Study of Electrical, Optical and Photoelectrical Properties of Noncrystalline Ge-Se-Te Semiconducting Films

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the physics department, faculty of science, Ain shams university

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Abstract

Chalcogenide glasses are attracting materials due to their application in solid state devices. Among these chalcogenide glasses there is the germanium – selenium – tellurium system is one of the most important compounds. Hence the study of these materials continues till the present time. Different bulk $GeSe_{١-x}Te_{x}$ samples (x = ٠٫٣٥, ٠٫٤ , ٠٫٥, ٠٫٦ and ٠٫٧) were prepared using ice – water melting quenching technique under vacuum of $١٠^{-٥}$ Torr. X-ray diffraction analysis, XRD confirmed the amorphous structure of the prepared bulk ingot materials. Differential thermal analysis, DTA data was carried out of $GeSe_{٠٫٤}Te_{٠٫٦}$ ingot material with different heating rates (١٠, ٢٠ and ٣٠ K/ min). The glass temperature, T_g, the onset crystallization temperature, T_c the maximum crystallization temperature, T_p, and the melting temperature T_m were determined from the DTA curves. The activation energy of the glass transition, E_g, and that for crystallization, E_c, were determined by three different methods. The prepared ingot bulk materials were used for depositing $GeSe_{١-x}Te_{x}$ thin films, fixing the film thickness and the other deposition parameters. Thermal evaporation technique under vacuum of ١٠^{-s} torr was used. Films thickness and deposition rate were determined using quartz crystal thickness monitor, connected to the used Edwards E-٣٠٦ coating unit. X-ray diffraction, XRD, and energy dispersion X-ray analysis, EDAX, were carried out. The amorphous structure of the prepared films was confirmed by XRD. The atomic percentage of the constituent elements Ge, Se and Te were identified from the EDAX. Optical transmission curves were obtained for all the prepared $GeSe_{١-x}Te_x$ thin films (x= ٠٫٣٥, ٠٫٤, ٠٫٥ and ٠٫٧). The envelope method was used for the analysis of the optical data. The absorption coefficient and, consequently the optical energy gap were determined It is found that there are allowed direct and indirect transitions. The refraction coefficient, n, the extinction coefficient, k, the real and imaginary parts of the dielectric constant ε_r, ε_i were determined in the wavelength range ٤٠٠- ١٤٠٠ nm. The dependences of both the allowed direct and indirect energy gaps and the width of the tail states upon film composition were studied.. The variation of both the electrical conductivity and the thermoelectric power with temperature were investigated in the temperature range ١٦٠-٣٥٥ K. The conduction mechanism in these films were suggested from the conductivity – temperature curves. Both the conduction and the thermoelectric activation energies were determined from their variation with temperature. The relationships between the conduction and thermoelectric activation energies as a function of film composition were also studied. The variation of the density of charge carriers with temperature was obtained from the thermoelectric power variation with temperature. The a.c. photoconductivity at room temperature was studied for these films using a tungsten lamp for illumination and a chopped light. The frequency dependence method of photoconductivity was used for this study, the life time (response time) was determined from such measurements. The variations of both the steady – state photoconductivity and the response time with film composition were studied.

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