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Study of Sulfur dopped kinetics parameters on $Se_{95-x}S_xZn_5$ for Chalcogenide Nanostructures

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ABSTRACT

The kinetics parameters of $Se_{95-x}S_xZn_5$ $0.2 \le x \le 10$ *are analyzed by using an isothermal the processes of crystallization kinetics are taken at the temperature (between glass transition temperature and the crystallization temperature). The crystallization temperatures and glass transition temperatures of sample are measured by using the differential scanning calorimeter at the heating rate of* ^0C*/min. Annealing at higher temperature leads to the creation of crystalline phase. The order parameter (n) and the activation energy of crystallization (*ΔE_c*) are calculated by fitting the data of extent at crystallization (α) in the Avrami's equation. The temperature dependence dc conductivity of sample is measured for study of conduction mechanism. The dc conductivity is increases with increase of Zn concentration in the glassy alloy.*

Keywords: Chalcogenide Nanostructures; Crystallization; Avrami Index; Activation energy; dc Conductivity.

I.INTRODUCTION

From last few decades the nanosize materials, as a type of new quantum solid materials, have been subjected to extensive research for their unique physical and chemical properties. Selenide sulfur Zinc $Se-S-Zn$ is a promising candidate from II-VI semiconducting materials due to their potential application in optoelectronic devices such as green-blue light emitting diodes (LED), laser diodes (LD) and solar cell, etc. [1–2]. $Se-S-Zn$ is a direct band gap semiconductor material with energy band gap 2.77 eV at room temperature [3]. This makes it a promising material for photo-electronic devices. It can also be used as dielectric mirrors; optically controlled switching devices [4]. Therefore, $Se-S-Zn$ is of great interest as a model material in such form as thin film, quantum wells and bulk crystals [5]. A wide range of applications could be anticipated in the use of nanometer size particles in electronic devices [6]. In current years, due to the number of practical applications in the field of optoelectronics and electro-optics, a great deal of interest has been shown in the study of the dielectric and conduction behavior of various semiconducting materials [7-9]. However, most of the experimental work carried out so far for $Se-S-Zn$ relates to various conduction mechanisms, which only provides information about the nature of transport processes.

The grand Scenario of amorphous chalcogenide glasses display many useful properties and are recently drawn great attention because of their use in various solid state devices. Moreover, they are interesting as core

materials for optical fibres for transmission especially when short lengths and flexibility are required [10]. These glasses based on transition metals are soft magnetic materials and are extensively used in the electronics and power industries [11]. The physical properties of materials depend on their atomic structure. Chalcogenide glasses do not retain their atomic structure obtained on production and the change in structure is dependent on the conditions under which a sample is stored [12]. Crystallization of chalcogenide glasses plays an important role in determining the transport mechanism, thermal stability and practical applications [13]. The study of the crystallization of a glass upon heating can be undertaken in several ways. Two popular methods, isothermal and non-isothermal methods have been widely employed for the study of the crystallization behaviour of chalcogenide glasses upon heating. In method of isothermal, the sample is brought quickly to a temperature above the glass transition temperature and the heat evolved during the crystallization process is maintained as a function of time. Moreover, it is suggested in many studies that the stability of metallic glasses are influenced by the production process and composition, which led to different initial structure and energy states [12]. The electrical properties are subjective by the structural effects associated with the thermal effects and can be related to thermally induced transition [14]. During non-isothermal method the sample is heated at a fixed rate and the heat evolved is again recorded as a function of temperature. During heating, various chalcogenide based glassy systems exhibit three consecutive transformations: glass transition ⇨ crystallization ⇨ melting. We used small amount of sulfur content in Se-S-Zn system to see the effect of Sulfur in Se based alloys at low concentration and the results are explained in terms of Se-S-Zn bonding. The present message reports the investigation of the crystallization behaviour of $Se_{95-x}S_xZn_x$ glasses by means of an isothermal method using conductivity measurements. We have chosen selenium because it exhibits [15] excellent property of reversible transformation. The property of these systems very useful in optical memory devices: xerography rectifiers, photocells, memory devices etc. However, pure selenium has low sensitivity and short lifetime. This problem can be overcome by alloying Se with some impurity atoms (Sb, Bi, Te, Ge ,Zn and As etc.) which gives high crystallization temperature and high sensitivity and smaller ageing effects [16]. Here we have chosen Sulfur as an additive. The addition of ternary element is quite useful to understand the electrical properties in chalcogenide glasses.

II.EXPERIMENTAL

The highly pure glassy $\mathbf{Se_{95-x}S_xZn_5}$ alloy materials (99.999%) (x=0. 2,2,5 and 20) are prepared by melt quenching technique and weighed according to their atomic percentages and sealed off in a vacuum of 10^{-5} Torr in quartz ampoules (length 8 cm and internal diameter 9 mm). The sealed ampoules are put in a microprocessor controlled programmable muffle furnace where the temperature is raised at the rate of 4 K/min up to 1123 K and kept at that temperature for 10 hours with common rocking to certify the homogenization of the melt. After that the quenching is to be done in high cool ice water to obtain the amorphous nature. The quenched samples $\mathbf{Se_{95-x}S_xZn_5}$ are removed by breaking the quartz ampoules. X-ray diffraction traces of all samples are use at room temperature by using (A Panalytical (PW 3710) X-ray power diffractometer. The copper (Cu) target is used as a source of X-rays with λ =1.5404 Å (Cu Ka1). Where the scanning angle in the range of 5-70^0, a continuous scan speed of 1^0/min are maintained for all the samples. The similar trends for four samples $Se_{94.8}S_{0.2}Zn_5$, $Se_{93}S_2Zn_5$, $Se_9S_5Zn_5$ and $Se_{85}S_{10}Zn_5$ are given in Fig.1 respectively. The clear sharp peak are indicates the Selenium peaks

in this XRD patterns. Therefore, the peaks are increases with increases the sulfur concentration in the glassy alloy.

DSC scans obtained by heating 8 mg of the powdered sample are kept in the aluminum pan at heating rate at 15^0C/min, using differential scanning calorimeter (Model-DSC plus, Rheometric Scientific Company, UK).The study of crystallization kinetics, it means an isothermal technique using conductivity measurements of the bulk samples in the form of pellets (diameter 1.0 cm and thickness 0.2 cm) are obtained by compressing the fine powder of glassy alloys under a load of about 4.11×10^4 Pa using the hydraulic press.The conductivity are measured in bulk sample by using two steel electrodes inside a metallic sample holder. We have annealed the sample at 350 K (below T_g) for 2 hrs and then it is cooled down to room temperature. The annealing helps to remove trapped moisture. Afterward the conductivity of the annealed sample has been measured. The transformation of (a-c) phase amorphous to crystalline is studied by measuring the dc conductivity (σ_{dc}) as a function of time at various annealing temperatures between the crystallization and glass transition temperatures. To measured the current by using (a digital Pico-Ammeter, Model DPA-111) at constant dc power supply 2.0 volt across the pellet sample and the temperatures are measured by mounting a copper-constant thermocouple near to the sample.Temperature dependence of *dc* conductivity are measured in the temperature range 319-601 K of all the same sample. All the measurement is maintained with a vacuum of ~ 10^{-3} Torr in the complete system.

III.RESULTS AND DISCUSSION

3.1 Powder X-ray diffraction analysis of $Se_{95-x}S_xZn_5$

The diffraction patterns of all $Se_{95-x}S_xZn_5$ samples are noted at room temperature by using (A Panalytical (PW 3710) X-ray powder diffractometer with Cu Kα radiation (λ = 1.5405 Å). All the samples were scanned in angular range of 5-70^0 with scan speed of 0.01^0/s under the similar conditions. From XRD pattern it was clear that all the four samples of $Se_{95-x}S_xZn_5$ are belongs to similar structure of polycrystalline in nature as shown in **Fig.1.** The clear sharp peak are indicates the Selenium peaks in this XRD patterns. Therefore, the peaks are increases with increases the sulfur (S) concentration in the glassy alloy. The X-ray patterns at different temperatures are shown in Figs. 1. The X-ray power diffraction patterns are gives the information about the nature and the structure of annealed samples of $Se_{94.8}S_{0.2}Zn_5$, $Se_{93}S_2Zn_5$, $Se_9S_5Zn_5$ and $Se_{85}S_{10}Zn_{5\,0}$ respectively in the glassy system. The presence of sharp peaks in the X-ray patterns shows the good crystalline nature of the samples. X-ray patterns shows different crystalline peaks due to sulfur, Selenium-sulfur-Zinc (Se-S-Zn) and Selenium (Se) phases. As the composition of Sulfur is increases in the system, the new numbers of crystalline peaks are observed and Se is found be in bonding with Se-S-Zn.The crystallize size is calculated by using Scherer's formula ($D=k\lambda/\beta\cos\theta$) of all the samples and found to be increases with increasing the sulfur (S) concentration in the glassy system $Se_{95-x}S_xZn_5$ and the values of crystallized size are recorded in the Table1.

3.2 Scanning Electron Microscope

From the characterization scanning electron micrographs of $Se_{95-x}S_xZn_5$ all samples it is confirms the polycrystalline nature of the synthesized materials as shown in **Fig.2.** The numbers of nanocrysts are decreases with

increase of sulfur (S) concentration in the complete system. It is clear from SEM micrograph at highest 10% sulfur (S) content that the nanocrysts are disappeared and convert into a single structures with the thickness in the glassy alloys $Se_{95-x}S_xZn_5$ .The morphology of SEM micrograph is suitable with the powder XRD result because the numbers of clear sharp peaks are increases with increase of sulfur (S) concentration in the glassy system.

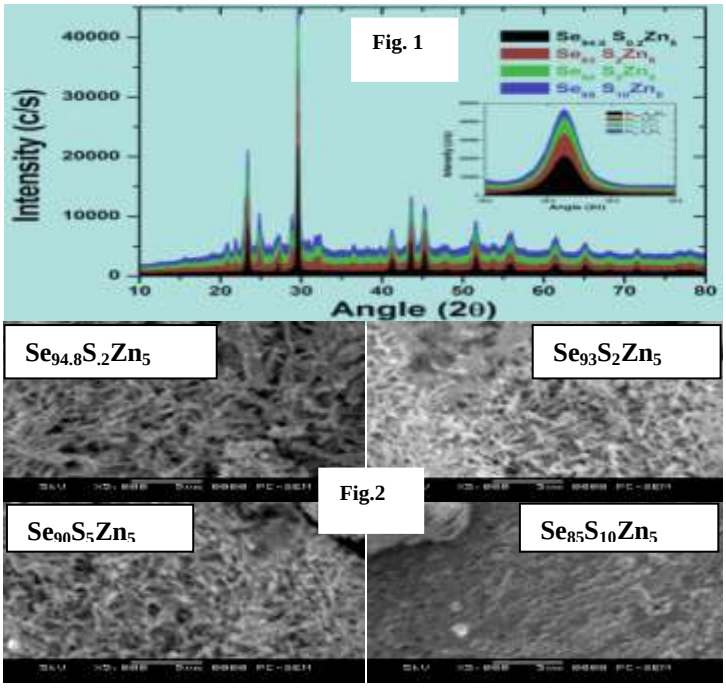

Figure.1. XRD diagrams for all the samples of $Se_{95-x}S_xZn_5$ .Figure.2.SEM micrograph for all the samples of $Se_{95-x}S_xZn_x$ glassy alloys.

3.3 Crystallization Study with Isothermal Process of $Se_{95-x}S_xZn_5$

DSC thermogramm for all samples of $Se_{95-x}S_xZn_5$ are obtained at heating rate at 15^0C/min are as shown in Fig.3.The obtained values of T_g, T_c and their differences are given in the Table 1.The samples $Se_{90}S_5Zn_5$ and $Se_{85}S_{10}2Zn_5$ are shows the double phase transition due to Sulfur and Se both of them have the same electronegativity value as the order of 2.While an isothermal annealed temperature (between the glass transition and crystallization temperatures) the electrical conductivity are varies with time. The Figs. (4) are indicates that time dependence dc conductivity (σ) with various annealing temperatures for $Se_{95-x}S_xZn_5$.The studies of others glassy alloy e.g., $Se_{94.8}S_{0.2}Zn_5$, $Se_{93}S_2Zn_5$, $Se_9S_5Zn_5$ and $Se_{85}S_{10}Zn_5$ are found to be a similar in nature as shown in the Figs. (4). These figures are indicating the three stages transformation of amorphous to crystalline state occurs by AB, BC and CD. In the part AB the conductivity of these curves is increase linearly with time and represents a gradual increase of (σ_{dc}) as a result of normal heating of the sample. The part BC shows a gradual but less pronounced increase in (σ_{dc}), which may be due to the nucleation of the crystalline phase. Since, the third part CD of these curves represents the release of thermal energy during the growth of crystalline phase, which is being totally lost from the samples and find a constant limiting value after a certain time. In the present study, we are

paying attention in understanding the crystallization phenomena during crystal growth process, i.e., the part CD of Figs. (4). Here, in the part AB, the conductivity $\ln\sigma_{dc}$ increases very slowly with time due to crystallization of the amorphous samples with time. The part BC shows the crystallization is almost accomplished and in the part CD, the number of grains increases excluding the point D, which gives the information about increasing the size of the grain in the glassy alloy. This is also explained upon combined surface and bulk nucleation of the sample. In the beginning, the surface nucleation starts afterwards surface and bulk nucleation take place [17].

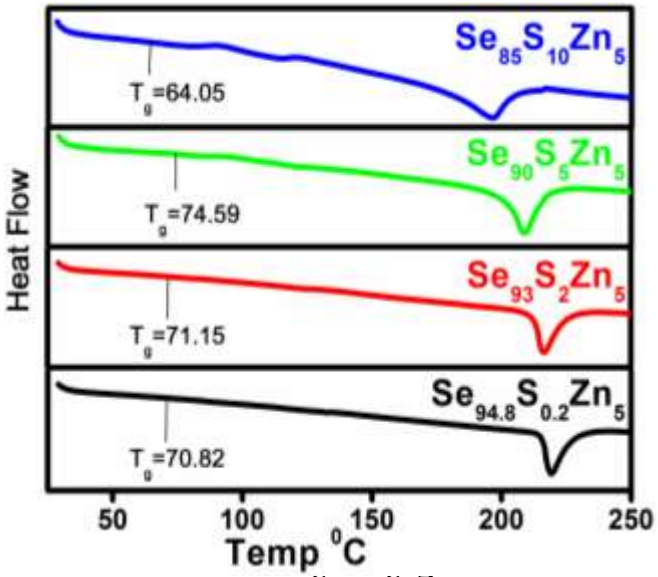

Figure.3.DSC plots for all glassy samples of $Se_{95-x}S_xZn_5$ at the constant heating rate of 15 ^{0}C/min.

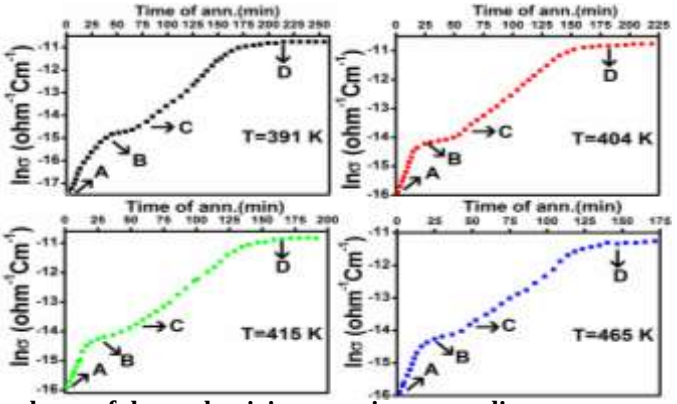

Figure.4.Time dependence of dc conductivity at various annealing temperatures for $Se_{94.8}S_{0.2}Zn_5$ and $Se_{93}S_2Zn_5$ during isothermal a-c phase transformation.

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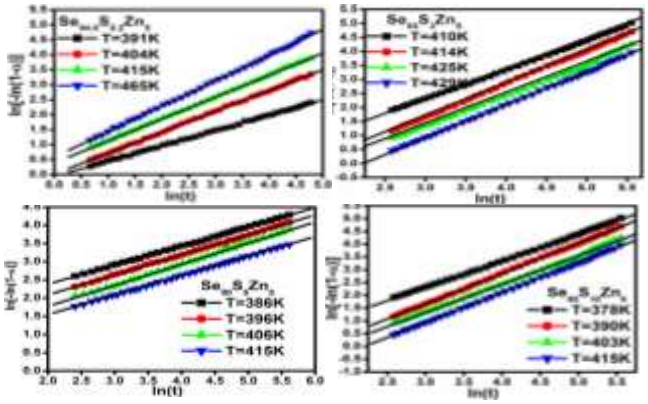


Figure 5. Avrami plots of the crystallization kinetics for all the samples of $Se_{94-x}S_xZn_5$ (x=0.2, 2,5 and 10) for different isotherms in the system.

In an isothermal experiment, the relationship between the nucleation and the crystallization fraction and growth rate is given by Johnson–Mehl–Avrami (JMA) equation [18]

$$\alpha(t) = 1 - \exp(k t^n) \qquad [1]$$

Where α (t), (n) and k are the crystallized volume fraction after time t, the Arvami exponent and the reaction rate constant respectively. It is given by Arrhenian equation as

$$k = \nu \exp\left[-\frac{\Delta E}{RT_c}\right] \qquad [2]$$

Where ν, ΔE_c, R and T are the frequency factor, the apparent activation energy, the ideal gas constant and an isothermal temperature respectively in Kelvin [19].The changes of any physical quantity are evaluated upon the crystallization and α can be taken as a characteristic parameters to measure with a function of time. The dc conductivity are used [20] as useful parameter to study the crystallization phenomena in chalcogenide glasses. The theory developed by Landauer for random mixtures based on the assumption that one of the phases (the dispersed phase) are surrounded by the homogeneous medium (the continuous phase) which has a different conductivity. The exponent of crystallization (α) is given by the equation, accordance to this above given theory [21].

$$\alpha = \left[\frac{(\sigma_c + 2\sigma_a)}{(\sigma + 2\sigma_a)}\right] \times \left[\frac{(\sigma - \sigma_a)}{(\sigma_c - \sigma_a)}\right] \qquad [3]$$

Whereσ, σ_a and σ_c are overall conductivity of the mixture, conductivity of amorphous phase and conductivity of crystalline phase respectively in the system. The equation (4) is point out by Landauer [21] and it is only valid for spheroid inclusions and cannot be applied to mixtures having needle or disc-shaped inclusions. On the other hand, this assumption may not be always valid for communicating system, e.g., alloys as used in the recent case. To calculate the conductivity of mixture (σ) during amorphous to crystalline transformation and Odlevsky [22] has been recommended a power formula.

$$\sigma^l = \alpha \sigma^l{}_c + (1-\alpha)\sigma^l{}_a \qquad [4]$$

Where (1 – α) and α are the volume fractions of σ and σ_c respectively. The calculated conductivity (σ) at a particular time during crystallization can be written as at power *l* =1.

$$\sigma = \alpha\sigma_c + (1-\alpha)\sigma_a \qquad [5]$$

In other words, when logσ is consider to representing the responsive parameter characterizing the conductivity of time dependence and then an empirical power formula can be written as

$$\log\sigma = \alpha\log\sigma_c + (1-\alpha)\log\sigma_a \qquad [6]$$

The author Kotkata et al. [23] is used the equations (5) and (6) to evaluate the degree of crystallization in some chalcogenide glasses. In which the equation (6) is found to be good satisfactory since, (σ_c-σ_a) has logically appreciate values in these glasses. The conductivity increases by several orders of magnitudes on crystallization in this present case. Since, equation (6) should be used to evaluate α by measuring σ with a function of time during isothermal annealing temperatures under below the crystallization temperature. Here, many workers [24-25] have also been calculated the value of extent of crystallization (σ) by using these relationships in chalcogenide glasses. The kinetic parameter (ΔEc and n) can be calculated by using equations (2) and (3), where the values of volume fraction α as a function of time are known at different isothermal temperatures of the transformation. The α has been calculated as a function of time at various annealing temperatures with the help measured values of conductivities, by using equation (6) where σ_a and σ_c are time dependent conductivity at point C, and at point D respectively in each curve of Figs. (4).It is mention here that point C and point D are taken as the growth kinetics of crystallization and where the material become completely crystallized respectively in each curve of Figs. (4). The variations in values of α as a function of time for all samples of $Se_{95-x}S_xZn_5$ glasses have the similar and here, we are presented the variation of α as a function of time for all the sample of $Se_{95-x}S_xZn_5$.

According to JMA formulation the value of order parameter 'n' can be calculated by plotting the curve between ln *t* vs. ln [- ln (1 - α) $^{-1}$] at different annealing temperatures for all the glassy samples of $Se_{95-x}S_xZn_5$. The four Avrami plots of the crystallization kinetics for all the samples of $Se_{94-x}S_xZn_5$ (x=0.2, 2,5and 10) are shows in Fig.5. All the plots of $Se_{94.8}S_{0.2}Zn_5$, $Se_{93}S_2Zn_5$, $Se_9S_5Zn_5$ and $Se_{85}S_{10}Zn_{5\ 0}$ are gives the similar trends respectively. The value of the order parameters (n) are calculated from the slope of the curve and rate constant (k) from the intercept on x-axis of Fig.5. The calculated values of order parameter (n) for all the samples of $Se_{95-x}S_xZn_5$ at various annealing temperatures are specified in Table 2.The Author [26] is calculated the value of order parameters (n) by using the non-isothermal method. The values of parameter (n) are satisfied with [26]. It is also clear from the Table 2 that the values of order parameter (n) are in the range of (1.17- 0.51) for all the samples at all the temperatures of measurements. The value of n = 1, shows one dimensional growth of crystalline [25] in the present glassy system. The curve ln k versus 10^3/T curves for all the glassy alloys of $Se_{95-x}S_xZn_5$ which comes to be straight lines. These observed straight lines in are gives validity confirmation of Eq.2. On the crystallization, the compositional dependent activation energy (ΔE_c) are calculated from the slope of this curve. The considering values of the compositional dependent activation energy (ΔE_c) are given in Table 2. It is observed from this table that the values of the compositional dependent activation energy (ΔE_c) for the crystallization are decreases linearly at % (2-10) of Sulfur content in the glassy alloy. By adding a little amount of Sulfur impurity in Selenium (Se) based system then the compositional dependent activation energy (ΔE_c) decreases

linearly with increase the concentration of Sulfur during the crystallization process of the present system. Therefore, the activation energy indicates that the speed of the rate of crystallization is very fast due to compositional dependent activation energy (ΔE_c) decreases linearly with Sulfur concentration. The minimum activation energy and maximum activation energy are found at 0. 2% and 2% of Sulfur concentration respectively and added impurity into Selenium (Se) based system. The system Se-S-Zn has a Sulfur blended structure both in thin films and bulk form [27-28]. The Sulfur blend structure is the most performed structure for Zn_xCd_{1-x}-Se_x on glass substrate and the grain size decreases with increasing Sulfur content in the system and it is also developed by the author Gupta et al [29].According to J.Schotmiller et al. [30] have studied the effect of the addition of group V element (As, Sb, Bi) on the structure of Se by infrared and Raman spectroscopy. According to them Se has about 40% atoms in a ring structure and 60% atoms are bonded polymeric chains with the conduction of p-type. However, the conductivity is increases that mean the increase the conduction mechanism associated with the impurity atoms [31]. They observed from their studies that the group (V) elements are dissolved into polymeric chains rather than into the Se ring structure. From the above discussion, Sulfur might enter into Se polymeric chains making Se-S-Zn bonds. Similar bonding may takes place with Se atoms. The electronegativity of sulfur is greater than selenium and zinc atom [32-33]. Since, there is the opportunity of Se-S-Zn bonding at greater than 2% concentration of Sulfur. In $Se_{100-x}S_xZn_5$, this effect is more evident if the concentration of Sulfur is 2 %.

3.4 Temperature dependence dc conductivity of $Se_{100-x}S_xZn_5$

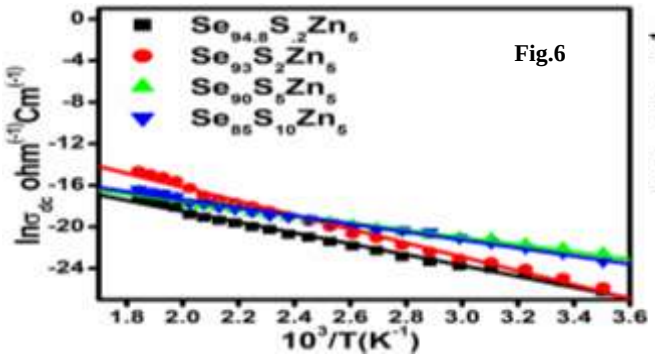
The temperature dependence of dc conductivity (σ_{dc}) for various ternary sample of $Se_{95-x}S_xZn_5$ $0.2 \le x \le 10$ are also measured in bulk. The dc conductivity (σ_{dc}) is decreases exponentially in the temperature range (319–601 K) as given in the Fig.6. These results clearly show the electrical conduction is through thermally activated process with single activation energy in these glasses [34-35]. The conductivity σ_{dc} is expressed by well known relation in case of glassy materials [36].

$$\sigma_{dc} = \sigma_0 \exp\left[-\frac{\Delta E}{kT}\right] \qquad (7)$$

Where (ΔE) is the activation energy for the dc conduction mechanism and 'k' is the Boltzmann constant,'σ_0' is the pre-exponentional factor. The activation energy (ΔE) and pre-exponentional factor (σ_0) calculated from the slope of $10^3/T$ vs. $\ln\sigma_{dc}$ for each sample and the values are given in the Table 3. The dc conductivity (σ_{dc}) and activation energy (ΔE) both are increases with sulfur concentration for glassy system $Se_{100-x}S_xZn_5$ as given in Fig.7. However, the conductivity is increases with S concentration that mean increase the conduction through the defect state associated with the impurity atoms.

To find out a clear distinction between these two conduction mechanisms, Mott [18] has suggested that the pre-exponential factor (σ_0) of equation.7 for conduction in the localized states should be two to three orders smaller than for conduction in the extended states, and should become still smaller for conduction in the localized states near the Fermi level. For conduction in the extended states the values of (σ_0) reported for a-Se a-Ga_xSe_{100-x} and other Se alloyed films are of the order of 10^4 (Ω^{-1} cm^{-1}), while as in the present case values of (σ_0) for a-Se, and other films are found to be greater than 10^4 (Ω^{-1} cm^{-1}).Finally, Mott's has been suggested that conduction in the

localized is completely ruled out and the conduction in the extended state in the band tails is most likely. The value of the pre-exponential (σ_0) are increases with increase of Sulfur content in the system. The mobility of charge carriers in the traps states are increases with increase of Sulfur content in the system [26]. The observed values of (σ_0) are given in the Table 3.



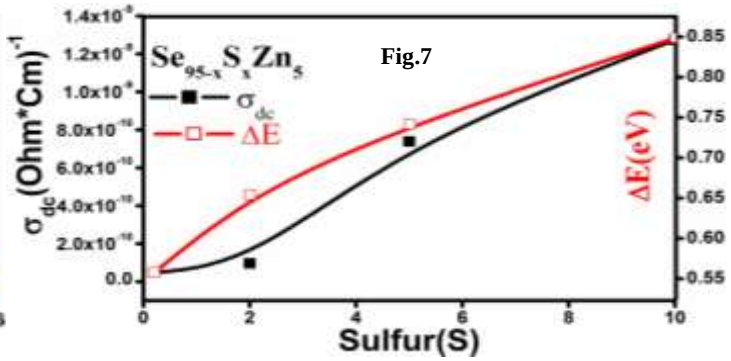


Figure.6.The plots of $\ln\sigma_{dc}$ vs. 10^3 in the temperature range (319-601) for $Se_{94-x}S_xZn_5$.Figure.7.The dc conductivity, Activation energy vs. sulphur (S) concentration for $Se_{94-x}S_xZn_5$.

Table 1.Composition dependence of glass transition temperature (T_g), crystallization temperature (T_c) and their difference for all the samples of $Se_{94-x}S_xZn_5$ using differential scanning calorimeter (DSC) at 15 ^{0}C/min.

Table 2. The value of Avrami exponent (n) at various annealing temperature for all the samples of $Se_{94-x}S_xZn_5$, and compositional dependence activation energy ΔE (eV) for $Se_{94-x}S_xZn_5$ glassy system.

Glassy Alloy $Se_{94.8}S_{0.2}Zn_5$		$Se_{93}S_2Zn_5$	T_c ^{0}C	$Se_{90}S_5Zn_5$	$T_c - T_g$ ^{0}C	$Se_{85}S_{10}Zn_5$	ΔE (eV)
Temp (K)	'n'	Temp (K)	'n'	Temp (K)	'n'	Temp (K)	'n'
391	0.51	417	130.62	386	59.80	378	3.58
404	0.70	424	123.10	396	53.95	390	16.71
415	0.73	425	124.00/83.19	406	49.41/8.60	403	9.18
465	0.85	429	121.10/82.37	415	57.05/18.32	415	7.15
		470	1.16		0.51		1.17
					0.52		1.12
					0.51		1.04
					0.59		1.18
					0.51		1.11

Table 3. Electrical parameters for all the samples of $Se_{94-x}S_xZn_5$ at temperatures T =457 K.

Sample	$\sigma_{dc}(\Omega^{-1}\ cm^{-1})$	ΔE (eV)	σ_0 ($\Omega^{-1}\ cm^{-1}$)	Crystallite Size(L)nm
$Se_{94.8}S_{0.2}Zn_5$	4.82×10^{-11}	0.56	2.59×10^{8}	26.40
$Se_{93}S_2Zn_5$	9.70×10^{-11}	0.66	7.40×10^{9}	32.28
$Se_{90}S_5Zn_5$	7.39×10^{-10}	0.74	1.57×10^{11}	35.51

$Se_{85}S_{10}Zn_5$	1.27×10^{-9}	0.85	6.42×10^{12}	42.87

IV.CONCLUSION

The present research work, we have studied kinetics parameters by an using isothermal method for annealed samples at fix set temperatures above the glass transition temperatures and below the crystallization temperatures and conductivity with time during crystallization. The thermal stabilities are decreases linearly with increase of sulfur concentration. It is found that thermal stability is highest at 0.2 of Sulfur content in $Se_{100-x}S_xZn_5$ the system. The samples $Se_{90}S_5Zn_5$ and $Se_{85}S_{10}2Zn_5$ are show the double phase transition in the system. In double phase transition thermal stability is increases linearly with increase of Sulfur concentrations. The values of order parameters are observed in the range (0.51-1.18), which show that the one dimensional growth of crystallites in the glassy $Se_{100-x}S_xZn_5$ system. The compositional dependence activation energy (ΔE_c) is decreases linearly at (2 -10) % Sulfur content due Sulfur has greater electronegativity than (Selenium and Zinc) for the samples of $Se_{100-x}S_xZn_5$.The compositional dependence activation energy (ΔE_c) is highest at 2% of Sulfur content.

The electrical parameters, the dc conductivity (σ_{dc}) and the activation energy (ΔE) both are increases due to the Fermi level shifted near to the band tails. The defect states are increases with increase of Sulfur in the mobility gap and the band gap are decreases with sulfur in glassy $Se_{100-x}S_xZn_5$ system. The value of pre-exponential factor (σ_0) is increases linearly with increases sulfur concentration. According to Mott, has been suggested that the conduction mostly likely in the extended states.

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REFERENCES

[1] J. Ren, K. A. Bowers, B. Sneed, D. L. Dreifus, J.W. Cook, J. F. Schetzina, Appl. Phys. Lett. 57 1901(1990).

[2] O. Schulz, M. Strassburg, T. Rissom, U. W. Pohl, D. Bimberg, Appl. Phys. Lett. 81 4916 (2002).

[3] S. B. Mirov, V.V. Fedorov, K. Graham, I. S. Moskalev, V. V. Badikov, V. Panyutin, Opt. Lett. 27 909 (2002).

[4] H. R. Dobler, Appl. Opt. 28 455 (2003).

[5] Y. Jing, X. M. Meng, W. C. Yiu, J. Liu, J. X. Ding, C. S. Lee, S. T. Lee, J. Phys. Chem. B 108 2784 (2004).

[6] D. V. Averin, A. N. Korokutov, K. K. Likharev, Phys. Rev. B 44 6199 (1991).

[7] R. D. Gould, C. J. Bowler, Thin Solid Films 164 281 (1988).

[8] B. B. Ismail, R. D. Gould, phys. stat. sol. (a) 115 237 (1989).

[9] S. Gogoi, K. Bagua, Thin Solid Films 92 227 (1982).

[10] J.Y. Shims'. Park, H.K. Bail, Thin Solid Films 292(1997) 25-31.

[11] F.E. Luborsky, L.A. Johnson. , J.Phys. C 8 (1990) 815-820.

[12] G. Riontino, M. Baricco., Philos. Mag. B 61(1990) 700-715.

[13] M.A. Abdul-Rahim., J. Mater. Sci. 27 (1992) 1750-1757.

[14] J.R. Bosnell, G.B. Thomas., Solid State Electron. 15 (1972) 1253-1261.

[15] I. Think. Tanaka, Phys. Rev. B 39 (1989)1265-1270.

[16] S.C.K. Mishra, T.P. Sharma, R. Kumar., Indian J. Technol.28 (1990) 199-205.S.C.K. Mishra, T.P. Sharma, R. Kumar., Indian J. Technol.28 (1990) 199-205.

[17] N.F. Mott, E.A. Davis., "Conduction in non-Crystalline systems" Philos.Mag.22 (1970) 895-903.

[18] M. Kitao, K. Yoshii, S. Yamada., Phys. Stat. Solidi (a) 91(1985) 266-271.

[19] M.C. Weinberg., J.Non-Cryst. Solids 142 (1992)120-126.

[20] M. Avrami., J. Chem. 8 (1940) 207-212.

[21] M.F. Kotkata, M.F. El-Mously, F.M. Ayad, 1979, Acta Phys. Hong. 46 (1996)14-19.

[22] Z. Jiqian, B. Zhonglin, D. Dakui. J. Non-Cryst. Solids 201(1996) 40-47.

[23] M.F. Kotkata, M.K. El-Mously., Acta Phys. Hung. 54 (1983) 299-303.

[24] R. Landauer., J. Appl. Phys.13 (1952) 770-779.

[25] V.I. Odlevsky., J. Tech. Phys. (USSR) 21 (1951) 668-673.

[26] M.F. Kotkata, A.F. El-Dib, F.A. Gani, J.Mater. Sci. Eng. 72(1985) 157-163.

[27] P. Agrawal, S. Goel, S.K. Tripathi, A. Kumar., 1991, J.Mater. Sci. 26 (1991) 4919-4924.

[28] A. Bhargava, A. Williamson, Y.K. Vijay., J.Non-Cryst. Solids 192(1995) 489-494.

[29] M. Nasir, M A.Majeed Khan, M. Husain, M. Zulfequar., J. MSA 2 (2011)289-294.

[30] R. Mach, P. Flgel, L.G. Suslina., J.Phys. Status Solid B 109 (1982) 600-607.

[31] H. Mitsubas, I. Mituishi, M. Mizuta., Jpn. J. Appl. Phys. 24 (1985) 570-578.

[32] P. Gupta, B. Maiti, A.B. Maity., Thin Solid Films 260 (1995) 68-75.

[33] J. Schottmiller, M. Tabak, A. Ward., J. Non-Cryst. Solids 4 (1970)72-80.

[34] N.F. Mott., "Conduction in non-Crystalline systems" Philos. Mag. 22(1970) 1-7.

[35] S. A. Khan.M. Zulfequar, M. Husain., J.Current Applied Physics (3)(2003) 337-343.

[36] Shagufta B. Husain, M. Zulfequar, M.A. Majeed Khan, J.Current Applied Physics 4 (2004) 445-451.