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Thermoelectric Properties of Vacuum Evaporated Indium Selenide Thin Films

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ABSTRACT

InSe thin films were prepared on glass substrate by vacuum evaporation technique at a pressure of 10^{-5} torr. The thermo electric properties of the films was determined over the thickness range of 1000 Ǻ, 1500 Ǻ, 2000 Ǻ, 2500 Ǻ and 3000 Ǻ. Thermo electric properties shows a positive sign exhibiting P- type semiconductig nature of films. Fermi energy and absorption coefficient were determined. The estimated values of Fermi energy and absorption coefficient are 0.089 to 1.23 eV and 1.43 to 1.94 respectively. The XRD analysis confirms that the deposited films are polycrystalline having cubic structure.

Key words: XRD, Fermi energy, absorption coefficient.

INTRODUCTION

Indium Selenide is important material of III - VI group compounds. The energy gap of InSe at room temperature is 1.3 eV, which makes it an attractive material for solar energy conversion (1-5), diodes (6), infrared devices, and lasers (4). It is also used as promising material for application in solid solution electrode (7), opto electronic devices (7), etc but little work has been reported concerning the thin film state (7). Although there have been several studies on the growth and characterization of InSe thin films, deposited by different growth techniques, there is still a lack of understanding of the electrical and structural properties which strongly affect device performance (3). Therefore we have made an attempt to synthesize indium selenide thin films by vacuum evaporation technique.

MATERIALS AND METHODS

The In-Se alloy was prepared from its own constituent elements. Appropriate weight of indium and selenium (purity 99.999%) were mixed together and placed in a quartz ampoule which was heated in furnace at temperature 1070^0C for 24 hours. Then sudden cooled by melt quench method. Thin films of InSe, varying thickness from 1000, 1500, 2000, 2500, $3000A^0$ were obtained on clean glass substrates held at room temperature, by vacuum evaporation technique at a pressure of 10^{-5} torr by thin film coating unit model no 12A4D. The lateral dimensions of the glass substrates were size 75mm × 25mm × 1.35mm and the source to substrate distance was 20 cm. A quartz crystal monitor model No. DTM 101, was used to measure the thickness of the films. In each deposition, a given quantity of material was taken in the boat of molybdenum and evaporated at the rate of 5 to10 A^0 per second. The deposition conditions were nearly the same during each evaporation.

X – Ray diffractogram (Rigaku Miniflex, Japan) were obtained of these samples to find out structural information and to identify the film structure qualitatively. The scanning angle (2θ) range was from 20^0 - 80^0 (CuK_α line).

The thermoelectric power (α) is measured by integral method (8). In integral method one end of the sample is heated while the other end is held at constant temperature. The temperature difference (ΔT) between two ends of sample causes the emf generation. "Pushpa Scientific" Hyderabad provided the experimental set up used for the measurement of thermal emf. Maximum temperature gradient obtainable is 150^{O}C in this set up.

RESULT AND DISCUSSION

The structural composition of the grown films was studied through the XRD analysis and optical microscopy. Figure 1 shows the XRD pattern of InSe thin film prepared at substrate temperature of 303k. The presence of large number of peaks indicates that the films are polycrystalline in nature [4, 5]. These results are well in agreement with the reported values. The grain size is found to be 11.18-11.93 nm.

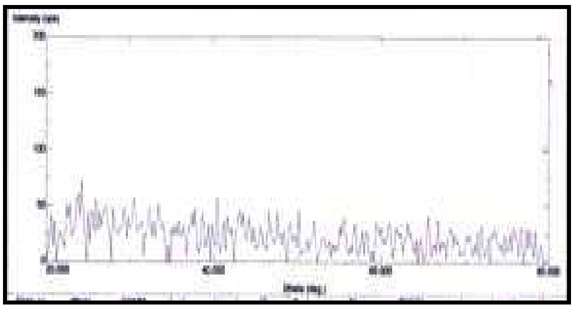

Fig.1 XRD of InSe thin film of thickness 2000 Å

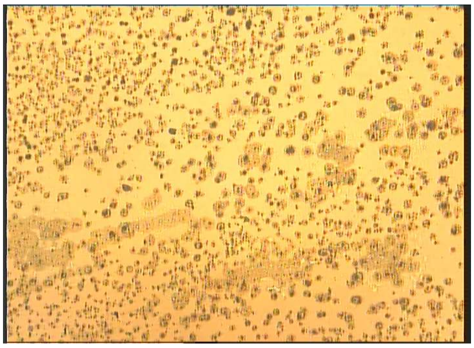

Fig. 2 Micrograph of InSe thin film of thickness 3000 Å

Figure 2 shows the photomicrograph of the InSe films of thickness 3000 Å. The films exhibit the growth of small grains distributed uniformly across the surface of the substrate.

The graphical representation of thermo emf verses change in temperature for different thickness of InSe thin films are shown in figure 3 and the graphical representation at Seebeck coefficient versus 1/ΔT for different thickness at phase thin film are as shown in fig 4.The positive slope of figure 3 shows that deposited films are P- type semiconductig nature. From figure 4 the estimated values of the Fermi energy and absorption coefficient were calculated and represented in table 1.

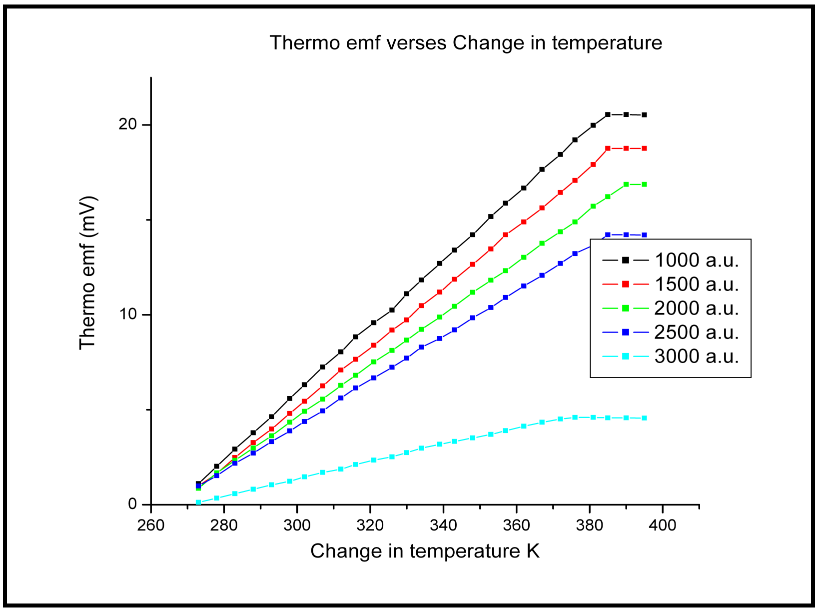

Fig 3: Thermo emf Verses ΔT

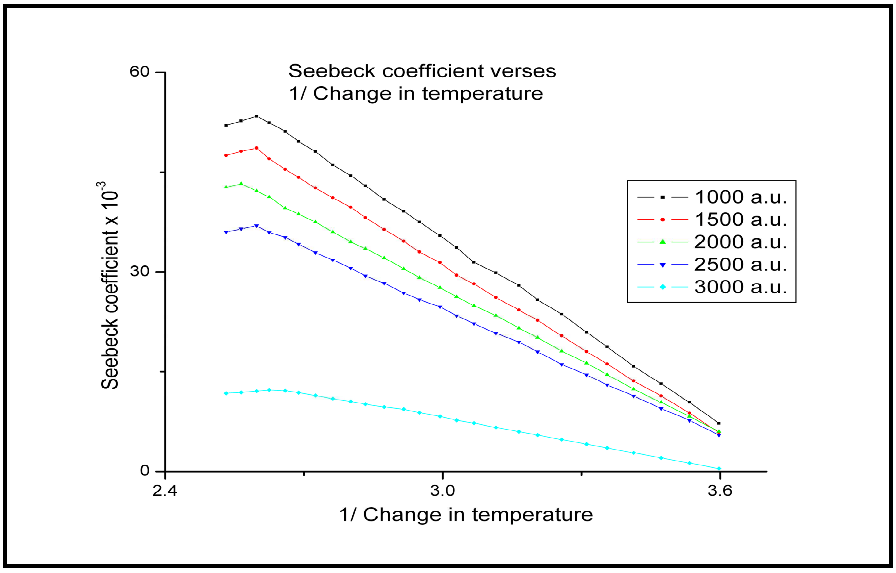

Fig 4: Seebeck coefficient verses 1/ΔT.

Table1

Thickness A^0	E_f eV	A
1000	1.23	1.94
1500	1.00	1.82
2000	0.8466	1.53
2500	0.92	1.456
3000	0.8927	1.431

CONCLUSION

From the temperature dependence of Thermo Electric Power the Fermi energy (E_f) and absorption coefficient (A) are thickness dependent and the deposited films were P type semiconductig in nature.

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