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BAND GAP STUDIES ON Se-Te-Sn TERNARY GLASSY FILMS

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Ternary glasses of desired composition were prepared by well-established melt quenching technique. So prepared material were then used to deposit thin films on glass substrate employing flash evaporation technique. Amorphous nature of the films was confirmed by their XRD patterns. Optical band gap of these thin films was determined with the help of absorption spectra of the films of different concentration of Sn in the Se-Te-Sn glassy matrix. It is observed that band gap decreases with the increase of Sn concentration in the system. This variation in the band gap is explained on the basis of change in structure of the system due to the introduction of Sn in Se-Te-Sn glassy system.

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1. Introduction

The pioneer experimental work of Ovshinsky [1, 2] on switching and memory has shown that amorphous materials have a bright future with a lot of useful potential applications concerned with their electrical and optical properties. In early 70's, the sensitivity of the chalcogenide alloys to the light has been already recognized [3-5] and xerography was widely used [6]. The photocrystalization [3] and the ability of Ovshinsky to forsee the future applications make him to hold the world patent on the rewritable optical memory technology that practically developed more than a decade later. Since then, to invent new chalcogenide glass materials for desired optical properties by chemical modification or doping have been a challenge for researchers [7].

Shortcomings of a-Se [8] can be overcome by the addition of other chalcogenides or metals of different group to get new binary, ternary or quaternary chalcogenide glasses with some modified / enhanced properties, which makes them very useful in photonics, X-ray imaging [9], optical fibers, lasers [10, 11] etc. where linear and non linear optical properties of glasses are of main concern [12-14]. Optical linear characterization of a material requires not only the values of both the refractive index and absorption coefficient at a specific wavelength but also their evolution as a function of the optical wavelength [15].

2. Experimental procedure

Powders of $Se_{75}Te_{25-x}Sn_x$ (x = 2, 4, 6 & 8) glassy [16] materials were prepared by melt quenching technique [17]. The high purity constituent materials were taken in elemental powders form. Mixture of these powders was then sealed in a quartz ampoule and this ampoule was heated at a maximum temperature about 900 ºC for 10 hours. The ampoule was frequently shaken to achieve better homogeneity. Finally the heated ampoule was quenched in ice-cooled water. So obtained ingot of material was grinded into its powder form. These powders were then used to deposit films using flash vacuum evaporation technique. The amorphous nature of powders and films was confirmed by X-ray diffraction patterns using Bruker D8 Advance machine. A representative XRD pattern of $Se_{75}Te_{17}Sn_8$ glassy film is shown in Fig. 1. With the help of Ocean Optics USB 2000

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Spectrophotometer, absorption spectra were recorded. These spectra were used to calculate the band gap using Tauc relation. Fig3 2 shows the absorption spectra of these glasses. Fig. 3 shows the calculation of band gap of $Se_{75}Te_{17}Sn_8$ film. Table 1 lists the band gap of glassy films. The variation of band gap with respect to Sn content in SeTeSn system is plotted in Fig. 4.

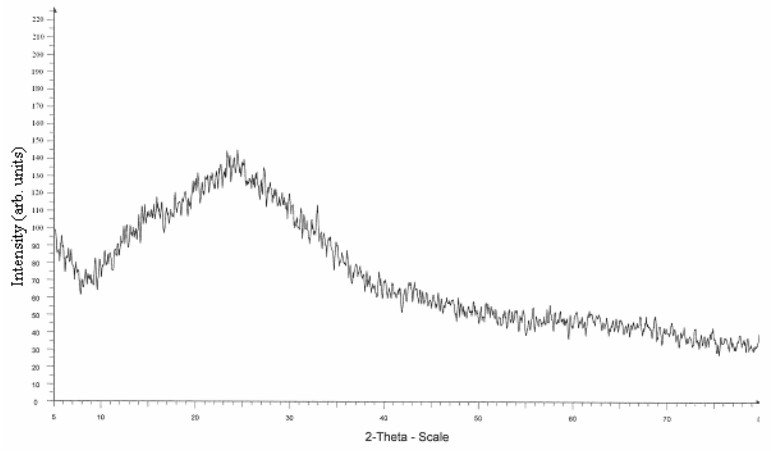

Fig. 1. XRD pattern of $Se_{75}Te_{17}Sn_8$ glassy film.

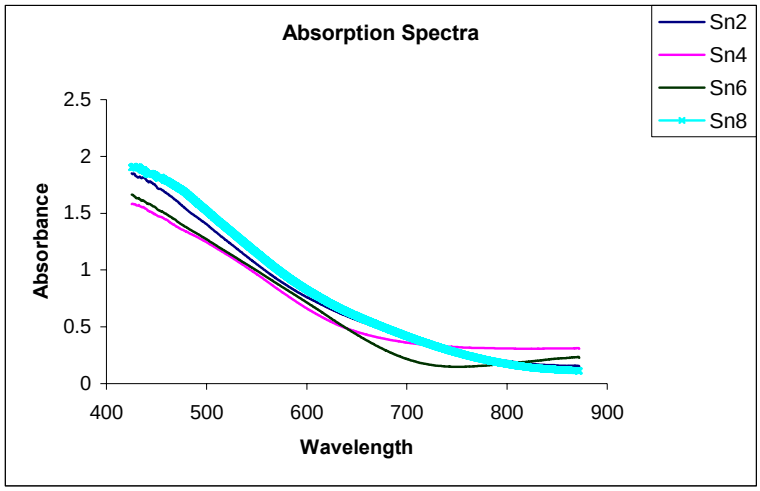

Fig. 2. Absorption spectra of $Se_{75}Te_{25-x}Sn_x$ (x = 2, 4, 6 & 8) glasses.

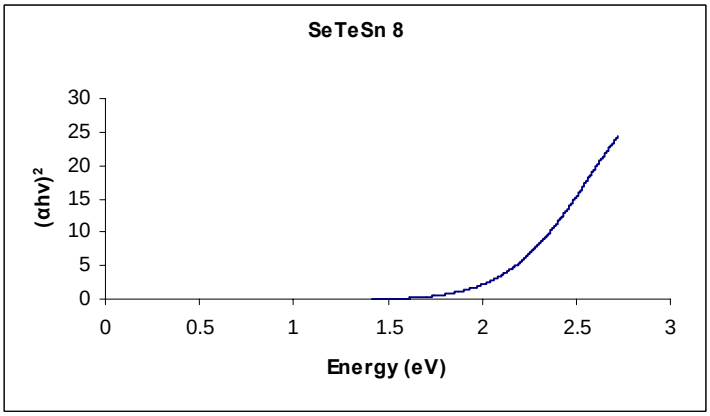

Fig. 3. Band gap calculation for $Se_{75}Te_{17}Sn_8$ glass.

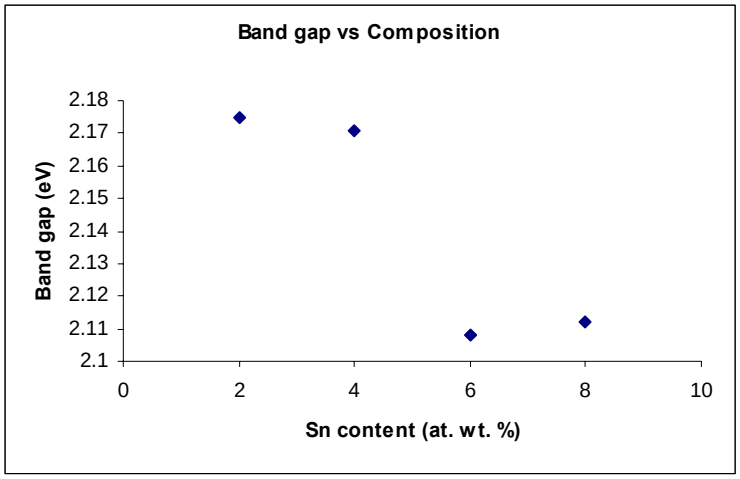

Fig. 4. Variation of band gap with respect to composition of glass.

Table 1. Band gap of $Se_{75}Te_{25-x}Sn_x$ (x = 2, 4, 6 & 8) glasses.

S. No.	Composition of glass	Band gap (eV)
1.	$Se_{75}Te_{23}Sn_2$	2.175
2.	$Se_{75}Te_{21}Sn_4$	2.171
3.	$Se_{75}Te_{19}Sn_6$	2.108
4.	$Se_{75}Te_{17}Sn_8$	2.112

3. Result and discussions

This variation in band gap of these glassy films could be explained on the basis of bond formation between Se & Sn and Te & Sn. The addition of tin in Se-Te system changes the configuration by forming Sn-Te cubic and $SnSe_2$ tetrahedral phase and decreases the concentration of Se_8 member rings. When content of Sn is increased in the SeTeSn system, Sn makes bonds with both Se and Te. Since Sn is added at the cost of Te hence the concentration of Se-Sn bonds (bond energy 402 kJ/mol) increases as compared to Te-Sn bonds (bond energy 320.5 kJ/mol) [18] causing the decrease in band gap upto Sn 6 at. wt. % in the sample. At Sn 8 at. wt. % band gap increases and this increase in band gap can be attributed to the changes occurred during the film preparation.

4. Conclusions

Following conclusions have been drawn:

1. Since the band gap is calculated using Tauc relation with parameter n=1/2, hence, all these glassy films under test possess direct band gap.
2. $Se_{75}Te_{19}Sn_6$ glassy film gives the lowest value of band gap in the proposed series. The band gap decreases as the concentration of Sn is increased from 2 to 6 at. wt. % in the sample. At 8 at. wt. % band gap increases. This increase in band gap may be due to the compositional changes occurred during the preparation of film.

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