RESULTS AND DISCUSSION

Chalcogenide glasses have been studied for several years because of their interesting in the field of electronics . The present work deals with dc electrical conductivity measurements and structure analysis, for Ge Te X (where X = Se. or In) . These composition are close to the eutectic point of Ge Te binary alloy (Te_{83} Ge_{17}) . The effect of aging on the electrical conductivity and structure transformation are presented in this chapter . In section 3.1 the electrical conductivity , I-V characteristics and structure transformations will be given for Ge_{20} Se_{12} Te_{68} chalcogenide . Moreover in section 3.2 the electrical conductivity , I - V characteristics and structure transformation will be given for $Ge_{27}Se_{11}$ Te_{62} system. Finally in section 3.3 also the electrical conductivity, I-V characteristics and structure transformation will be given for Ge_{15} Te_{75} In_{10} system.

3.1- Electrical conduction and microstructure for system $Ge_{20}Se_{12}$ Te_{68}:-

The effect of the thermal annealing on the electrical conductivity of Ge_{20} Se_{12} Te_{68} system is studied to show the stability of these materials as devices . Samples of 2 x 2 x 1 mm^3 dimension are prepared according to the mentioned method (chapter II). The samples are annealed at two degrees of temperature , the first is 423°K (before the crystallization temperature) and the second is 473 °K (the crystallization temperature). The samples are devided into two sets . Each sample of the first set is annealed at the desired temperature 423°K for a certain period, and left to cool slowly to room temperature . Then the conductivity σ , is measured starting from room temperature in steps up to 473°K. Figure (3.1) illustrates the temperature dependence of σ for the first set of samples . The conductivity σ obeys Arrhenious relation in the form : -

$$\sigma = \sigma_o \exp(-\Delta E / KT) \qquad 3.1$$

where σ_o is constant, ΔE the activation energy and K is Boltzman constant . The calculated values of ΔE as well as the room temperature conductivity after annealing are given in Table (3.1) . It is clear that the room temperature conductivity σ_r increases with the

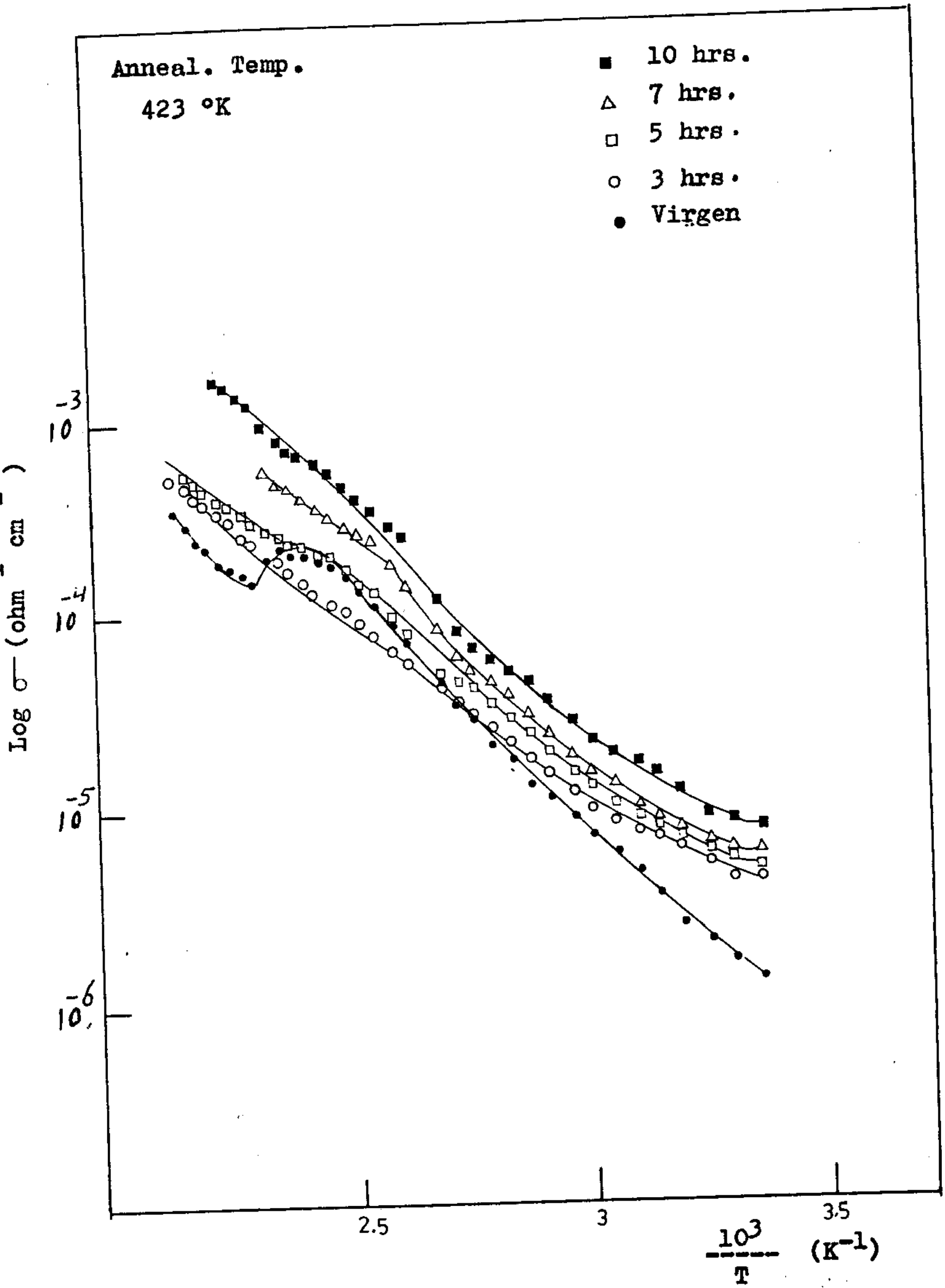

Fig.(3.1): Log σ Vs $\frac{10^3}{T}$ for Ge_{20} Se_{12} Te_{68}

samples annealed at 423°K

Table (3.1)

Effect of annealing temperatures and annealing time on the activation energy (ΔE) and electrical conductivity at room temperature (σ_r) for $Ge_{20}\ Se_{12}\ Te_{68}$ system.

Anneal. temp. °K	Anneal. time. hrs.	ΔE eV	σ_r $ohm^{-1}cm^{-1}$
423	0	0.49	1.4×10^{-6}
	3	0.38	4.2×10^{-6}
	5	0.37	5.0×10^{-6}
	7	0.43	6.0×10^{-6}
	10	0.44	7.7×10^{-6}
473	0	0.49	1.4×10^{-6}
	3	0.06	1.3×10^{-4}
	5	0.04	2.2×10^{-4}
	10	0.04	4.0×10^{-4}
	20	0.045	4.8×10^{-4}

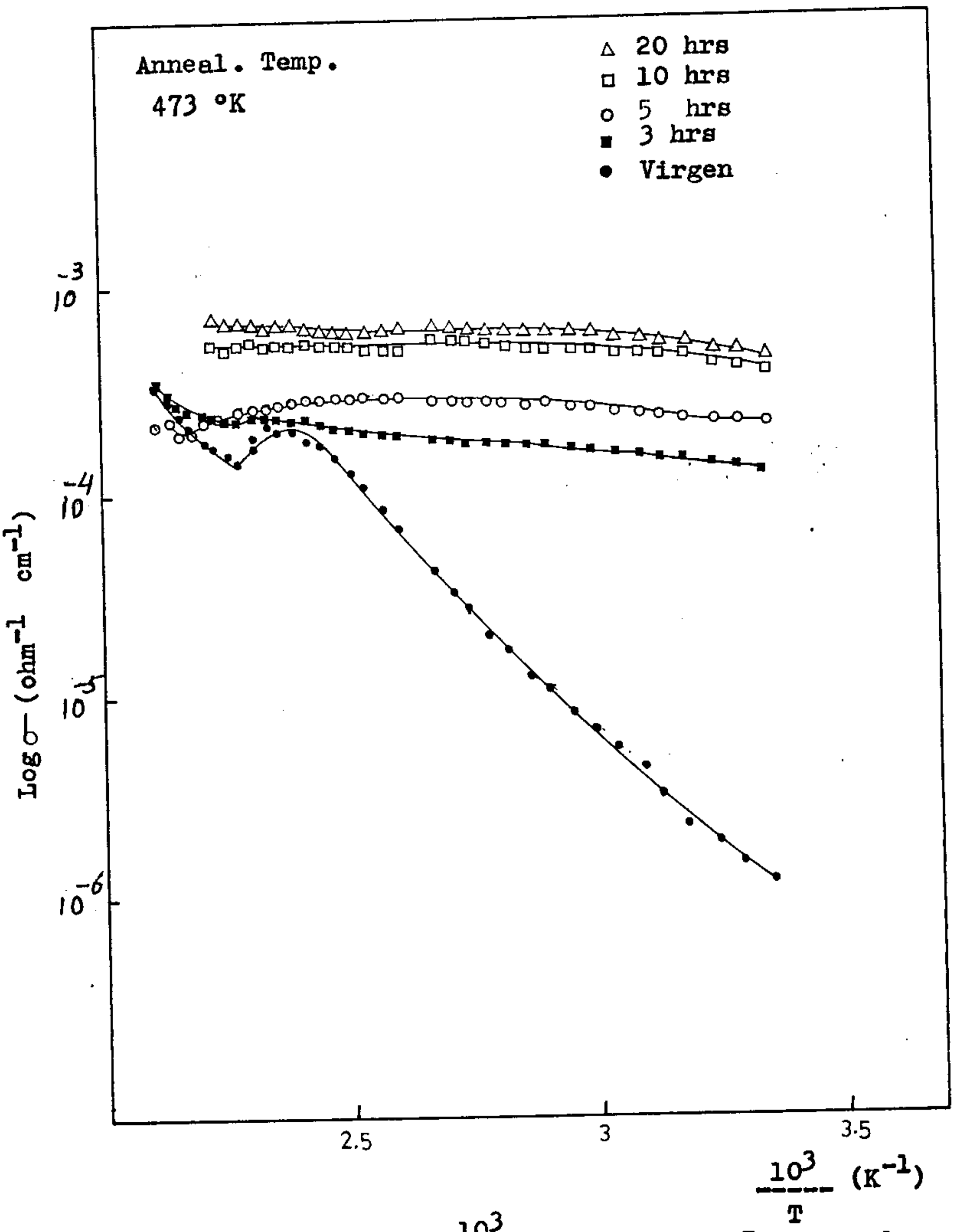

Fig.(3.2): Log σ Vs $\frac{10^3}{T}$ for $Ge_{20}\ Se_{12}\ Te_{68}$ samples annealed at 473 °K .

It is clear that the extention of annealing temperature to T_c (crystallization temperature)enhances the amorphous - crystalline transformation . From the above discussion, it is noticed that the decrease in ΔE and the increase in σ_r with annealing time is due to the formation of microcrystalline phase , embeded in the amorphous matrix . This phase will act as a conductivity path ways for carrier transport . The time dependence of σ for Ge_{20} Se_{12} Te_{68} glassy material at the crystallization temperature (T_c = 473 °K) was conducted to study the crystallization kinetics of this system. Figure (3.3) shows the time dependence of σ , the σ-values increases monotonically with the time of annealing . The crystallization kinetics process could studied from (conductivity - time relation) by applying Avrami's equation (36,44) in the form :-

$$\theta = \exp(-B\,t^{n}) \qquad 3.2$$

where θ is the amount of material left uncrystallized at time t, n is an integer constant depending on the mechanism of crystallization, B is the crystallization

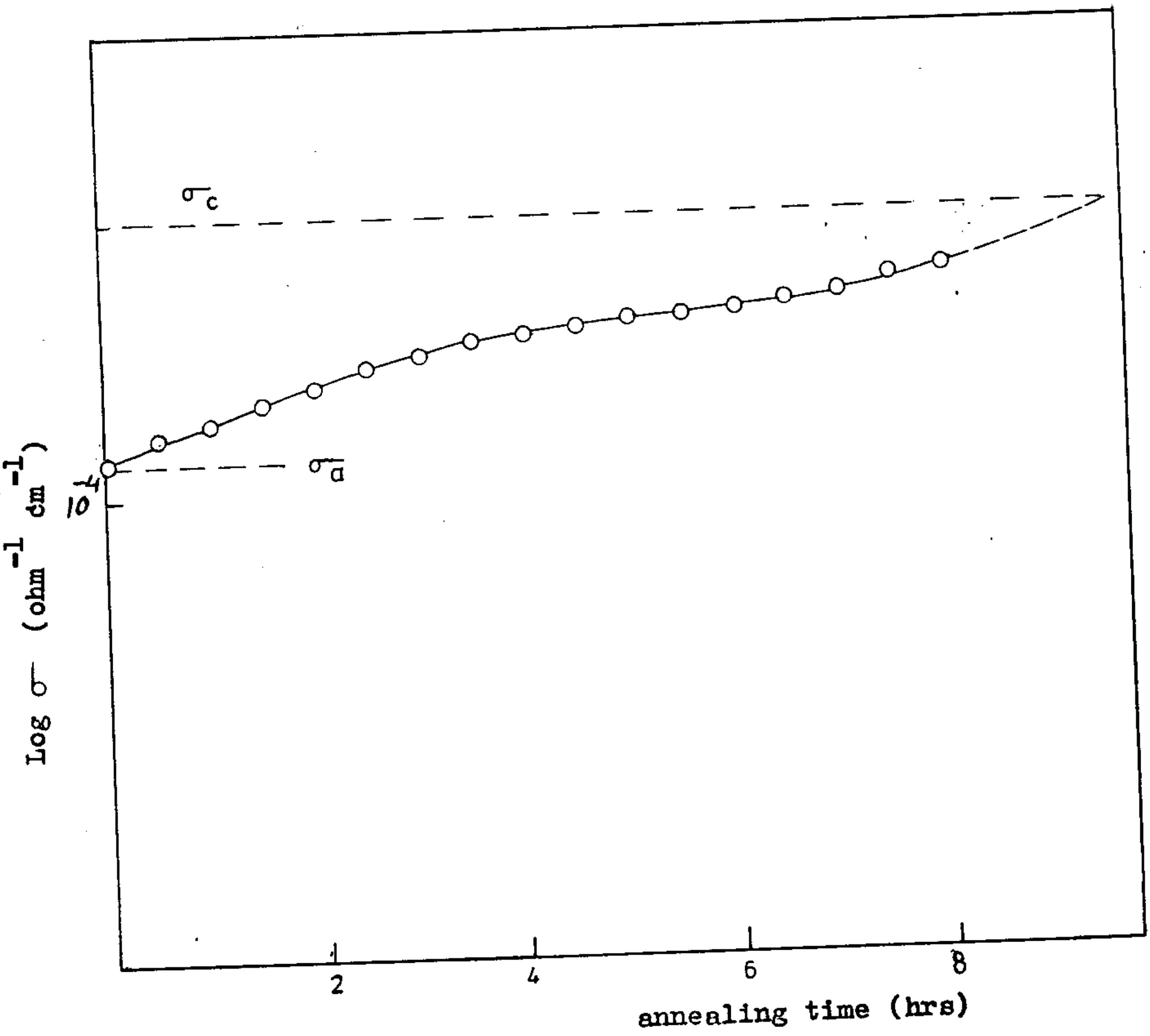

Fig.(3.3): Log σ Vs annealing time for $Ge_{20}\ Se_{12}\ Te_{68}$ at 473 °K.