



TO STUDY CONCENTRATION DEPENDENT RELAXATION BEHAVIOR OF INDOL IN POLAR SOLVENT USING DIELECTRIC SPECTROSCOPY

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Abstract : The Enhancement in superconducting materials are one of challenging trends in field of condense matter physics. For this purpose different materials are studied using different methods. Dielectric spectroscopy is one such technique that includes the study or response of material to an applied electric field. In this paper we are presenting the investigation of concentration dependent relaxation behavior of Indol in polar solvent using dielectric spectroscopy. We also present the graphical representation of Concentration dependent dielectric loss, permittivity and relaxation time of indol in polar solvent.

Keyword: Dielectric Constant, Dielectric permittivity, INDOL, Relaxation Time, Time Domain Reflectometry (TDR).

I. INTRODUCTION

To know the intermolecular relations for dielectric studies with the help of time domain reflectometry. Paper presents complex permittivity of INDOL-DMSO mixtures is measured using TDR and also represented on curve. Indol is a sweet-smelling heterocyclic natural compound. It has a bicyclic construction, It has five-membered nitrogen-containing pyrrole ring. DMSO is an Organo-Sulfur compound with the recipe (CH₃)₂SO. DMSO is drab fluid it is a significant polar aprotic dissolvable that breaks up both polar and nonpolar mixtures and is miscible many natural solvents as well as water.

II. MATHEMATICAL EXPLANATION

According to Cole-Davidson and Cole-Cole equations,

$$\epsilon^* = \epsilon_{\infty} + \frac{\epsilon_0 - \epsilon_{\infty}}{[1 + (j\omega\tau)^{1-\alpha}]^{\beta}} \quad (1)$$

Where $\alpha=0$, then Cole-Davidson equation is retained and $\beta=1$ the above equation decreases to a Cole-Cole one.

III. EXPERIMENTAL WORK

TDR was used to measure complex permittivity such as dielectric dispersion (ϵ') and dielectric loss (ϵ'') throughout a frequency range of 5GHz-50GHz for four different concentrations. The highest miscalculations in the observed values of ϵ' and ϵ'' found to be ± 2 and $\pm 3\%$ correspondingly. The frequency dependent ϵ' and ϵ'' curves for the INDOL-DMSO mixture are displayed in this order. Table 1 lists the dielectric factor values such as the relaxation time (τ) and dielectric constant (ϵ_0) that were achieved by fitting the Indol-DMSO mixture with a volume proportion of DMSO into Equation 1.

IV. OBSERVATION TABLE:

Table 1: Concentration Dependent Relaxation Behaviour of Indol in Polar Solvent Using Dielectric Spectroscopy

Concentration	Dielectric constant (ϵ_0)	Dielectric loss (ϵ_∞)	Relaxation Time (τ)	$(\Delta\epsilon)=\epsilon_0-\epsilon_\infty$	Alpha α
0.25	77.34	1.22	22.91	76.12	0.17
0.50	71.82	2.17	24.62	69.65	0.10
0.75(5GHz)	70.32	0.25	36.39	70.07	0.36
1.00(5GHz)	69.13	0.95	38.96	68.18	0.95

IV. RESULTS AND DISCUSSION:

1. Frequency versus Dielectric Permittivity and Dielectric Loss:

Complex permittivity measurements, or dielectric dispersion (ϵ') and loss (ϵ''), were obtained for the frequency range of 5 GHz–10 GHz using TDR at 4 different concentrations. The frequency-dependent ϵ' and ϵ'' curves for INDOL-DMSO mixes are shown in Figure 1. The several polarization mechanisms all depend differently upon frequency. Thus, as the frequency varies, various mechanisms will regulate the relative permittivity ϵ^* . A multitude of different elements contribute to the frequency-dependent response. The inertia of circling electrons must be taken into consideration for electronic and atomic polarization. These polarization mechanisms will be negligible for any frequency other than the resonant frequency because of this inertia effect. Below this frequency minute contribution to ϵ' and ϵ'' is given from these contrivances. ϵ'' will occur at the resonant frequency and ϵ' occur at dispersion. Molecules entirely rotate too fast if applied field of relaxation frequency of oscillation. Results, when the relaxation frequency is reached ϵ' will decrease and frequency is increased then applied field is cancelled by the dipoles.

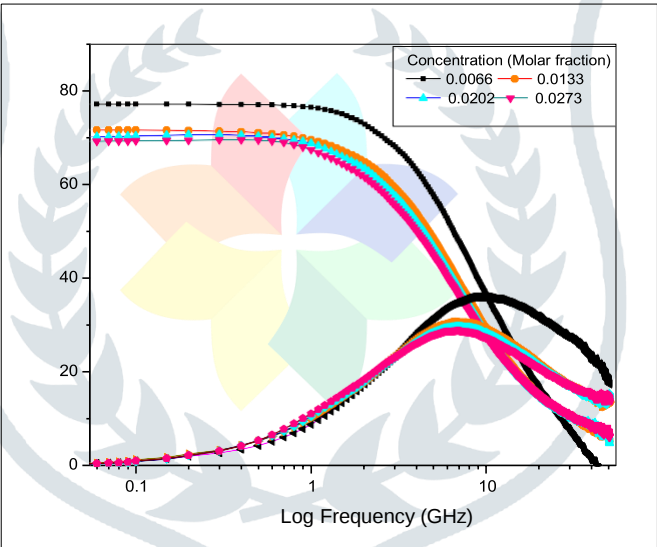


Figure.1. spectra of log frequency (GHz) versus Temperature dependent complex permittivity

Figure 1 shows the complex permittivity spectra it indicates that increase in the values of dielectric permittivity towards lower temperature.

The graph shows how the dielectric loss peak moves to a subordinate frequency as the temperature decreases. Above cure also predicts that if we move towards lower temperature dielectric loss is a smaller amount it indicates that this is moving close to superconducting material. Similarly, we can carry out the same experiment using TDR on other kind of material and can observe temperature dependent behavior. It will help to decide that whether the material is near to superconductor or not. The molecular relaxation behavior of Indol in DMSO shows hydrogen bonding and molecular interactions between Indol and DMSO. When the molar concentration of the solute rises, results the relaxation time increases and the dielectric constant decreases. This showed in figure 2 and 3.

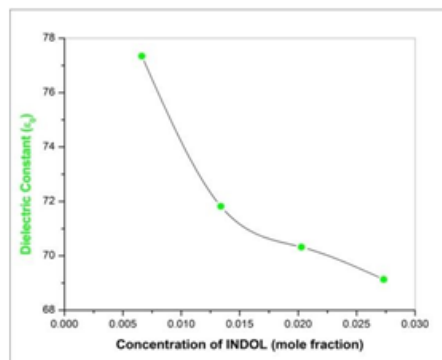


Figure.2. Concentration of INDOL in Mole Fraction versus Dielectric constant

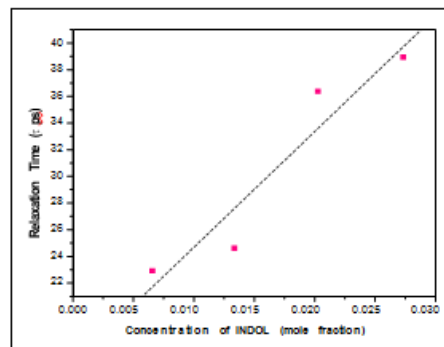


Figure.3. Concentration of INDOL in Mole Fraction Versus Relaxation Time (τ ps)

V. CONCLUSION

Molecular interaction and structural dynamics of Indol under polar surrounding of DMSO has been studied using Time domain reflectrometry in the frequency region of 10 MHz- 50 GHz at different solvent concentration. From the complex permittivity spectra dielectric parameters such as dielectric constant, dielectric relaxation strength, dielectric relaxation time has been evaluated and discussed in terms of molecular association/dissociation of solute and solvents. Observed dielectric parameters it has been concluded that there is a strong molecular contact or hydrogen bonds between molecules of the solvent and the solute. This can be confirmed from the behaviour of static dielectric constant and dielectric relaxation strength as a function of concentration. The result also increase the possibility of molecular interaction exists between DMSO and Indol from the relaxation time behaviour which was found to be increasing with concentration.

VI. INFERENCES

The work we present in this paper can be helpful in research for development of superconductors. The imaginary term of complex permittivity calculate heat loss. a smaller amount heat loss is essential condition for superconducting material. At different relaxation time and temperature along with variation in concentration mixture the internal structure of molecule of mixture changes when studied under TDR. This means that if studied more closely there can be possibility of observing sudden phase transition at particular temperature which is again helpful in deciding superconductivity of material we can take similar type of material and can study with same technique.

VII. REFERENCES

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