Study of Band Gap of Solid Solution ZnTe Thin Films by Prepared by Spray Pyrolysis

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Abstract: ***Zinc telluride thin films prepared by using aqueous solution of zinc chloride and tellurium tetrachloride of 0.02 M of each at pre-heated glass substrate at 350^{0}C. The optical band gap energy were calculated from the plot of $(\alpha h\upsilon)^2$ verses hυ was of 2.26 eV. The ZnTe thin films appears to bea material which has a direct band gap. This shows that the direct allowed transition are appears to be operative. Elemental analysis was carried out on inductively coupled plasma atomic absorption and was found to be 49.01 and 54.09 of zinc and tellurium respectively.***

Keywords: ZnTe thin films, band gap chemical analysis

1. Introduction

Now a day researcher have more concentration on the study of solid solution II-VI group of semiconductor, due to their optical band gap very small (<2 eV). Because of small band gap energy it use to produce upto-electronic devices such as solar cells photodetectors and light emitting diodes. This ternary group of compounds are the most important material for epitaxial deposition of the important infrared detectors material $Hg_{1-x}Cd_xTe$. It has been also found that matching the lattice constant among two the solid solutions such of as, $Cd_xZn_{1-x}Te$, $Cd_xZn_{1-x}Se$, $Cd_xZn_{1-x}S$ in optimised condition. Various desirable properties such as band gap tune ability, lattice parameter will alloy composition and high values of transmittance can be achieved. These characteristics have gained the attraction of may scientists and researchers to perform experiments with this material.

ZnTe is the best materials for top cell structure in solar cells owing to the low leakage of current and high quantum efficiencies which empowers the operation of photovoltaic (solar cells) other detectors (gamma- ray and X-ray)most probably at room temperature. It has band gap energy less than 2 eV are best suitable for its use in tandem solar cells structure particularly for absorber layer due to longer carrier life time and large absorption coefficient (10^4 eV) and lower carrier mobility. There are several method to prepare thin films of ZnTe such as,r.f. sputtering, flash evaporation, vacuum evaporation chemical vapour deposition and spray pyrolysis (1-3).

We have chosen spray pyrolysis method due to cheap and inexpensive method to produce a thin films on large substrate area. In this paper we reported preparation of thin films and studied their optical properties.

2. Experiment

Thin films of ZnTe have been prepared by using aqueous solution of zinc chloride and tellurium tetrachloride of 0.02 M of each. The proportion of the solution was taken as 1:2.2 by volume. Excess tellurium required to deposite desired ZnTe films. The films shows a tellurium deficiency if the ratio of the solution was taken as 1:1 by volume. Temperature of the substrate was maintained at 350^{0}C which was measured by pre-calibrated copper constantan thermocouple. The glass sprayer was mechanically move to and fro to avoid the formation of droplets on the substrate and insure that instant evaporation from the substrate. The spray rate was maintained at 3.5 ml/min at the pressure 12 kg/cm^2.Thickness of the films was measured by Michelson interferometer. Optical transmission was taken on UV-1800 Shimandzu Spectrophotometer.

3. Optical Analysis

Figure.1 shows the transmission verses wavelength of as deposited ZnTe thin films.

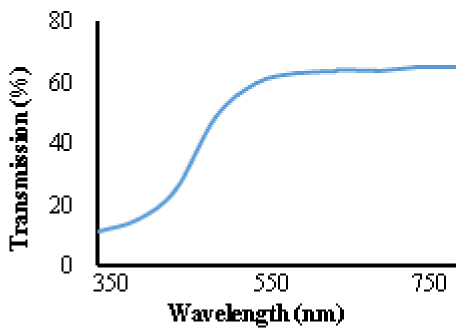

Figure 1: Transmission verses wavelength of as deposited ZnTe thin films.

From this graph it was observed that onset of decrease of transmission gives the value of optical absorption edge.From the transmission of curve the absorption coefficient (α) can be calculated for each wavelength of the curve and given by the relation,

$$\alpha = 1/t \ln (I_0/I) \quad (1)$$

Where t-the thickness of the films, I_0 and I be the intensity of incident and transmitted radiation.

The direct band gap of the thin films is calculated by using the Taucrelation (4),

$$\alpha= A/h\upsilon(h\upsilon-Eg)^n \quad (2)$$

Where A and n are constant, hυ-photon energy, Eg-the band gap energy n=2 for indirect transition and n=1/2 for direct transition.

To calculate exact valueof band gap, plotting the graph between $(\alpha h\upsilon)^2$ verses hυ. The plot becomes as shown in figure 2.

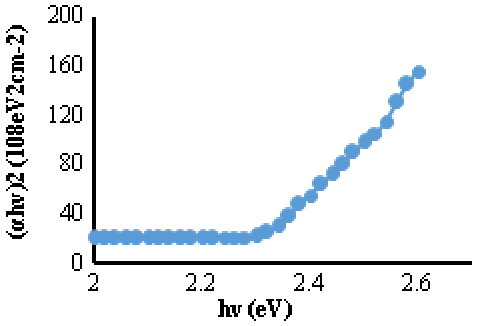

Figure: The graph between $(\alpha h\upsilon)^2$ verses hυ of as deposited ZnTe thin films

The linear portion of the graph was extrapolated to meet hυ axis gives the value of optical band gap energy. The band gap energy is found to be 2.26 eV. This results are well agree with results reported by the other worker [5] deposited ZnTe thin films by different preparation technique. In our method of calculating the absorption coefficient α, the reflection coefficient was assumed to be constant. Tuttle et al [6].Worked with thermal evaporation method for ternary compounds have shown that the reflection varies between 10 % and 35% in the wavelength range 400-1600 nm. It appears that are calculated value of band gap may be due to the uncertainty cause by the assumption regarding the constancy of reflection coefficient. This shows that spray pyrolysis deposited ZnTe this films have good stoichiometric semiconductor.

4. Chemical Composition Analysis

Elemental analysis can be calculated by using Inductively Coupled Plasma Atomic Absorption. For this films deposited on the glass substrate was mechanically scrapped. This scrapped material of thin films was used for the analysis of the chemical which are present in the films. The analysis of the composition of the films revealed the presence of 49.01 and 51.09 atomic percent of zinc and tellurium in the films respectively. It indicates the ZnTe thin films have a good stoichiometric semiconductor.

5. Conclusion

Spray pyrolytically deposited zinc telluride thin films have a good stoichiometric semiconductor. Band gap energy obtained as 2.26 eV from the plot of $(\alpha h\upsilon)^2$ verses hυ. It shows shows the direct allowed transition.

6. Acknowledgement

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