CONDUCTION AND SWITCHING PHENOMENA IN Ge Te Se CHALCOGENIDE GLASS

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Abstract

The electrical conductivity measurements of $Ge_{20}Te_{68}Se_{12}$ glass have been carried out in the range between room temperature and crystallization temperature T_c. The effect of annealing at T_c, on both conductivity σ and activation energy ΔE has been studied. The experimental results show that σ increases while ΔE decreases as the time of annealing ncreases. The structural transformations are used to explain these results. The determination of I-V characteristics is carried out to illustrtate the switching phenomena and interpretation is given on the basis of the electrothermal model.

Introduction

Conduction in amorphous materials, in particular those prepared from the chalcogen elements, is attracting interest because of the mechanism of conduction (1-7). Some of these glasses show a switching between two well defined states. Several investigations have been performed on the physical properties of some chalcogenides, particular those illustrate the switching phenomena (8-12). Till now little attentions are given to investigate the physical properties of Ge Te Se chalcogenide glasses. The stability of these glasses against the effect of aging is very interesting because of their applications in the field of electronics as a memory switching devices.

In the present work, I-V characteristics are studied to illustrate the memory switching of these chalcogenides. In addition, X-ray investigations and conductivity measurements are used to study the effect of aging on the structural transformations.

Experimental

Bulk glass samples were prepated in the conventional way by mixing the pure elements in powder from and then melting in vacuum sealed silica tube at 1000°C for 24 hours. The molten was occasionally shaken to obtain homogenous alloy. The tube was then removed and quenched in an iced water. Structural transformations were confirmed using X-ray analysis. Samples in the powder fotm were investigated using X D-3 Shmiadzu diffractometer. Specimens of 3x2x1 mm^3 dimensions were used in conductivity measurements.

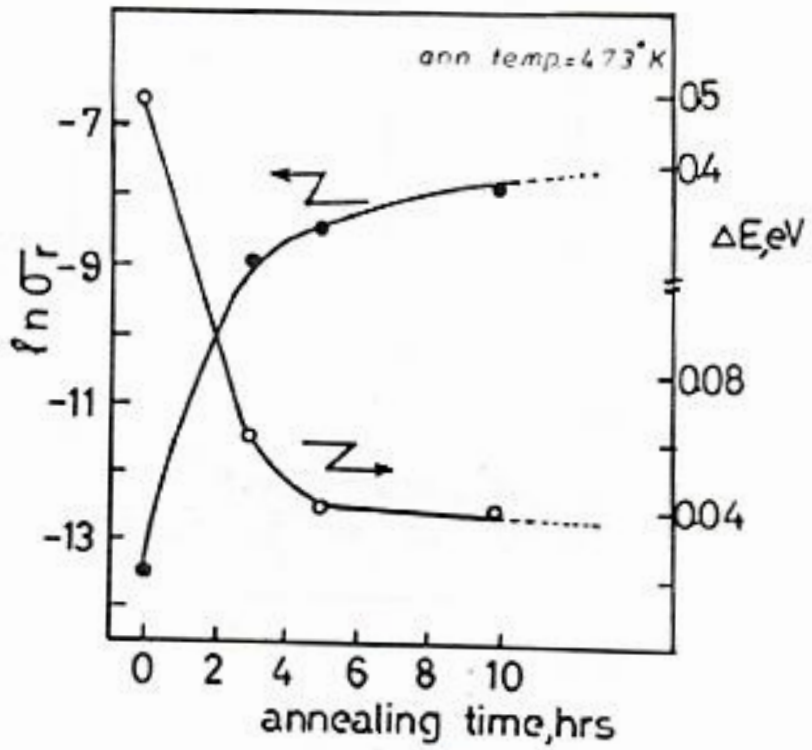

Fig. (1): Ln and E versus the time of annealing at the crystallization temperature (473°K) for $Ge_{20}Te_{68}Se_{12}$ glass.

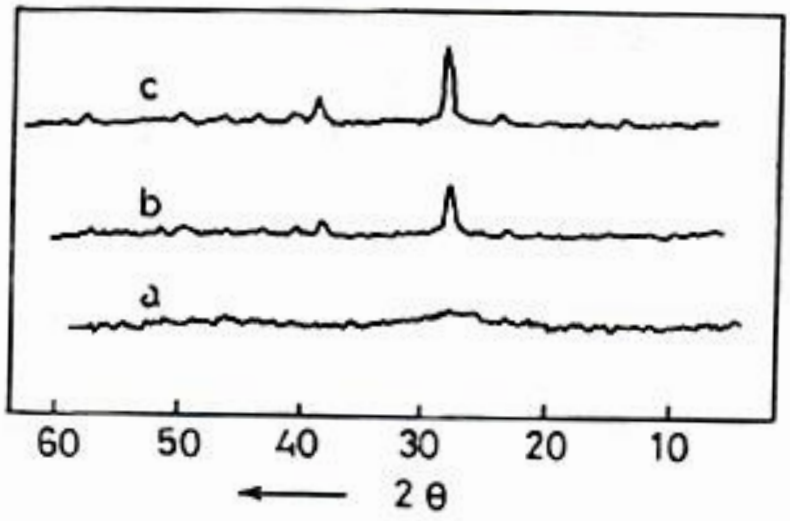

Fig. (2): X-ray diffraction pattern for $Ge_{20}Te_{68}Se_{12}$ chalcogenide (a) Virgin sample (b) Sample annealed for 5 hours at T_c and (c) Sample annealed for 10 hours at T_c.

$$V_{th} \exp (V_{th}/2V_0) = (B\alpha K/\sigma_0 \Delta E)^{1/2} T. \exp (\Delta E/2KT) \quad (3)$$

where α is the thermal conductivity and V_0 is constant. Considering the case of thick layers, of chalcogenide, K. Nakashima and K.C. Kao have approximated equation (3) to be (12).

$$V_{th} = (B\alpha K/\Delta E)^{1/2} T \exp (\Delta E/2KT) \quad (4)$$

Figure (3b) shows the plot of ln $(V_{th}T^{-1})$ versus T^{-1} which is in good agreement with equation (4). The deduced value of ΔE is 0.4 eV. This value is lower than that deduced at low fields (0.49 eV). This leads to the possibility that some field dependence is involved in the process.

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