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Optical Anisotropy of Dodecyl Benzene Sulfonic Acid

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Optical Anisotropy of Dodecyl Benzene Sulfonic Acid

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In smectic A phase of Dodecyl benzene sulfonic acid (DBS), the extra-ordinary and ordinary refractive indices have been measured with a modified Abbe refractometer. The polarizability anisotropy was calculated from birefringence data in smectic A phase of DBS using the Lorenz-Lorentz relation and it was found to be very small (of the order 1.3×10^{-24} cm^3) owing to the negative contribution from SO_3 group of DBS molecule.

INTRODUCTION

In a recent paper,[1] it was shown that dodecyl benzene sulfonic acid (DBS) exhibits the smectic A phase. The nature of transition being *solid* $\xrightarrow{20\,^\circ C}$ *smectic A* $\xrightarrow{110\,^\circ C}$ *iso*. Lorenz-Lorentz relations are used to calculate the polarizabilities in smectic A phase of DBS using refractive index data reported in this paper.

EXPERIMENTAL

The refractive indices were measured using an Abbe refractometer in which the lower prism was removed and in its place a rectangular glass slab (3 cm × 0.7 cm × 0.1 cm) of index $n = 1.5300$ was used (since n_e and n_0 of DBS at room temperature are less than 1.53 see Ref. 1). The temperature was controlled by circulation of water and was measured to an accuracy of $\pm 0.5\,^\circ$C using a calibrated thermometer. The Abbe refractometer was calibrated using standard liquids such as water, benzene and toluene.

When a thin section of the specimen is taken between the upper prism and the glass slab, and for orientations along the length of the slab, then associated with the propagation of light in the plane of the specimen, i.e., along the direction of orientation, we get only one index n_0 for electric vector perpendicular to the optic axis. On the other hand, for orientation perpendicular to the length of the glass slab (lying in the plane of the glass slab), then associated with the propagation of light, we have two indices n_e and n_0 for electric vector parallel and perpendicular to the direction of orientation (or optic axis). These facts are verified by using an analyser. The surface of the upper prism was rubbed with clean cotton along the desired direction and the specimen was pressed between this surface and the glass slab to obtain a thin layer. The refractive index n_0 measured with orientation parallel

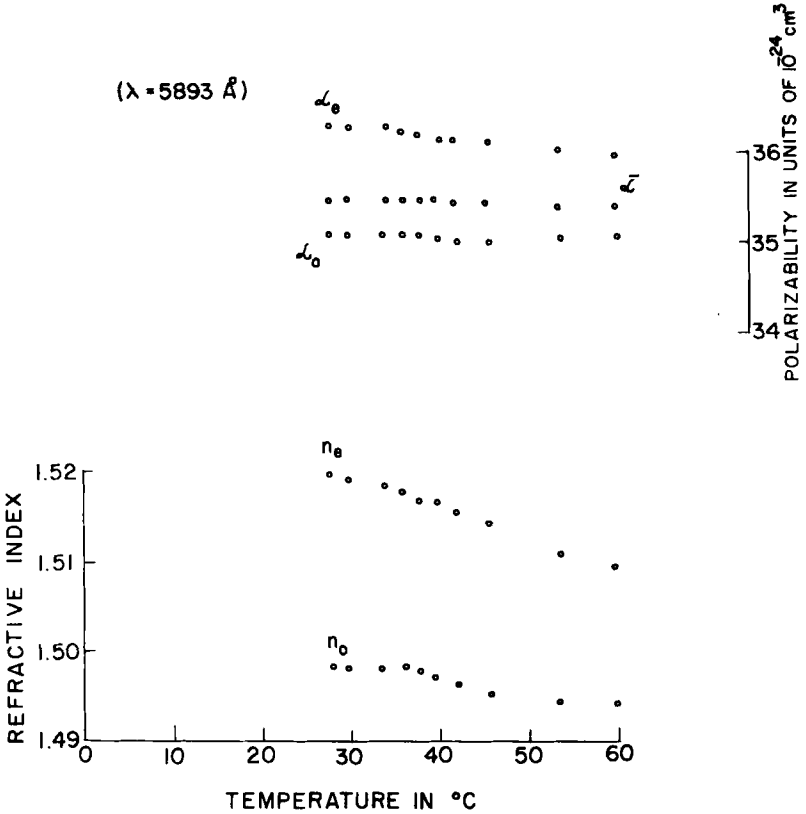

FIGURE 1 Variation of refractive index and polarizabilities with temperature, calculated from index data for λ5893 Å.

TABLE I

Refractive index data of DBS

T Temp. in °C	Wavelengths in Å			
	5461		6230	
	n_e	n_0	n_e	n_0
28	1.5200	1.4970	1.5180	1.4970
30	1.5200	1.4980	1.5180	1.4970
34	1.5190	1.4980	1.5170	1.4965
36	1.5185	1.4975	1.5160	1.4955
38	1.5175	1.4970	1.5150	1.4950
40	1.5165	1.4970	1.5150	1.4950
42	1.5160	1.4970	1.5140	1.4950
46	1.5150	1.4965	1.5130	1.4945
54	1.5110	1.4960	1.5090	1.4930
60	1.5100	1.4950	1.5080	1.4920

to the glass slab agreed with that of n_0 measured with orientation perpendicular to the length of the glass slab (lying in the plane of the glass slab), and also with the reported index measured using prism method, to within ± 0.001. The measured values of refractive indices reported here are correct to ± 0.0005. Measurements were carried out for three wavelengths 5893, 5461 and 6230 Å and for $\lambda 5893$ a graphical plot of refractive index with temperature is shown in Figure 1. The refractive indices for 6230 and 5461 Å are given in Table I. For temperatures above 60 °C, the clarity of the image is lost and hence the refractive index could not be measured.

RESULTS AND DISCUSSION

The extra-ordinary and ordinary polarizabilities α_e and α_0 are calculated using the Lorenz-Lorentz relation[2] and density data reported earlier[1]

$$\frac{n_i^2 - 1}{n_i^2 + 2}\left(\frac{3}{4\pi N}\right) = \alpha_i \qquad i = 0, e$$

Here, we neglect the anisotropy of the Lorentz field because the birefringence itself is small. The values of α_e and α_0 for different temperatures are also shown in Figure 1. Figure 1 clearly indicates that the $\alpha_e - \alpha_0$ is almost a constant and is of the order 1.3×10^{-24}

cm^3. This is due to the fact that even if the end chain methylene groups are fully extended and give a positive contribution to the $\Delta\alpha$, optical anisotropy, the net value of $\Delta\alpha$ is small, owing to the negative contribution from SO_3 group of DBS molecule.[3]

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