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Temperature Dependence of the Frequency Exponent for $(Ge_{0.17}Se_{0.83})_{100-X}In_X$ Chalcogenide glasses

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Abstract: *The Ge-Se-In ternary system is a prototypical chalcogenide system.The frequency exponent (s) were carried out in the temperature range 300 to 423K. The temperature dependence of the frequency exponent (s) is reasonably well interpreted by the correlated barrier hopping model. The maximum barrier height is also interpreted. The barrier height (W_m) agrees with theory of hopping charge carrier over potential barrier between charged defect states as suggested by Elliott in case of chalcogenide glasses.*

Keywords: *frequency exponent, maximum barrier height and optical gap.*

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I. Introduction

Chalcogenide glasses are promising material for optical applications such as infrared power delivery, thermal imaging, all optical switching, optical limiting etc.[1-5]. These glasses are highly photosensitive and the photosensitivity mechanism in these materials is complex due to transformations involving local electronic, electro-optic, thermal, and photo structural and photo-chemical phenomena.

Chalcogens (Se, Te and S) are basis elements in many ternary and quaternary systems in which the third or fourth components are added as a glass network former such as Ge and Si.[6-7], or as an impurity to modify the investigated properties of amorphous materials [8-10]. This category of materials do not have long-rang order, exhibit semi-conductive properties such as band gap, switching phenomena which have been measured and discussed by many investigators. It is considered that many of these properties are due to presence of localized states [11-12]. The present work reports the dependence of frequency exponent over a wide range of temperature and on optical energy gap for $(Ge_{0.17}Se_{0.83})_{100-X}In_X$ (X = 0, 5, 10, 15) Chalcogenide glassy systems.

II. Theoretical Consideration And Discussion

The frequency exponent (s) and absolute temperature (T)is correlated according to the following equation [13],

$$S = 1 - 6k_BT/W_m$$

Where k_B = Boltzmann constant

T = Absolute temperature

W_m = the maximum barrier height which is energy required to take two electrons from the D^- state to the conduction band in the absence of D^+ states.

It is known that the value of Wm is related to the optical band gap [14]. The obtained value of W_m is excepted to be equal to $E_g/4$.The measured value of E_g for the present composition are communicated in the previous published paper [15]. The measured value of E_g and W_m are listed in Table-1.

Table-1: Value of Optical gap (E_g) and Maximum barrier height (W_m) for the $(Ge_{0.17}Se_{0.83})_{100-X}In$ Chalcogenide glasses

Composition	Optical energy gap E_g (eV)	Max. barrier height W_m (eV)
X = 0	2.653	0.663
X = 5	2.584	0.646
X = 10	2.579	0.644
X = 15	2.562	0.640

The working temperature dependence of the frequency exponent (s) for the investigated composition is illustrated in Fig.-1.

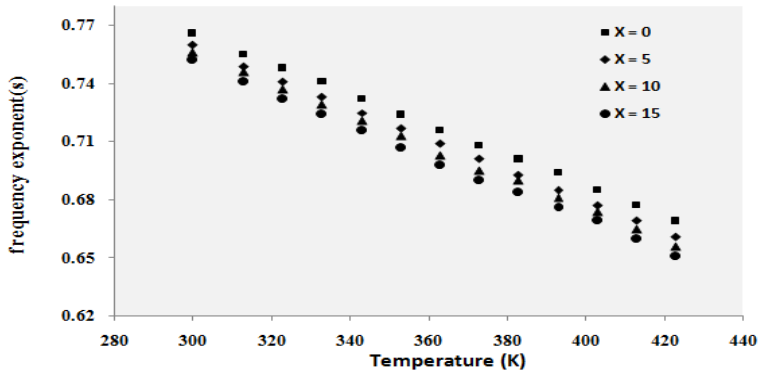

Fig.-1, Variation of frequency exponent with temperature

It is clear that (s) has a value less than the unity in the range 0.766 to 0.669 for X = 0, 0.760 to 0.661 for X = 5, 0.756 to 0.656 for X = 10 and 0.0.752 to 0.651 for X = 15 composition and decreases with increasing working temperature. The observed behavior of s(T) may be analyzed by assuming that the ac conduction mechanism is correlated barrier hopping model [16]. According to this model the conduction occurs via a bipolar hopping process where two polarons simultaneously hop over the potential barrier between the two charged defect states D^+ and D^- and the barrier height is correlated with the inter-site separation via a Coulombic interaction.Shimakawa [17-18] suggested further that at higher temperature D^O states are produced by thermal excitation of D^+ and D^- states and a single polaron hopping becomes the dominant process.

III. Conclusion

In the temperature range 300K to 423K, the frequency exponent (s) is the temperature dependence, decreasing with increasing temperature through the temperature range and conduction support the correlated barrier hopping model.

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