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Electric and Dielectric Properties of Chalcogenide Optic Fiber Material Based Selenium

M.M.El-zaidia ,Z.H.El-Gohary, M.S.AboGhazala, G.M.Turky[*] and E.A.Rabea.
Phys.Dept. Faculty of science, Menoufia university shebinEl.koom,Egypt
[*]Microwave Physics & Dielectrics Department, National Research Centre (NRC),Egypt.

Abstract: *- The Ac conductivity of the system $Se_{80}S_{20-x}In_x$ where x= 0, 2.5 ,5 is very small under the effect of each frequency and temperature. The exponent factor of the frequency of the Ac conductivity decreases with temperature. The zero value of this exponent at high temperature confirm, the insulating character of these materials. The dielectric constant and dielectric loss of these materials were very high. At high frequency, the dielectric constant becomes temperature independent. The addition of In on the expense of S, decrease the Ac conductivity and increase the dielectric properties of these materials.*

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I. Introduction

Chalcogenide glasses important for various application such as electronic, optoelectronic, optical and memory switching devices, guided wave devices and infrared telecommunication systems [1-5].

Due to the nature of covalentbonds in chalcogenide glasses which influence on their unique optical and dielectric properties, such as high refractive index, low phonon energy, photosensitivity and chemical-mechanical durability[6-8]. Also, chalcogenide glasses are widely selective for in infrared opticsand Fiberlasers [9].Among chalcogenide elements, only Selenium is available in amorphous form, but it suffers from short life time and low sensitivity [10-11]. Then the addition of impurities leads to relatively stable glasses with improved physical qualities

Dielectric relaxation studies are important to understand the nature and the origin of dielectric loss which, in turn, may be useful in the determination of structure and structure defects in solids. Therefore, it is interesting to study the electrical behavior of these materials in A.c. fields which gives an important information about the transport process in localized state in the forbidden gap [12-13].

The aim of the present research is to study the electric conduction and the dielectric properties of the system $Se_{80}S_{20-x}B_x$ (x=0,2.5,5 and B=In orAs) and the effect of environmental factors on it.

II. Experimental

The chalcogenide samples of the system $Te_{80}S_{20-x}In_x$ where (x=0,2.5,5) were prepared by melting quenching technique. Elements Se, S, Te&In were weighted and mixed well using the ball milling method for each sample alone. The homogeneous mixture was placed in an evacuated (10^{-4} Pa) and capsulated silica tube. The silica tube containing each sample was heated at fixed temperature for fixed time. The sample $Te_{80}S_{20}$ and the samples contain In on the expense of S were melted at 500C for 8 hours and quenching in ice water. The Ac conductivity and dielectric properties of samples were investigated using Broadband dielectric spectroscopy (BDS)technique.

III. Result And Discussion

1. Frequency dependenceof the Ac conductivity: -

Fig [1] shows the nonlinear variation of Logσ_{AC} as a function of frequency for the samples of the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5) at different isotherms.

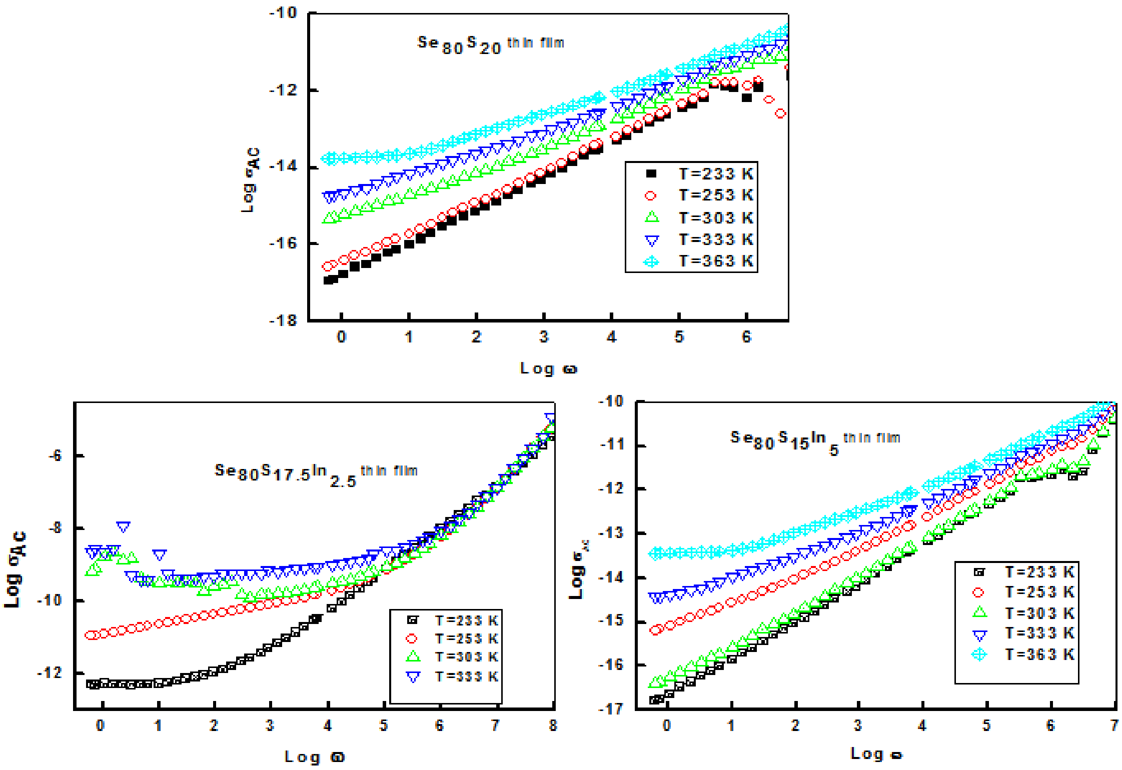

Fig [1] variation of log σ_{Ac} as a function of Log ω at different isotherms of the system $Se_{80}S_{20-x}In_x$ where (x=0,2.5,5)

The change of the Ac conductivity is very small during the frequency range -1&8 Hz, and depends on the sample structure. For the sample $Se_{80}S_{20}$, the Ac conductivity was in the range -17 to -10. This range has been increases little pit as the sample isotherm increases. The addition of 2.5 or 5 at % In on the expense of S leads to decrease the Ac conductivity within the same frequency range to be in the range -13 to -5 for the sample $Se_{80}S_{17.5}$ $In_{2.5}$and $Se_{80}S_{15}$ In_5.

Fig [2] shows the exponent factor (S) decrease as the temperature increases. This may mean that, at very high temperature, the value of the exponent S reachs zero. This will reduced the formula $\sigma = A\omega^S$ to be σ = A. Under this conduction, the electric conduction through the given samples becomes minimum and constant. This indicate that the given material is insulating one and can be used as an optic fiber cable, saving light energy the environment.

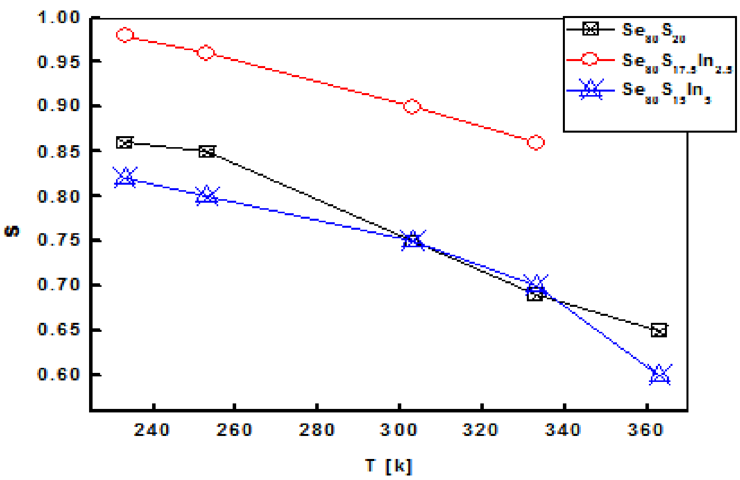

Fig [2] The exponent factor S as a function of temperature T of the system $Se_{80}S_{20-x}In_x$ where (x=0,2.5,5) .

2. The temperature depends of Ac conductivity: -

Fig [3] shows the variation of Ln σ_{Ac} as a function of temperature at different constant frequencies for the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 &5) .

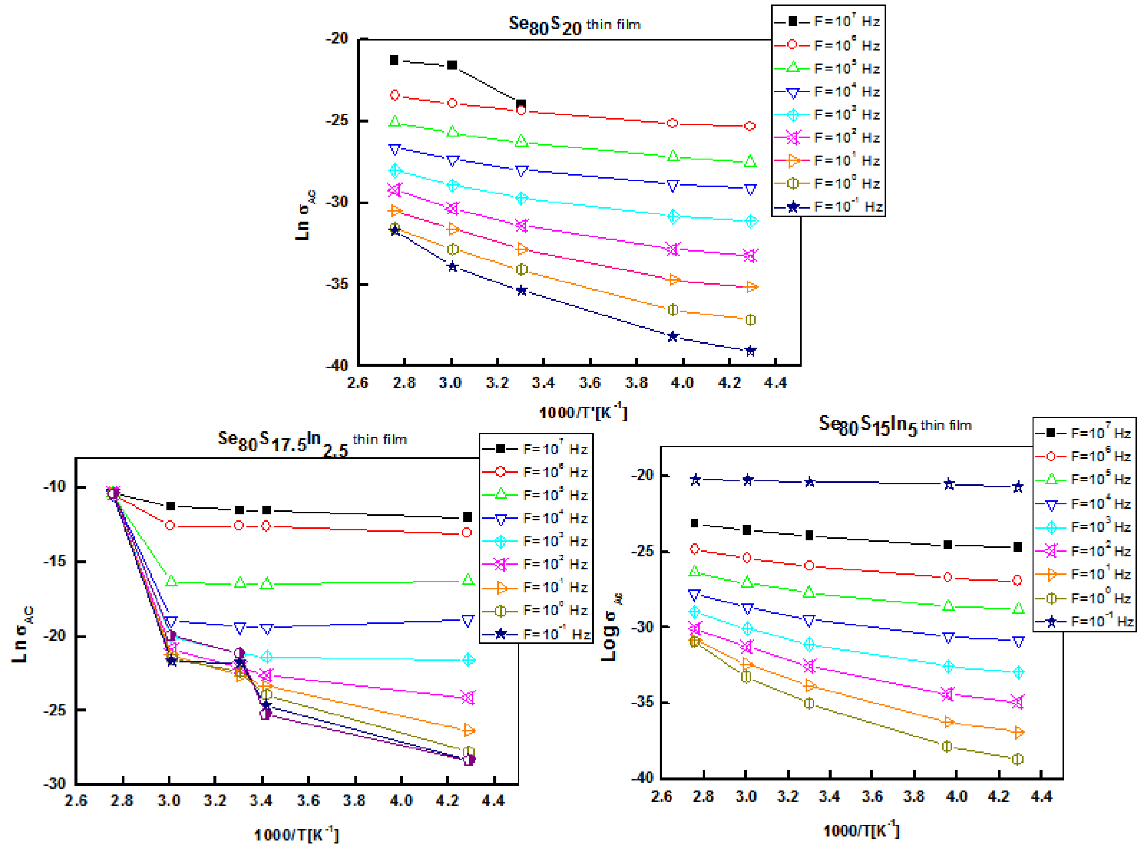

Fig [3] variation of Ln σAc as a function 1000/T at different constant frequency of the system $Se_{80}S_{20-x}In_x$ where (x=0,2.5,5)

This behavior confirms the dependence of the conduction mechanism on the temperature range. At low temperature range, the electric conduction may be due to the charge carriers hopping between localized states. As the temperature increase more than 300K, the electric conduction becomes due to the charge carrier transition between states.

3. Frequency dependence of the dielectric constant and dielectric losses: -

Fig [4&5] shows the frequency dependence of dielectric constant and dielectric losses at different isotherms for the samples of the system $Se_{80}S_{20-x}In_x$ where (x=0,2.5,5).

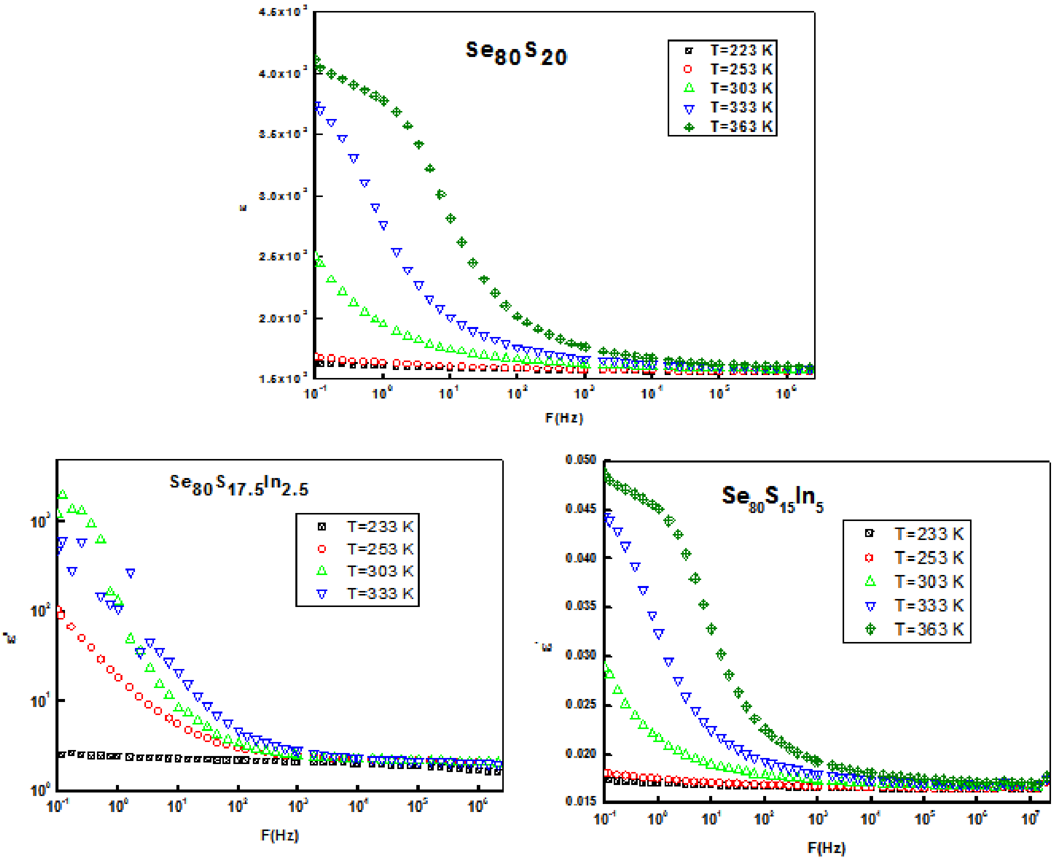

Fig [4] show the variation of dielectric constant (ε') as a function frequency for the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5) .

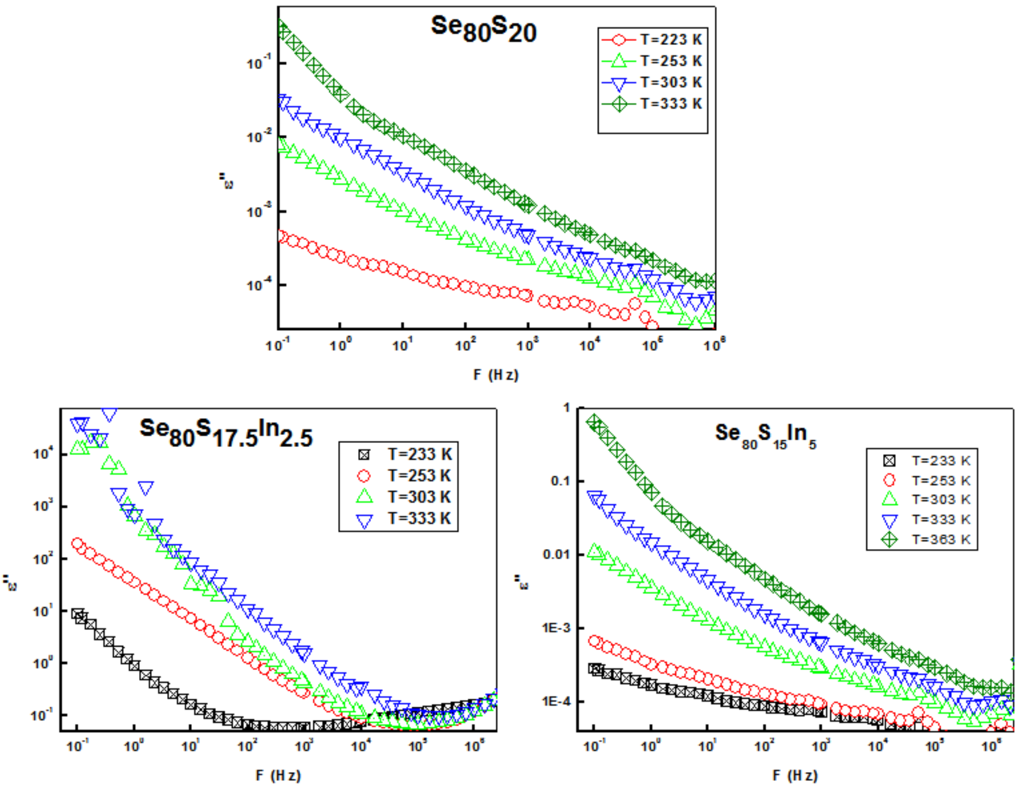

Fig [5] Variation of dielectric losses (ε'') as a function frequency at different isotherms for the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5).

It's clear that the values of the dielectric constant and dielectric losses were high at low frequency range and decreases as frequency increases. The values of the dielectric constant and that of the dielectric losses for the sample $Se_{80}S_{20}$ at low frequency range (0.1 -1 Hz) were in the range 0.0015-0.04 and 0.0004-0.1 respectively.

The addition of 2.5 or 5 at %. In on the expense of S keep this behavior as it is, and increase the values of the dielectric constant as well as the values of dielectric losses

4. Temperature dependence of the dielectric constant ε' and dielectric losses :-

Fig [6&7] shows the variation of dielectric constant and the dielectric losses as a function of temperature at different constant frequencies for the system $Se_{80}S_{20-x}In_x$ where (x=0,2.5,5).

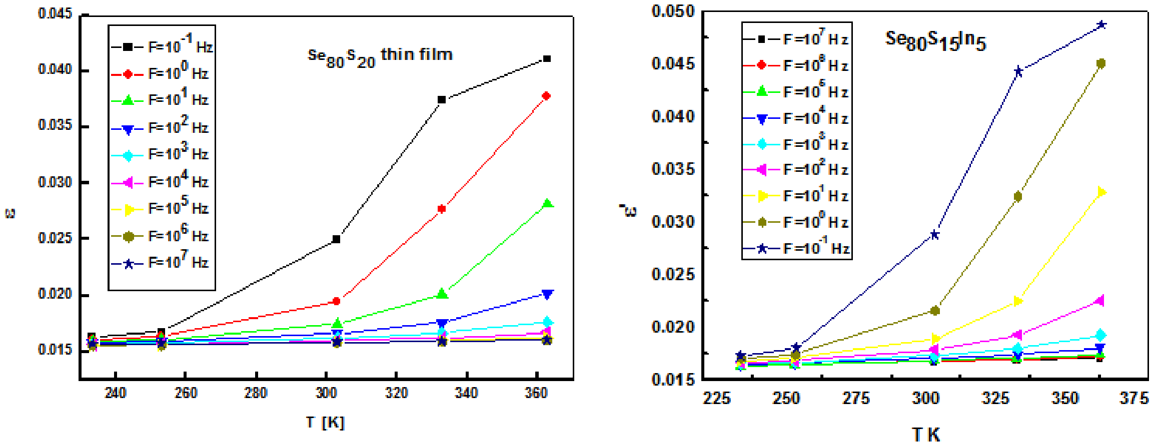

Fig [6] Variation of dielectric constant (ε') as a function temperature at different frequency for the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5).

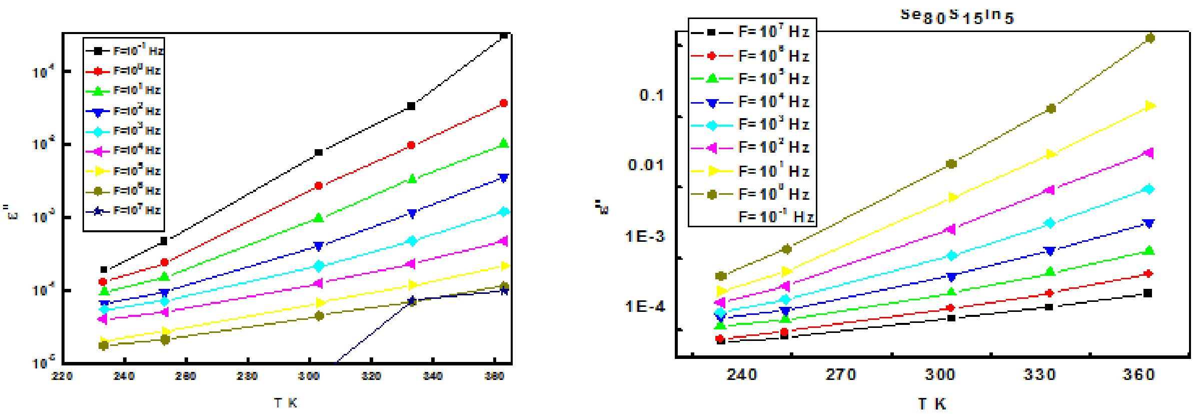

Fig [7] Variation of dielectric loss (ε'') on temperature at different frequency applied for Se80S20 sample.

It's clear that, the dielectric constant increases as a function of temperature at low frequencies values. At constant high frequency values, the dielectric constant becomes insensitive to temperature and may be temperature independent. The addition 5 at % In on the expense of S, keep this behavior qualitative and quantitative at it is.

Also, the dielectric losses increase with temperature for all samples. The dielectric losses of the sample $Se_{80}S_{20}$ was in the range 0.0004 to 0.1 depending on the constant frequency value. The addition of 5 at % In on the expense of S confirm these results qualitative and quantitative.

IV. Conclusion

[1]. The Ac conductivity of the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5) was very small under the effect of frequency and under the effect of temperature.

[2]. The exponent factor S of the relation $\sigma = A\omega^s$ was decreased as temperature increases, and can be reach zero value at very high temperature.

[3]. The zero value of the exponent factor keep the electric conduction constant at minimum value.

[4]. The dielectric constant and dielectric losses was high and the actual value depending on the sample structure.

[5]. At high frequency, the dielectric propertiesbecomes temperature independent.

[6]. The addition of In on the expense of S decrease Ac conductivity and increase dielectric properties.
[7]. The material of the system $Se_{80}S_{20-x}In_x$ where (x=0 ,2.5 ,5) can be employed as optic fiber cables.
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