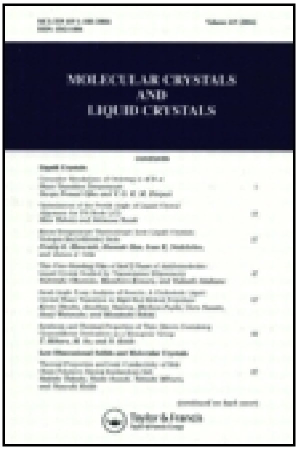

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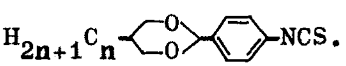
Abstract The liquid crystal mixture of two S_A smectics: 4DBT and 12DBT has been investigated by X-ray method. This compound exhibits an induced nematic phase for a molar fraction of 12DBT of $0.1 \leqslant x \leqslant 0.6$. The smectic mass density fluctuations have been studied in the nematic phase near the INA point at x = 0.12. Values of the critical exponents: $\nu_\parallel$, $\nu_\perp$, γ and the anisotropy parameter $\xi_\parallel/\xi_\perp$ do not practically change with approaching the INA point along the smectic A - nematic transition line.

INTRODUCTION

Both components of the studied binary mixture 4DBT/12DBT belong to the same homologous series nDBT (5-n-alkyl-2-(4′-isothiocyanatophenyl)-1,3-dioxane) described by the formula



All members of this series have monolayer smectic A phases and show smectic A_1 - isotropic phase transitions. Smectic A phase of nDBT is characterized by the layer spacing d_n,(obtained from X-ray Bragg scattering measurements) which changes from d_2 = 1.53 nm for n = 2 to d_{12} = 2.97 nm for n = 12. Physical and chemical properties of nDBT compounds for n from 2 to 12 and of 4DBT/nDBT mixture for n from 5 to 12 were discussed by Dąbrowski et al. [1].

The interesting feature of the 4DBT/nDBT mixtures for $n \geq 7$ is the appearance of the induced nematic phase on the (T,x) phase diagram: T is the temperature, x denotes the concentration of the nDBT in the mixture. The smectic layer spacing ratio d_n/d_4 changes from $d_5/d_4 = 1.08$ to $d_{12}/d_4 = 1.64$. The nematic phase appears for $d_n/d_4 \geq d_7/d_4 = 1.23$. For n = 7 the nematic phase is observed for $0.4 \leq x \leq 0.6$ in the temperature range of 1K. The temperature and concentration range of the induced nematic phase changes with the value of n. For n = 12 the nematic phase exists for $0.1 \leq x \leq 0.6$ and in the temperature range of 15K. The (T,x) phase diagram for the 4DBT/12DBT mixture is shown in Fig. 1. The points at x = 0.1 and x = 0.6 are the so called INA multicritical points.

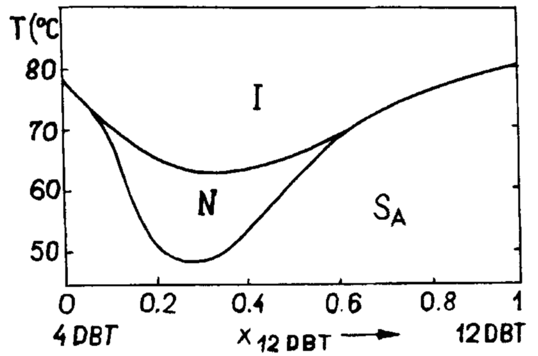


FIGURE 1 The phase diagram for the binary mixture composed of 4DBT and 12DBT.

EXPERIMENT AND RESULTS

The X-ray scattering measurements have been performed on the two-crystal spectrometer using the $Cu_{K\alpha}$ radiation [3]. The instrumental resolution function expressed as the half-width at half maximum was $6 \cdot 10^{-3}$ Å^{-1} in the longitudinal in-plane direction, $8 \cdot 10^{-4}$ Å^{-1} in the transverse in-plane direction and $2 \cdot 10^{-2}$ Å^{-1} in the direction perpendicular to the scattering plane.

The sample was electrically heated and the temperature was controlled within ±0.01K. The director was aligned in the scattering plane by a magnetic field of 0.8 T on cooling the liquid crystal from the isotropic phase to the smectic phase.

The X-ray critical scattering has been carried out in the vicinity of the INA point for x = 0.12 and for three other concentrations: x = 0.18, 0.24, 0.30, near the phase transition line between the smectic A and induced nematic phase. The measurements for $x < 0.1$ and $x > 0.3$ were impossible to discuss because of very weak orientational properties of the smectic phase.

The intensity of the scattered beam was measured above the S_A - N transition: $T = T_c + \Delta T$ in the longitudinal direction (along the director): $q_\perp = 0$, $q_\parallel$ - varied and in the transverse direction (perpendicular to the director): $q_\parallel = q_o$, $q_\perp$ - varied. The results were analyzed using the expression for the cross-section in the form [2]

$$\sigma(q) = \frac{\sigma_o(q_o)}{1 + (q_\parallel - q_o)^2\xi_\parallel^2 + q_\perp^2\xi_\perp^2}$$

The longitudinal $\xi_\parallel$ (parallel to the long axes of the molecules) and the transverse $\xi_\perp$ correlation lengths and the static susceptibility were calculated for different temperatures and concentrations. The values of the correlation lengths $\xi_\parallel$ and $\xi_\perp$ and the ratio $\xi_\parallel/\xi_\perp$ obtained for the reduced temperature $t = 10^{-3}$ ($t = T/T_c - 1$) are given in Table I. The change of the correlation lengths and the

TABLE I The longitudinal $\xi_\parallel$ and the transverse $\xi_\perp$ correlation lengths and $\xi_\parallel/\xi_\perp$ for different concentrations of 12DBT at reduced temperature $t = 10^{-3}$.

x	$\xi_\parallel$ (Å)	$\xi_\perp$ (Å)	$\xi_\parallel/\xi_\perp$	T_c (K)
0.12	170	100	1.7	337.66
0.18	210	110	1.9	324.32
0.24	250	120	2.1	322.29
0.30	290	130	2.2	321.10

susceptibility with temperature is shown in Fig. 2

for x = 0.12.

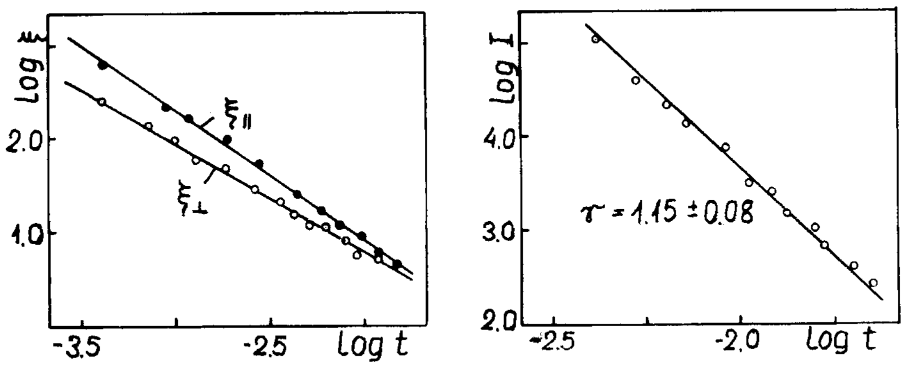


FIGURE 2 The longitudinal $\xi_{\parallel}$ and transverse $\xi_{\perp}$ correlation lengths and the susceptibility as function of reduced temperatures for x = 0.12.

The critical indices describing the temperature dependence of the correlation lengths and the susceptibility are given in Table II for all four concentrations.

TABLE II Critical exponents: $\nu_{\parallel}$, $\nu_{\perp}$ and γ for different compositions of the 4DBT/12DBT mixture.

x	$\nu_{\parallel}$	$\nu_{\perp}$	γ
0.12	0.80 ± 0.05	0.65 ± 0.05	1.15 ± 0.08
0.18	0.80 ± 0.05	0.70 ± 0.05	1.20 ± 0.07
0.24	0.76 ± 0.05	0.68 ± 0.04	1.18 ± 0.07
0.30	0.85 ± 0.06	0.70 ± 0.05	1.20 ± 0.08

CONCLUSIONS

The values of the critical indices near the INA point at x = 0.12 are practically equal to the values obtained for other concentrations of 12DBT. The anisotropy of the critical scattering defined as the ratio $\xi_{\parallel}/\xi_{\perp}$ also does not change significantly with the composition of the mixture: $\xi_{\parallel}/\xi_{\perp} \simeq 2$.

For other binary mixtures composed of different mesogens and with different smectic phases of pure components, the ratio of the longitudinal to the transverse correlation length increases with approaching the INA (or NAC) multicritical points along the t = const line near the nematic - smectic A transition [4]. For the 8DBT/12OCB mixture [3] its value was an order of magnitude greater close to the INA point (at $x_{12OCB} = 0.15$) than far from it ($x = 0.4$). In that mixture the increase of the anisotropy parameter was connected with the decrease of the correlation length in the direction perpendicular to the long axes of the molecules with composition near the multicritical point, while the longitudinal correlation length did not depend practically on the composition of the mixture.

For the 4DBT/12DBT mixture both longitudinal and transverse correlation length do not depend on concentration of 12DBT in the interval $0.12 \leqslant x \leqslant 0.3$. In this case the obtained results indicate that the character of the molecular interaction does not change with the composition of the mixture near the INA point.

In binary mixtures mentioned above [4] the molecular interaction responsible for ordering in smectic layers seems to decrease at the multicritical points and leads to the minimal value of the transverse correlation range.

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