporation. The films shows the tellurium deficiency (1-3) if the solution of proportion was taken as 1:1 by volume. The sprayer rate was maintained at 3.5 ml/min at the pressure 12 kg/cm^2. The thin films were prepared at the different constant temperature of 300^{0}C,325^{0}C, 350^{0}C & 375^{0}C in the inverval of 25^{0}C. The temperature of the substrate was measured by pre-calibrated copper constantan thermocouple. Transmission was taken on UV-1800 Shimandzu Spectrophotometer in the wavelength 350 nm to 800 nm.

III. Transmission Study

Fig.1 shows the transmission verses wavelength of as deposited ZnTe thin films prepared at different temperature a) 300^{0}C b) 325^{0}C c) 350^{0}C & 375^{0}C.

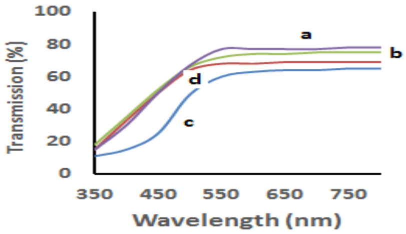

Fig. 1 Transmission verses wavelength of as deposited ZnTe thin films prepared at different temperature a) 300^{0}C b) 325^{0}C c) 350^{0}C & 375^{0}C

From the transmittance curve it was observed that onset of decreases of transmission towards higher wavelength side when the preparation temperature increases which shows the absorption edge. The optical absorption coefficient (α) was calculated from the each transmission curve of each wavelength and it is given by the relation,

$\alpha = 1/t \ln (I_O/I)$ (1)

Where t-the thickness of the films, I_O and I be the intensities of incident and transmitted radiation respectively. To calculate the exact value of band gap, plotting the graph between $(\alpha h\upsilon)^2$vshv for the region near and above the fundamental absorption edge shown in fig.2.

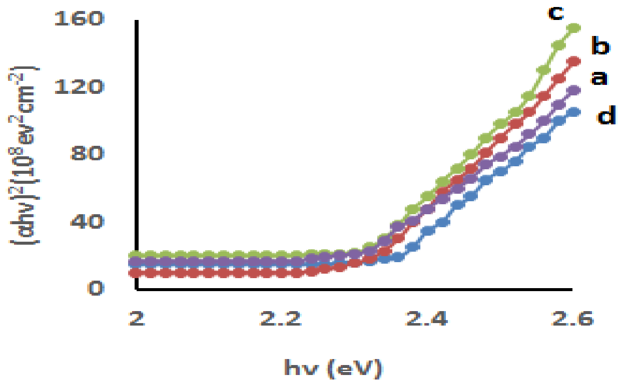

Fig. 2 The graph between $(\alpha h\upsilon)^2$ vshv of as deposited ZnTe thin film prepared at temperature a) 300^0C b) 325^0C c) 350^0C & 375^0C

The linearity of the graph indicated that directly allowed transition describe by the relation,

$\alpha = A/h\upsilon\ (h\upsilon\text{-}Eg)^{1/2}$ (2)

is probable responsible for the absorption process. Where A-the constant hυ-the radiation energy, Eg-the optical band gap of the semiconductor.

The linear portion of the each graph extrapolated on hυ axis gives the value of optical band gap energy. Table 1. Shows the optical band gap energy and thickness of the films with different preparation temperature.

Table.1

Temperature T (^{0}C)	**Band gap energy Eg (eV)**	**Thickness t(□m)**
300	2.32	0.1435
325	2.29	0.1595
300	2.27	0.1740
375	2.25	0.1630

IV. Measurement Of Thickness

Thickness of the thin films were measured by Michelson interferometer and weight difference method unipan microbalance. The difference between both is of the order of 0.003 micrometer and are listed in table 1.

V. Results And Discussion

Optical band gap calculated at the optimised temperature was of 2.27 eV. This value well agree with the result reported by other workers [4,5]. The optical band gap and thickness of the films increases as the temperature of the preparation temperature increases upto the temperature 350^0C. After increase the preparation temperature band gap energy and thicknessof the films is slightly decreases. This indicates the 350^0C temperature was the optimised temperature of the ZnTe thin films. This indicate that at lower temperature (less than 350^0C) may not be sufficient to decompose the sprayed droplets from the solution and therefore the deposite result into a low thickness was estimated (6). This is due to higher evaporation the initial ingredient [7]. Similar results also reported by Tembhurkar [8,9,10] for different II-VI solid solution of CdTe, CdSe, ZnSe, thin films. This shows the CdTe thin films direct allowed transition.

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