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Advances in Applied Science Research, 2013, 4(3):86-88

ISSN: 0976-8610
CODEN (USA): AASRFC

Dielectric measurement of low loss liquid at microwave frequency

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ABSTRACT

Dielectric constant (ε') and loss factor (ε") of dilute solution of acetophenone in benzene medium at room temperature at 10.15 GHz frequency. Microwave bench (X-band) were measured using Smyth's method. Gopalakrishna's single frequency method was used to determine the microscopic relaxation (τ) and microscopic dipole moment (μ) of acetone solutions. The results obtained in this work are in agreement with literature values.

Key words: Dielectric constant, Dilute solution, Microwave frequency, Dipole moment.

INTRODUCTION

Studies of dielectric constant, of polar liquids and especially in dilute solutions in non-polar medium have a important role in liquid state[1-5]Dielectric constant is a molecular property of substances, which is due to contribution from orientation, vibration and electronic polarization. Dielectric investigation mainly probe weak forces and help to understand intermolecular reorientational dynamics of the solute as well. In the present paper, we have carried out dielectric measurements of a polar liquid Acetophenone in a non-polar medium (benzene) at single microwave frequency (10.15GHz.) and at 27^0C. The results are discussed to interpret molecular structure in terms of relaxation time (τ) electric dipole moment (μ) of reorientation motion of the dipole in the medium.

MATERIALS AND METHODS

The Acetophenone (LOBA Chemie) and non-polar benzene (sd-fine chem..) of AR grade obtained commercially and ware used without any further purification. Dilute solutions of Acetophenone for few dilute concentrations in benzene. The solution were mixed well and kept for 12Hrs. in a well stopper volumetric flask to ensured good thermal equilibrium. These systems in non-polar benzene were assumed to be dilute solutions.

The X-band microwave bench was used to measure the wavelength of the microwave radiation in liquid dielectric cell. The liquid sample was hold vertically in a liquid dielectric cell by supporting a thin mica sheet whose VSWR and attenuation were assumed negligible small. The liquid dielectric cell was attached at the end of microwave bench and maintained at 27^0c temperature. The following equations [6-7] are used to calculate dielectric constant, dielectric losses at microwave frequency.

$$\varepsilon' = \{\lambda_0 / \lambda_c\}^2 + \{\lambda_0 / \lambda_d\}^2 \quad \text{----------(1)}$$

$$\varepsilon'' = 2/\pi[\lambda_0 / \lambda_d]^2[\lambda_g / \lambda_d]^2 \quad \text{----------(2)}$$

Where,
λ_0 - Wavelength of mirowave radiation.
λ_0 - Cutup wavelength in the wave guide.
λ_d - Wavelength of mirowave radiation in liquid medium.

The procedure of measurement on X-band is describe elsewhere [4-6]

A Gopala Krishna method [8] based on eq.(3) is is used to determine a relaxation time(τ) eq.(4) and electric dipole moment (μ) eq.(5) of polor liquid.

$[Є^{*}-1/ Є^{*}-2]=[Є_{\infty}-1]/ [Є_{\infty}-2]+[4\pi\eta\mu^{2}/9KT][1/(1+j\omega\tau)$ ----------(3)

Where,

$Є^{*=} Є^{'}-jЄ"$

$\tau = (1/\omega)(dy/dx)$ ----------(4)

$\mu^{2}=9KTM/4\pi Nd_{0}\{1+(dy/dx)^{2}\}dx/dw$ ----------(5)

Where, x and y are the variables are depend on concentrations of the polar liquid in non-polar medium.

RESULTS AND DISCUSSION

The determined values of dielectric constants (ε') and dielectric losses (ε'') of Acetophenone in benzene are reported in Table 1, below.

Fig (1) Linear behavior between Y and X

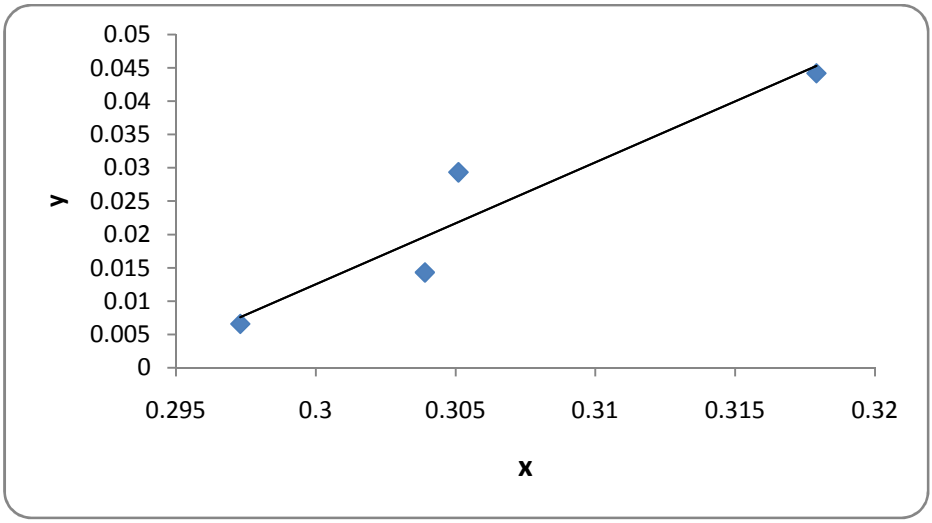


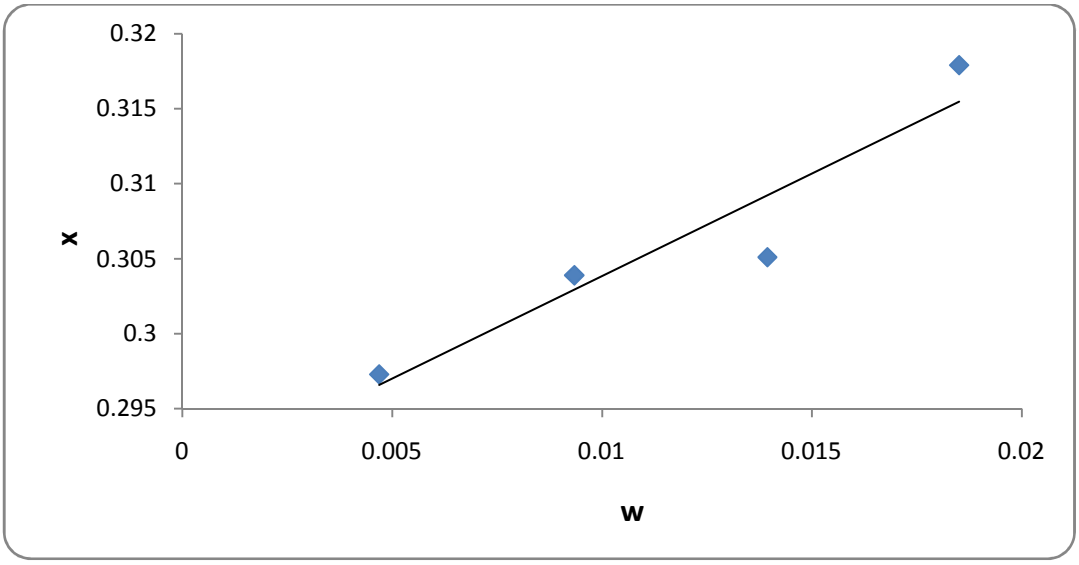
Table 1: determined values of dielectric constants (ε') and dielectric losses (ε'') of Acetophenone

Sr. No.	Wt. fraction (W)	ε'	ε''	X	Y
1	0.004691	2.2686	0.040127	0.2973	0.006606
2	0.009339	2.3082	0.08861	0.3039	0..01431
3	0.01394	2.3099	0.1819	0.3051	0.02932
4	0.018507	2.3710	0.3470	0.3179	0.05415

To determine relaxation time (τ) and dipole moment (μ) Y and are plotted, which is linear Fig . (1).

X and W are plotted which is also linear fig. (2), Determines relaxation time (τ) and dipole moment (μ) of Acetophenone in non-polar Benzene medium.

Fig (2) Linear behavior between X and W



CONCLUSION

The values of dielectric constant (ε'), and dielectric loss (ε'') Acetophenone in dilute solution of benzene is increases as function of concentration of polar substance. There vary with the concentration of the solution were sufficiently dilute to minimize the solute-solute interaction. The values of relaxation time (τ) = 5.5850 ps and electric dipole moment (μ) = 3.0466 D of Acetophenone in benzene agree well with the values quoted in the literature [10]

Acknowledgement
Author (SBG) thank Dr. L. H. Khalsa, Principal, M. G. College Armori for encouragement and UGC WR Pune for grand of Teacher fellowship under faculty improvement programme [FNo.32-09(WRO)]. The author (BMS) thanks to UGC WR Pune for grant of Minor research Project (No. F.4)-10/2003.

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