International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 12, pp: 195-197 www.ijaem.net ISSN: 2395-5252

Study of Dielectric behavior of N-methylaniline-1,4-Dioxane mixture using Time Domain Reflectometry.

S.S.Kadam
Dept. of Physics, N. W. College A. Balapur. (MH). India.

Date of Submission: 25-12-2020 Date of Acceptance: 06-01-2021

ABSTRACT: The Complex permittivity spectra $\varepsilon^*(\omega)=\varepsilon'-j\varepsilon''$ of binary mixture of N-methylaniline with 1,4 Dioxane were obtained in the high frequency range 10 MHz to 30 GHz using Time Domain Reflectometry(TDR) technique. The static dielectric constant (ε_0) and relaxation time (τ) have been obtained. On the basis of these parameters, intermolecular interaction and dynamics of the molecules at molecular level are studied.

Keywords: Time domain,Complex dielectric spectra, Relaxation time.

I. INTRODUCTION:

Studying the dielectric properties at microwave frequency will reveal the dielectric relaxation of polar molecules and its variation with respect to the interaction with the neighbouring polar as well as non polar molecules. Patil et al. [1] obtained the complex dielectric spectra for alcohols and aniline binary mixtures and reported that ε_0 and τ decrease with increasing concentration of aniline in the alcohol. From microwave absorption measurement in dilute solutions, Deogaonkar & coworkers [2] found that N, N-dimethylaniline form complexes with o-chlorophenol through hydrogen bonding at room temperature. Oswal et al [3] suggested strong cross association due to strong hydrogen bonding between –OH and $–NH_2$ groups, from the viscosity and excess molar volume studies of liquid mixtures of alcohols with amine. In the present paper, the study of dielectric behaviour of N-methylaniline-1, 4 dioxane (NMA- DX) mixture in the frequency range of 10 MHz to 30 GHz using Time Domain Reflectometry (TDR) at temperature 25^0C.

II. EXPERIMENTAL:

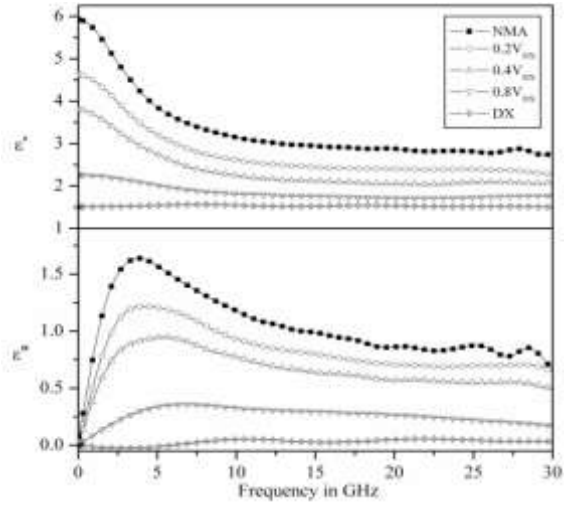
N-methyl aniline (NMA) and 1, 4-Dioxane (DX) was obtained commercially (S. D. Fine, India) and was used without further purification. The solutions were prepared. The complex dielectric spectra were obtained by the time domain reflectometry (TDR) technique. The Tektronix model no. DSA8200 Digital Serial Analyzer sampling mainframe along with the sampling module 80E08 has been used for the time domain reflectometry (TDR). Reflected pulse without sample R_1 (t) and with sample R_x (t) were recorded in time window of 2ns and digitized in 2000 points.

The time dependent data were processed to obtain complex reflection coefficient spectra $\rho^*(\omega)$ over the frequency range from 10 MHz to 30 GHz as [4, 5].

$$\rho*(\omega)=\left(\frac{c}{j\omega d}\right)\left[\frac{p(\omega)}{q(\omega)}\right] \quad (1)$$

where $p(\omega)\ \&\ q(\omega)$ are Fourier transforms of [R_1 (t)-R_x (t)] and [R_1 (t) +R_x (t)] respectively, c is the speed of light, ω is the angular frequency, d is the effective pin length and j= $\sqrt{-1}$. The complex permittivity spectra $\varepsilon^*(\omega)$ was obtained from reflection coefficient $\rho^*(\omega)$ by applying calibration method as described earlier [6].The dielectric permittivity ε' and dielectric loss ε'' of NMA with1, 4 Dioxane at 25˚C are shown in Figure. From dispersion plot it is observed that values of ε' decreases with increase in frequency and maximum of the dielectric loss ε''_{max} shifts from the lower frequency to higher frequency in NMA-DX system.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 12, pp: 195-197 www.ijaem.net ISSN: 2395-5252



III. RESULTS AND DISCUSSION:

The complex dielectric permittivity data were fitted to a Havriliak-Negami model using non linear least squares fit method in order to extract dielectric relaxation parameters with the following expression [7].

$$\varepsilon^*(\omega) = \varepsilon_\infty + \frac{\varepsilon_0 - \varepsilon_\infty}{[1+(j\omega\tau)^{1-\alpha}]^\beta} \quad (2)$$

where $\varepsilon^*(\omega)$ is complex permittivity at an angular frequencyω, ε_0 is the static permittivity, ε_∞ permittivity at high frequency, τ is the relaxation time, α is shape parameter representing symmetrical distribution of relaxation time and β shape parameter of an asymmetric relaxation curve. Equation (2) includes Cole-Cole (β=1) [8], Davidson-Cole (α=0) [9], and Debye (α=0, β=1) [10] relaxation models. The dielectric relaxation model for fitting dielectric parameters suitable for present systems is Davidson-Cole model. Therefore the complex permittivity spectra has been fitted in Davidson-Cole model with (α=0) and β ($0 < \beta \leq 1$) as one of the fitting parameters along with ε_0 &τ. The values of dielectric parameters ε_0 and τ obtained from equation (2) for NMA-DX with volume fraction of DX at 25^0C are reported in table. The experimental values of ε_0 and τ are in good agreement reported earlier [11, 12]. It can be observed that ε_0 decrease with increase in volume fraction of DX in NMA. Relaxation time (τ) decrease with increase in volume fraction of DX in NMA The decrease in τ values indicates that number of dipoles decreases in the solution, the intermediate structure formed rotates fast thereby giving the decrease in values of τ in the solution.

Vol. Frac. of DX	ε_0	τ
0.0	5.984(7)	39.26(15)
0.2	4.652(4)	35.17(10)
0.4	3.806(2)	33.08(8)
0.6	3.025(4)	28.25(8)
0.8	2.253(5)	20.42(26)
1.0	2.201(2)	7.2(20)

IV. CONCLUSIONS:

The complex permittivity spectra of NMA with DX have been studied at 25^0C, using time domain reflectometry technique in the frequency range 10 MHz to 30 GHz. The values of ε_0 shows systematic change with increase in volume fraction of DX in the system. The decrease in τ values indicates that number of dipoles decreases in the solution, the intermediate structure formed rotates fast thereby giving the decrease in values of τ in the solution.

ACKNOWLEDGEMENT:

The Author is thankful to the school of physical sciences, Swami Ramanand Teerth Marathwada University, Nanded for availing the laboratory facility.

REFERENCES:

[1]. S.P.Patil,A.S.Chaudhari, B.R.Arbad, and S.C.Mehrotra, J.Chem.Eng.Data,875(1999).
[2]. V.S.Deogaonkar,C.S.Adgaonkar,andS.N.Jaj oo,IndianJ.Pure and Appl.Phys. 617(1982).
[3]. S.L.Oswal, and H.S.Desai, Fluid Phase Equilibria, 149,359(1998).
[4]. C.E.Shanon, Proc.IRE, 37, 10(1949).
[5]. H.A.Samulan, Proc.IRE, 39, 175(1951).
[6]. A. C. Kumbharkhane, S. M. Puranik, and S. C. Mehrotra, J. Chem Soc. Faraday Trans., 87**,** 1569 (1991)
[7]. S.Havriliak, and S.Negami, J.Polymer Sci. C 14, 99(1966).
[8]. K.S.Cole, and R.H.Cole, J. Chem.Phys. 9**,**341(1941).
[9]. D.W.Davidson, and R.H.Cole, J. Chem.Phys. 18**,** 1484(1950).

[10]. P.Debye, Polar Molecules (The Chemical Catalogue Company, New York, 1929).
[11]. V.A.Rana, and A.D.Vyas, J.Mol.Liquids, 102/1-3,379(2002).
[12]. CRC Handbook of Chemistry and Physics 87th ed., ed. D.R.Lide (CRCPress, 2006).