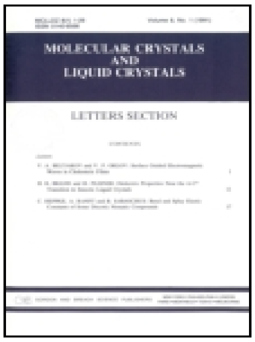

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Correlation between the density and refractive index with higher homologues 5O.m series

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ABSTRACT
The density dependent refractive indices study of the higher homologues liquid crystalline compound 5O. m (m = 14, 16) is reported in this paper. The compounds are interdigitated with highly skewed alkyl chains. The density study of the sample has been done with the capillary tube method. For the refractive indices study, the extraordinary component ne and the ordinary component no of the samples were measured by the thin prism technique with He-Ne laser beam of wavelength 633 nm. These the results obtained were used to find the correlation between the density and refractive indices in both samples.

KEYWORDS
Birefringence; refractive index; density; interdigitated

Introduction

Liquid crystal compounds are partially ordered fluids with spontaneous anisotropy, and they are thermally sensitive. Liquid crystals possess optical properties that are important in technological applications [1–5].

The birefringence and average refractive index of the LC samples can be directly determined from the observed values of refractive indices. The liquid crystals are optically anisotropic and their birefringence shows dependence on temperature and density[3–8]. The temperature dependent refractive indices of the LCs are important for understanding their anisotropy and also their alignment. The liquid crystalline compound possesses two refractive indices, one ordinary refractive index (n_o) and other extraordinary refractive index (n_e). The birefringence of the sample is calculated by using the relation $\Delta n = n_e - n_o$ [3–5, 9–13]. The density dependent study of two liquid crystalline homologues is reported in this article. The study of the variation of density of the LCs with temperature is a powerful tool to investigate the phase transitions and the different phases of the LCs. The correlation between the density and refractive indices can be used to obtain the molecular polarizabilities and order parameter values in different LC phases [14, 15].

Experimental details

The samples (5O.14 and 5O.16) used in this study was synthesized by a method reported elsewhere [16]. The molecular structure of the liquid crystalline compound and phase transition temperatures are shown in Fig 1.

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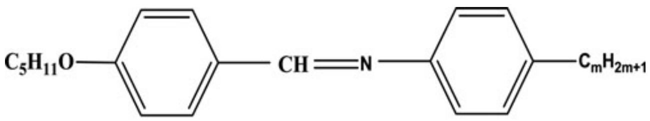

5O.16	Temperature	5O.14	Temperature
I-N	69.3 °C	I-N	71.5 °C
N-S_A	67.7 °C	N-S_A	69.3° C
		S_A-S_B	51.7° C
S_A-C	54.6 °C	S_B-C	43° C

Figure 1. Molecular structure of the liquid crystalline compound 5O.m (m = 14, 16).

The density of the compound was measured by using a capillary type dilatometer [17]. The refractive indices of the two samples were measured as a function of temperature using the thin prism technique. A He-Ne laser (MellesGriot) with a wavelength of 633 nm was used for the experiments. The samples in the isotropic phase were inserted in the glass prism by capillary action. The details of this method are reported in the literature [3, 12]. All the data were recorded during the cooling cycle. The experimentally measured ordinary (n_o) and extraordinary (n_e) refractive indices were calculated using the following equations [18].

$$n_{e,o} = \left(1 + \frac{2d_2^{e,o}}{d_1}\right) \tag{2.2}$$

where d_2^0 and d_2^e are, respectively, the distance of the ordinary spot and the extraordinary spot from the direct spot on the screen. d_1 is the distance between the positions of the image of directly transmitted beam on the screen from the image of the first reflected beam on the screen. The details of this method were reported in [10–12].

Results and discussion

The sample used in this study is higher homologues 5O.m (m = 14, 16) series. These samples are interdigitated with unsymmetrical alkyl chain length, the compounds are reported to exhibit the phase sequence N-S_A-S_B or N-S_A [18–22]. The molecular structure and phase transition temperature of these compounds is given in Fig 1.

From the Fig 2(a, b), it is observed that n_o for both the samples increase with increasing density. However, in the case of n_e, the value decreases with the increase of temperature. Though there is a small difference in length between the two samples are owing to the extra alkyl unit in 5O.16, the value of refractive index is higher in compound 5O.16 compared to that of 5O.14.

Fig 3(a, b) shows that the with the increasing density the birefringence of the compound decrease. From the literature, we know that the compounds are interdigitated, and the d spacing of the compounds decrease with the decrease of temperature. Generally in XRD study d-spacing is the distance between the adjacent planes. Due to decreasing d spacing,

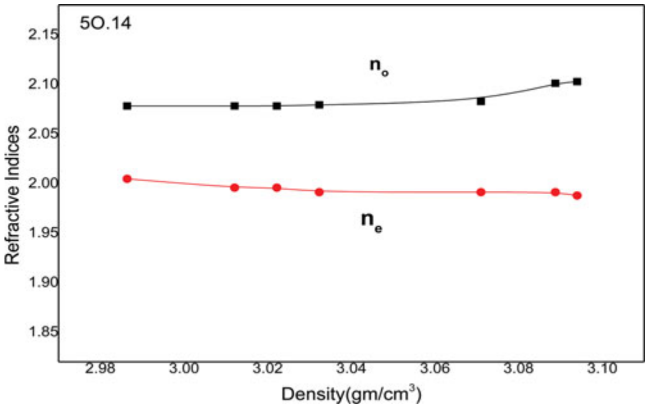

Figure 2a. Variation of refractive indices with the density of the compound 5O.14.

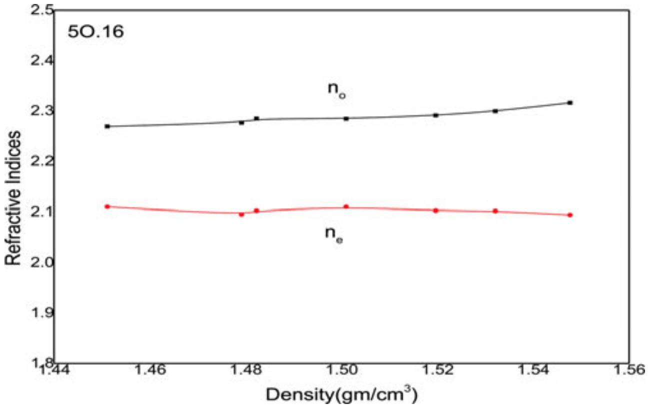

Figure 2b. Variation of refractive indices with density for the compound 5O.16

the molecular ordering decrease [18–22]. There for with the increasing density the d spacing also decreases. This is the reason for the decreasing the birefringence with the increasing density in both the cases.

In the case of the average refractive index <n>, Fig 4(a, b) shows that both the compound show similar trends. The value of <n> slightly increases with temperature. The value <n>

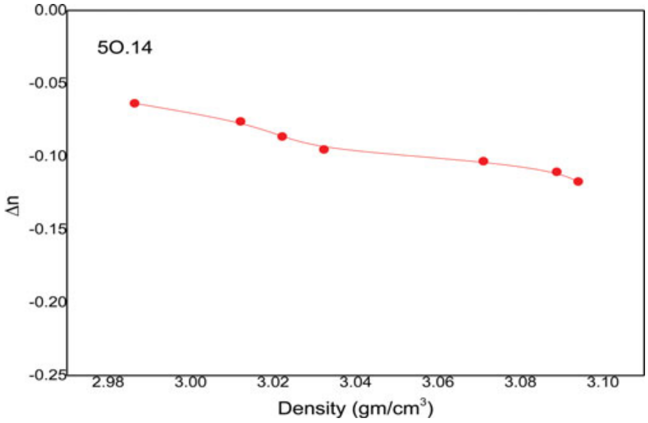

Figure 3a. Variation of birefringence with the density of the compound 5O.14.

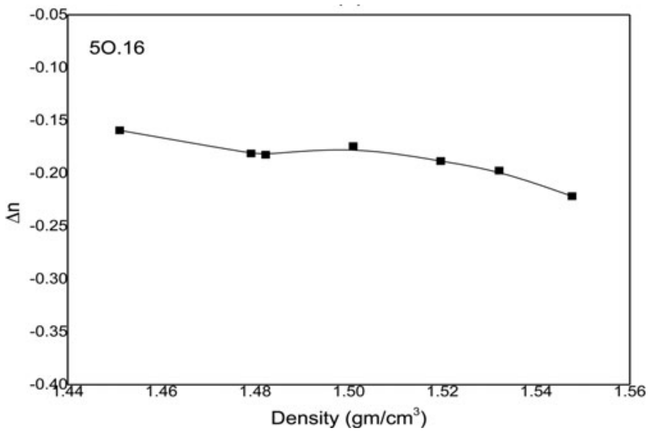

Figure 3b. Variation of birefringence with density for the compound 5O.16

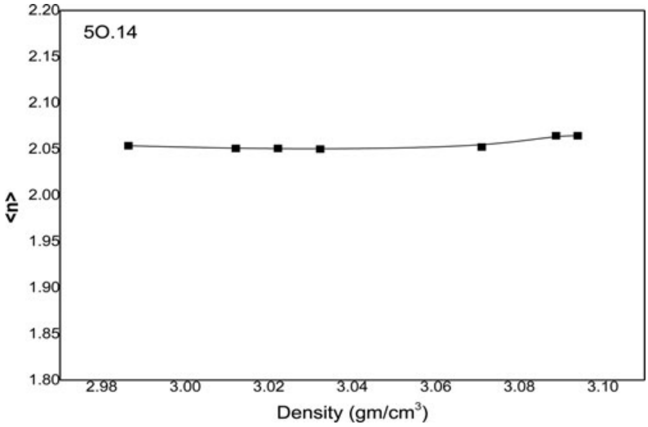

Figure 4a. Variation of <n> with density for the compound 5O.14.

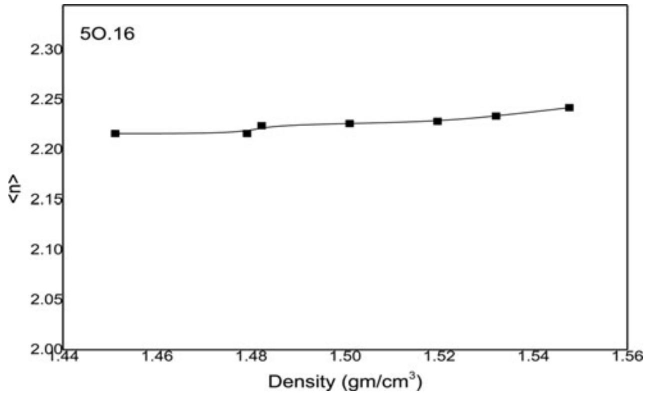

Figure 4b. Variation of <n>with density for the compound 5O.16

for 5O.16 is higher than that of 5O.14 which is due to the fact that the refractive indices of 5O.16 are more than 5O.14.

Conclusion

From the experiment, it is observed that both the compounds exhibit the same nature. The variation of the refractive indices with the density shows interesting changes in properties in both samples. The value of the refractive index is greater in 5O.16 compared to 5O.14. From birefringence study, we find that with the increasing density the birefringence of the both sample decrease. This happens due to the decrease in d spacing as the density increase. With reducing temperature interdigitation occurs and so the molecular ordering decreases. This is a reasonable condition for decreasing birefringence with increasing density. In the case of <n>, the sample slightly increases with density in both the compounds. From the above discussion, it implies that both the compounds behave same in refractive indices, birefringence and average refractive indices study.

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