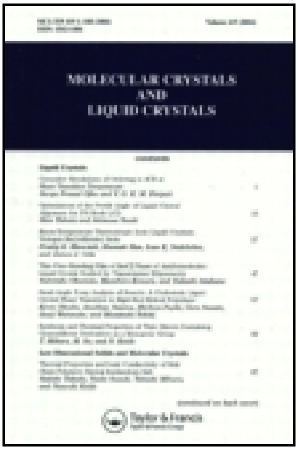

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Elastic Properties of n-Octyloxycyanobiphenyl

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ELASTIC PROPERTIES OF n-OCTYLOXYCYANOBIPHENYL

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Abstract The temperature's behaviour of the splay and band elastic constants for n-octyloxycyanobiphenyl (8-OCB) has been studied. The constants have been determined on the basis of threshold values B_0 and U_0 resulting from the Frederiks transitions in magnetic and electric field, respectively. The K_{11} and K_{33} show the pretransitional nematic-smectic A effect.

INTRODUCTION

In nematics the elongated molecules are aligned with their long axis parallel to a preferred direction that can be labelled by a unit vector $\underline{n}$. The centers of mass of the molecules are distributed at random. In an ideal nematic single crystal, $\underline{n}$ is uniform over the whole sample. For a distorted nematic, the space variations of n are small over molecular dimensions and a continuum description of the nematic liquid crystal can be used. In the bulk of a nematic sample three types of distortion can occur: splay, twist and bend; the associated elastic constants are K_{11}, K_{22} and K_{33}, respectively. The distortions free energy (per unit volume) of a nematic is given by Oseen[1] and Frank[2]:

$$F = \frac{1}{2} \left[K_{11} (\mathrm{div}\, \underline{n})^2 + K_{22} (\underline{n}\cdot \mathrm{rot}\, \underline{n})^2 + K_{33} (\underline{n} \times \mathrm{rot}\, \underline{n})^2\right] \qquad (1)$$

Much of the interest in liquid crystals is associated with the fact that the orientation of the director can easy be influenced by external fields. Consequently, knowledge of elastic constant of various liquid crystalline materials is important.[3,4]

In this paper we present the temperature dependence of the K_{11} and K_{33} elastic constants, and magnetic anisotropy $\Delta\chi$ for 8-OCB determined on the basis of Frederiks transitions.[5]

EXPERIMENTAL

For the K_{11}, K_{33} and $\Delta\chi$ determination, three experiments have been made. First, the electric field has been applied to the planar oriented nematic. From the threshold value U_0 and dielectric anisotropy $\Delta\varepsilon$, one can easily calculate the K_{11} elastic constant:[6,7]

$$K_{11} = \frac{U_0^2 \, \varepsilon_0 \, \Delta\varepsilon}{\pi^2} \tag{2}$$

Next, for the same sample, the magnetic field has been applied. On the basis of the threshold value B_0 and K_{11} obtained in the previous experiment, can be calculated:

$$\Delta\chi = \mu_0 \, K_{11} \sqrt{\frac{\pi}{B_0 \, d}} \, , \tag{3}$$

d - denotes the thickness of the nematic sample.

The K_{33} elastic constant has been obtained from the Frederiks transitions envolved by the magnetic field applied to the homeotropically oriented sample:

$$K_{33} = \frac{\Delta\chi}{\mu_0} \sqrt{\frac{B_0 \, d}{\pi}} \tag{4}$$

RESULTS AND DISCUSSION

Figure 1 presents the results of the measurements of static electric permittivities and conductivities carried out in isotropic, nematic and smectic A phases. Nematic-smectic A (N-S_A) phase transition manifests itself especially strong in the anisotropy of electric conductivity of 8-OCB.

Figure 2 shows the dependence of K_{11} and K_{33} on temperature. In the vicinity of the N-S_A transition one observes a strong increase in the elastic constants value. The dependences K_{ii} on temperature can be approximated by the relation of type:

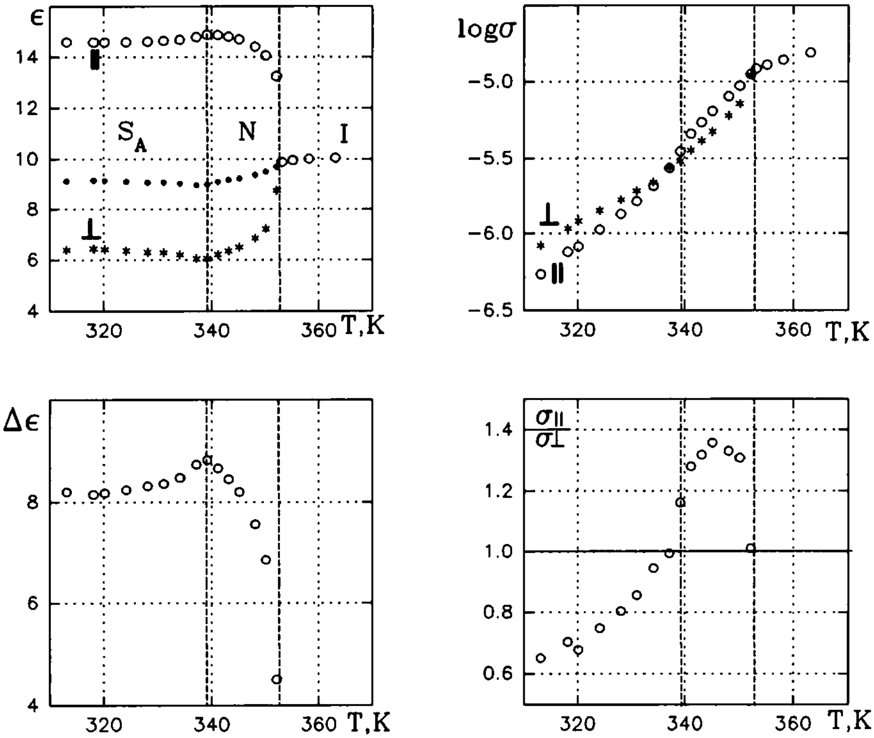

FIGURE 1 Static electric permittivities and conductivities of 8-OCB.

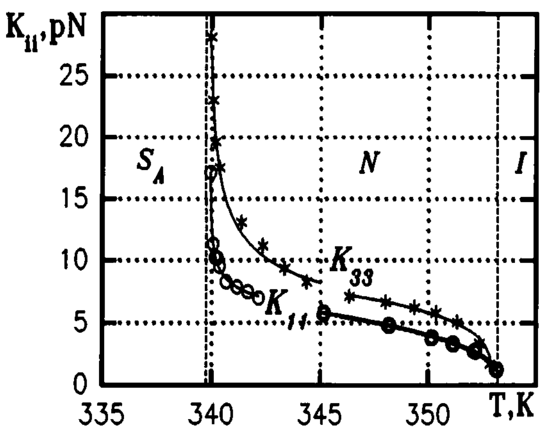

FIGURE 2 Elastic constants K_{11} and K_{33} of 8-OCB as a function of temperature. The solid lines correspond to dependence of (5) type.

$$A = A_o \left(\frac{T^* - T}{T^*} \right)^{\alpha_i} \quad (5)$$

where T^* denotes the reduced temperature. The values of α_i (i = 1 corresponds to N-I transition, i = 2 - N-S_A transition) obtained from the best fitting of the experimental data to the exponential function (5) are given in Table I.

TABLE I Values of the parameters α_i obtained by the least square fitting K_{ii} vs. T, according to relation (5).

	α_1	α_2
K_{11}	0.409	- 0.169
K_{33}	0.378	- 0.330

The value of the α_1 parameter is typical for nematics and is similar to that obtained by other authors for optical anisotropy and order parameter.[8,9]

The magnetic anisotropy determined in our experiment for 8-OCB is presented in Figure 3.

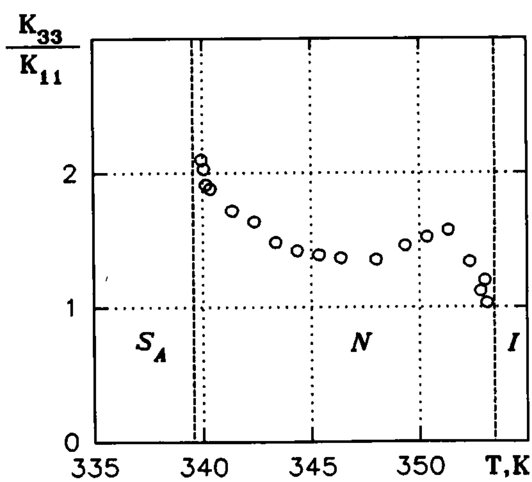

FIGURE 3 Bend-to-splay elastic constant ratio for 8-OCB.

Figure 4 presents the ratio bend to splay elastic constants as a function of temperature.

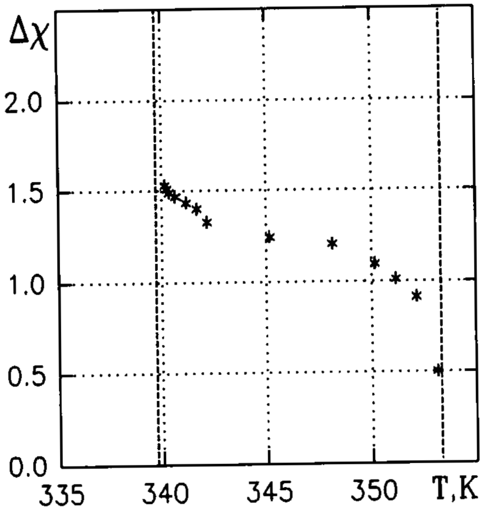

FIGURE 4 The magnetic anisotropy of 8-OCB calculated from Eq.(3).

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