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Thermal and Dielectric Properties of Amorphous Semiconductors

ABSTRACT

For the past three decades the properties of amorphous semiconductor have been of great interest for both applied and fundamental considerations. While considerable effort has been expended in the study of both elemental chalcogenides and the binary Se-Te based glassy systems, considerably less work has been done on amorphous Se-S alloys. The purpose of this thesis is to present a wide range of characterization data for the Se-S based glassy systems. Moreover, since chalcogenide glasses have been of great interest for both applied and fundamental considerations, the characterization study have been explained on the basis of recent contributions to the theoretical description of the thermal, electrical and optical behaviour of chalcogenide glasses. The melt-quenching technique was adopted to prepare the entire glassy systems understudy. The prepared glassy systems are $Se_{100-x}S_x$ (x = 5, 10, 15, 20), $Se_{90}S_{10}In_x$ (x = 2.5, 5, 10), $Se_{70}S_{30}Bi_x$ (x = 0, 2, 4, 6, and 10) and $Se_{70}S_{30}Ga_x$ (x = 0, 2.5, 5 and 15).

DSC Measurements has been carried out under non-isothermal temperature control modes. In view of the obtained results the following conclusions can be drawn:

- The incorporation of additive results in significant improvement of the thermal stability of the Se-S phase.
- For all of the investigated compositions the alloying results in decreasing the crystallization rate for the binary glassy system.
- With the exception of Friedman method, all the applied isoconversion methods, Kissinger-Akahira-Sunose, Flynn-Wall-Ozawa and starink method, give consistent values of the calculated crystallization activation energy.

The dielectric and electrical properties of Se-S, Se-S-In and Se-S-Bi glassy systems were carried out in the frequency range 0.12–100 KHz and temperature range 300 - 390 K. In view of the obtained results the following conclusions can be drawn:

- § The frequency dependence of the AC conductivity for S-S and Se-S-In glassy is found to obey the modified form of the universal power law, $\sigma' = \sigma_0 + A\omega^s + B\omega^{s'}$. The observed nearly constant loss (s'=1) for Se-S-In glassy system is attributed to caged ions. The observed relaxation behaviour for Se-S-In glassy system is due to the incorporation of indium which is assumed to be present in In^{+3} ionized state.
- § The investigated Se-S-Bi glassy alloys exhibit negative capacitance in the operating frequency range. The suggested origin of the observed negative capacitance is attributed to the contact injection interface states.

The Optical properties of $Se_{65}S_{30}X_5$ thin films (where X=In, Bi, Ga and Sn) have been studied in wavelength range 250-1000 nm. The thin films were prepared by physical vapor deposition method. In view of the obtained results the following conclusions can be drawn:

- § For the thin films deposited at room temperature, the Ga and Bi additive results in decreasing of the absorption coefficient while the other additives, In and Sn, has no effect.
- § For thin films deposited at low temperature there is massive enhancement in the absorption coefficient as effect of alloying with Bi and In.
- § For the thin films deposited at room temperature, the alloying process results in decreasing the optical band gap while for thin films deposited at low temperature the optical gap decreases due to the incorporation of Bi and In.