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Study of Optical Properties of $ZnIn_2Se_4$ Thin Films by Spray Pyrolysis

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Abstract: ***Spray pyrolysis is a simple and inexpensive method to prepare thin films on large substrate area. $ZnIn_2Se_4$ thin films prepared by this method using aqueous solution of Zinc Chloride, Indium Tri-chloride and Selenium di-oxide of 0.02 M of each in the proportion 1:2:5.2 by volume. The optical band gap energy calculated from absorption coefficient was found to be decreased with increasing thickness of the films. The optical absorption studies show the existence on indirect allowed transition.***

Keywords: Spray pyrolysis, $ZnIn_2Se_4$ thin films, optical properties

1. Introduction

II- III_2-VI_4 ternary group of compound is a semiconductor that presents usual combination of high transparency in the visible region with the high electrical conductivity. The transparent conductors are used in electronic, optoelectronic and industrial devices such as solar cells, LED's, heat mirrors and laser damage resistant coating. Many researchers have more interested in the study of II-III-VI4 compound. Many author had prepared $ZnIn_2Se_4$ single crystal using chemical vapour deposition and chemical transport reaction. However these methods have some drawbacks that inclusion of the transporters into the crystal as an impurity Inevitable. Hence it is difficult to obtained single crystal with high purity. Many of the authors should calculate the optical constant which was determined from transmittance and reflectance spectra.

There are several methods to prepare thin films, such as vacuum evaporation, flash evaporation, sputtering method, chemical bath deposition and spray pyrolysis [1-4]. We have chosen spray pyrolysis method due to very cheap, inexpensive easy to preparation, high purity quality and uniformity thickness. Moreover it does not cause radiation damagedto the substrate.

In this paper we reported optical band gap energy study for two different thicknesses and also studied the chemical composition of the element in the $ZnIn_2Se_4$ thin films.

2. Experimental

Experimental details already given elsewhere [5-6]. Aqueous solution of Zinc Chloride, Indium Tri-chloride and Selenium Di-oxide of 0.02 M were prepared chemical was used of AR-grade, biological glass plate used as substrate. Temperature of the substrate was measured by using pre-calibrated copper constantan thermocouple. Thickness of the films was calculated by Michelson interferometer. The transmission was taken on Hitachi-330 Spectrophotometer in the wavelength range 300 nm to 2000 nm. Aqueous solutions of each of the above solution were taken in the proportion 1:2:5.2 by volume and spray on the preheated glass substrate. They show the selenium deficiency [5-6] if we take the solution of the proportion in the ratio 1:2:4 by volume.Temperature of the substrate were maintained at 325 ^{0}C. The chemical compositions were taken on inductively coupled plasma atomic absorption.

3. Transmission Study

Fig. 1 (a, b) shows the graph of transmission verses wavelength of the $ZnIn_2Se_4$ thin films for two different thickness.

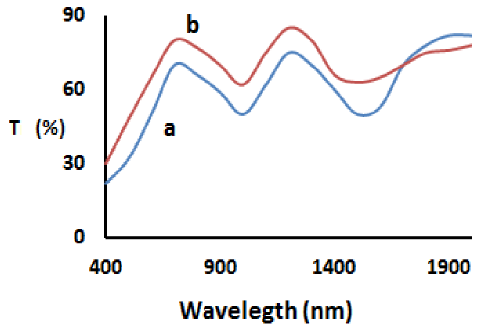

Figure 1: Transmission vs Wavelength (a) t = 0.195 μm (b) t = 0.183 μm

The absorption coefficient "α" were calculated from the transmission curve of each wavelength by using the relation,

$$\alpha = \frac{1}{t}\log(\frac{I_0}{I}) \quad (1)$$

Where I_0 and I are the intensity of the beam before and after the collision of the beam and t be the thickness of the films. To calculate the exact value of band gap energy, plotting the graph between $(\alpha h\upsilon)^{1/2}$ vs hυ the plot as shown in fig. 2 (a,b). The plot is extrapolated on hv axis give the value of the optical band gap energy was of 1.81 eV to 1.72 eV. These values are well agreed with results obtained by other workers [7-9]. This shows that if the thickness of the films increases the optical band gap energy decreases.

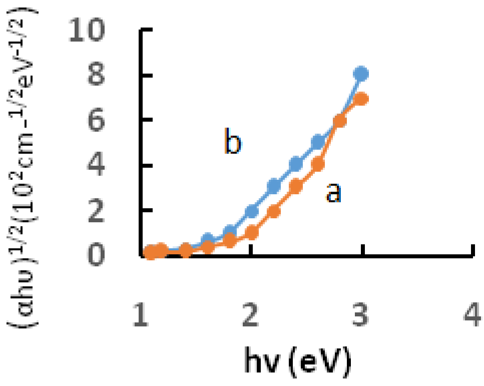

Figure 2: Shows $(\alpha h\upsilon)^{1/2}$vs hυ for (a) t = 0.195 μm (b) t = 0.183 μm

Table. 1 shows the chemical composition of the two different thicknesses of $ZnIn_2Se_4$ thin films. It was observed that the chemical composition of these films shows the minute increase in the percentage of Zn which is less volatile, while Se and In percentage decreases (More volatile). Such changes in the composition may lead to untected changes in the microstructure of the compound with increase in the thickness of the films.

Table 1: Chemical Composition of $ZnIn_2Se_4$ thin films

Thickness	*Zn %*	*In %*	*Se %*
t = 0.183 μm	10.831	38.241	50.928
t = 0.195 μm	10.889	38.10	50.906

4. Conclusion

Spray pyrolysis is a simple and inexpensive method to prepare thin films of water soluble materials. The optical transmission spectrum shows that the existence of indirect allowed transition. The optical band gap energy decreases as the thickness of films increases.

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Author Profile

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