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Static Dielectric Studies of Some Nematogenic Compounds

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Static Dielectric Studies of Some Nematogenic Compounds

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Static dielectric constant studies of three nematogenic compounds, viz., 4'-(hexyloxy)-4 biphenyl carbonitrile, 4'-(heptyloxy)-4 biphenyl carbonitrile and 4-isothiocyanatophenyl 4-pentylbicyclo (2,2,2) octane 1-carboxylate, have been carried out and reported in this paper. The behaviour of the dielectric constants with temperature in these compounds have been explained in terms of the dipole moment.

Keywords: dielectric constant, dipole moment

1. INTRODUCTION

Dielectric studies of nematic liquid crystals have played an important role in the development of electro-optic devices. There is a continued interest in the study of liquid crystals with a large positive dielectric anisotropy after the observation of twisted nematic effect by Schadt and Helfrich.[1] On the basis of the dipolar theory proposed by Madhusudana and Chandrasekhar[2] the dielectric data reported[3–10] for molecules with strong polar groups indicate the existence of antiparallel near neighbour correlation. In this paper we report measurements of the temperature variation of dielectric constants for the following three nematic compounds, namely, 6 OCB[4'-(hexyloxy)-4 biphenyl carbonitrile ($C_{19}H_{21}NO$)], 7 OCB[4'-(heptyloxy)-4 biphenyl carbonitrile ($C_{20}H_{23}NO$)] and IPBOC[4-isothiocyanatophenyl-4-pentyl bicyclo(2,2,2) octane 1-carboxylate ($C_{21}H_{27}NO_2S$)]. Compounds 6 OCB and 7 OCB have a —CN group and IPBOC has a —NCS group.

2. EXPERIMENTAL

All the compounds studied here were obtained from M/s Aldrich Chemical Company, (USA). Owing to the limited quantities of the sample available, these were used without further purification. The transition temperatures of all the compounds were determined using 'Orthoplan Leitz Polarising microscope' in conjunction with a hot stage and they are given in Table I. These are in good agreement with the standard values. For dielectric studies the sample was taken between clean aluminium coated glass

TABLE I

Nematic-isotropic transition temperatures (t_c) and average values of μ_l, μ_t and $\bar{\mu}$ of three nematic compounds.

Compound	t_c (°C)	μ_l (D)	μ_t(D)	$\bar{\mu}$ (D)
6 OCB	76.0	4.15	2.75	3.21
7 OCB	75.7	4.27	2.83	3.31
IPBOC	113.5	3.15	1.96	2.36

plates and was oriented using a strong magnetic field of strength 2.4 T. The capacitance was measured using impedance analyzer HP(4192A) in the cooling mode, being cooled from isotropic phase. During every measurement, the constancy of temperature of the cell was maintained to an accuracy of $\pm$ 25 mK. For measurement perpendicular to the nematic director, the cell was treated with the polyimide solution and then used. The static dielectric constants $\varepsilon_\parallel$ and $\varepsilon_\perp$ were determined at different temperatures using the capacitance data (at 2 KHz). The data acquisition was handled by a microcomputer which was also used for storage and analysis of data. Figures 1–3 show the experimental results.

3. RESULTS AND DISCUSSION

From Figures 1–3 it follows that the average value of the dielectric constant ($\bar{\varepsilon}$) in the nematic phase of all the three compounds is less than that of its extrapolated isotropic

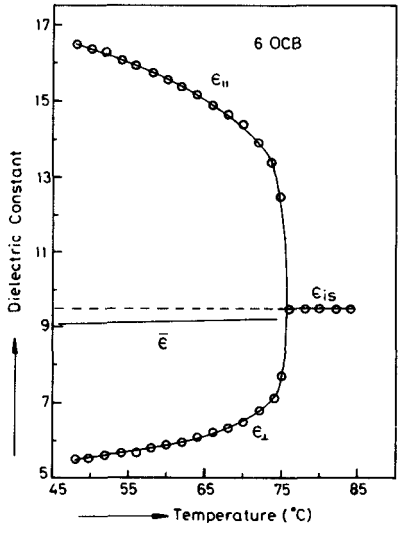

FIGURE 1 Variation of dielectric constants with temperature (°C) in 6 OCB.

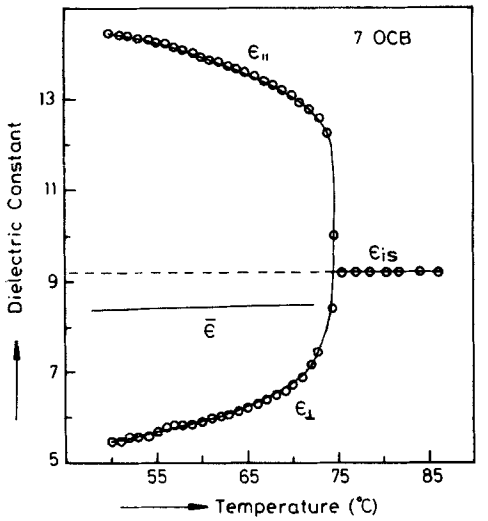

FIGURE 2 Variation of dielectric constants with temperature (°C) in 7OCB.

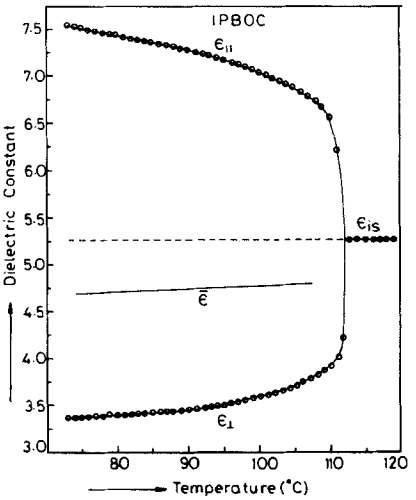

FIGURE 3 Variation of dielectric constants with temperature (°C) in IPBOC.

value. It is evident from the dipolar theory proposed by Madhusudana and Chandrasekhar that in such cases the dipole moments associated with the molecules are arranged antiparallel to each other. Under these circumstances we have estimated the effective parallel and perpendicular components μ_l and μ_t of dipole moment of the molecules[11] using the values of $\varepsilon_{\parallel}$ and $\varepsilon_{\perp}$ at different temperatures and extrapolated values of refractive indices (n_{∞}) determined for various wavelengths for all the com-

pounds.[12,13] We find that the components of dipole moment do not vary with temperature and the average values of μ_l, μ_t and $\bar{\mu}$ are given in Table I for all the compounds. In all these compounds the dielectric anisotropy is large ($\varepsilon_\parallel \geq 2\varepsilon_\perp$) indicating that there is a strong dipole moment along the length of the molecule, which agrees broadly with our observation as given in Table I. The results reported here for 6 OCB are also in conformity with earlier studies on the dielectric constants for nCB series,[5,6] 8 OCB[4] and mixtures of 8 OCB and 6 OCB compounds.[14]

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