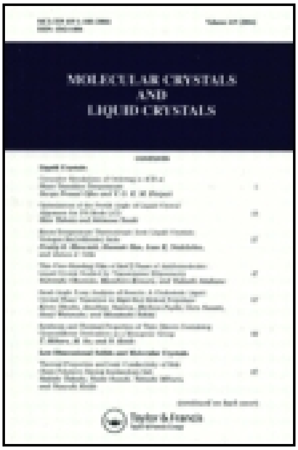

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Field Effect in a Mixture of Cholesteryl Chloride and Cholesteryl Crotonate (75: 25% by weight)

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The cholesteric-nematic phase transition in cholesteryl chloride and cholesteryl crotonate (75:25% by weight) is investigated. The dependence of the critical field on temperature is determined either by microscopical examination under polarized light or by following a DLI technique under electric field. Agreement between these methods has been obtained.

Field-induced cholesteric-nematic phase transition was investigated both theoretically[1,2] and experimentally.[3–8] It was shown that in compensated cholesteric mixtures the nematization temperature is changed when the phenomenon is watched under electric or magnetic fields; critical fields which produce nematization were determined as well as temperature and pitch dependence on the field.

To investigate the cholesteric-nematic phase transition† in a mixture of cholesteryl chloride and cholesteryl crotonate (75:25% by weight) sandwich cells were used: glass electrodes covered with SnO_2 and Mylar sheets of different thickness. The cell was filled with the liquid crystal mixture by capillarity and sealed with epoxy. Then the cell was introduced in a special heating stage with accessories for registering temperatures and application or removal of external voltages.

The measurements were performed under polarized light with an IOR-MCl microscope equipped with a photocell and an automatic system for

† The purities were 99.95% and 99 80% respectively as determined by chromatography.

registering the light signal during the heating or cooling of the cell at a constant rate of 3°/min.†

The light source was an Osram HBO 100 W/2 mercury lamp equipped with filters.

First texture changes and depolarized light intensity traces were followed in the absence of external fields. As shown in a previous paper,[9] the mixture exhibits the cholesteric mesophase in the temperature range (298°K–362°K) when heating from the solid state and in the range (358°K–298°K) when cooling from the isotropic liquid.

Texture changes are revealed under polarized light when the mixture is cooled from the isotropic point. First, after nucleation of the cholesteric mesophase the texture is focal conic up to 330°K; then it becomes planar and, in the vicinity of 315°K the fingerprint texture is evident which indicates that the cholesteric axes are parallel to the electrode surface.

At 307°K a cholesteric-nematic phase transition is noticeable. At temperatures lower than 307°K the texture becomes again homeotropic and the mixture exhibits a metastable supercooled state for several days at room temperature (298°K).

In order to follow the cholesteric-nematic phase transition under electric fields, the following experiments were performed.

1) The liquid crystal cell was heated at a temperature in the range of isotropic liquid and then held at this temperature for 15 to 30 minutes. After cooling at a desired measurement temperature T_i, an increasing electric field was applied and changes in the cholesteric helix pitch were determined by microscopic investigations. In this way, the critical field $E_c(T_i)$, which makes the pitch infinite, was detemined.

The experimental results obtained using this method are shown in Figure 1.

2) Arrhenius plots $\ln j = f(1/T)$, where j is the current density, were determined when different electric fields were applied on the liquid crystal cell. Following the same method described by Baessler and Labes,[10] the nematization temperature T_{ni} under the field E_{ci} is determined by plotting the function:

$$\frac{d(\ln j)}{d(1/T)} = f\left(\frac{1}{T}\right)$$

This function reaches an extreme value at the nematization temperature corresponding to the applied electric field.

Critical field values and nematization temperatures obtained in this way are shown in Figure 1.

† The precision in measuring temperatures was of $\pm$ 0.1°C.

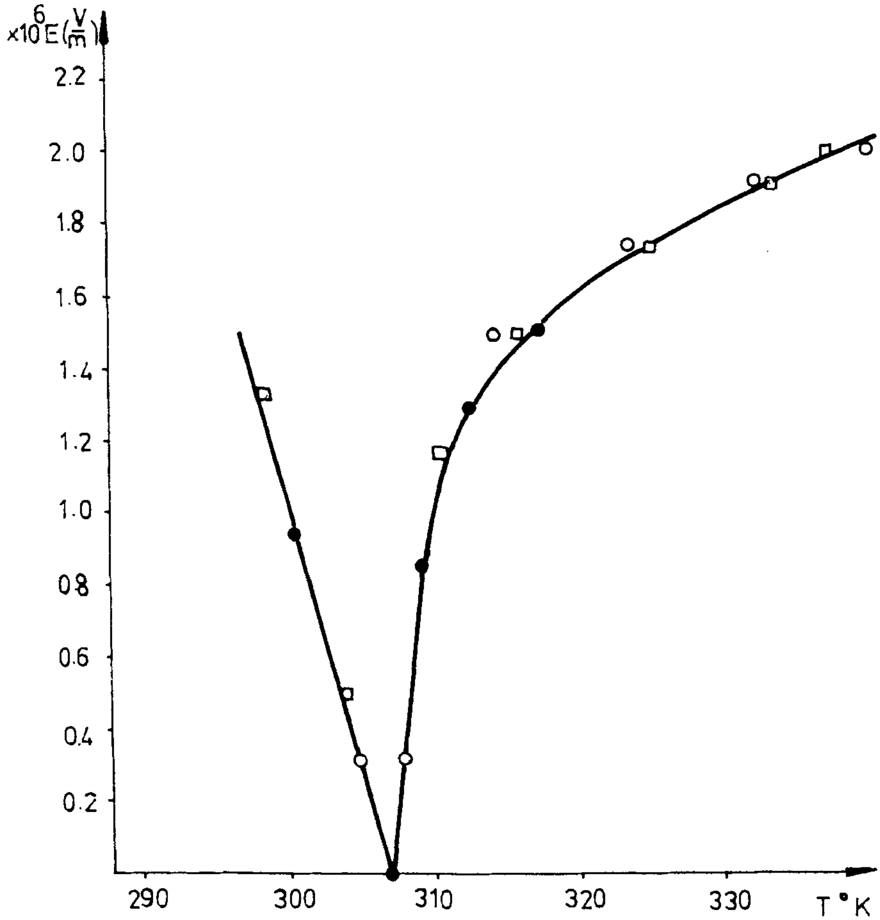

FIGURE 1 Critical field as function of temperature. ● Experimental values determined by microscopic investigations. □ Values determined using Baessler and Labes[10] method. ○ Values obtained from depolarized light intensity traces under the action of electric fields.

3) Depolarized light intensity traces were obtained under the action of electric fields.

The electric field was applied when the mixture was kept at a temperature within the isotropic range. The cooling of the cell was performed while different d.c. electric fields were applied.

Depolarized light intensity traces were obtained for the following d.c. field values: 0.33×10^6 V/m, 1.5×10^6 V/m, 1.66×10^6 V/m, 1.86×10^6 V/m and 2.00×10^6 V/m.

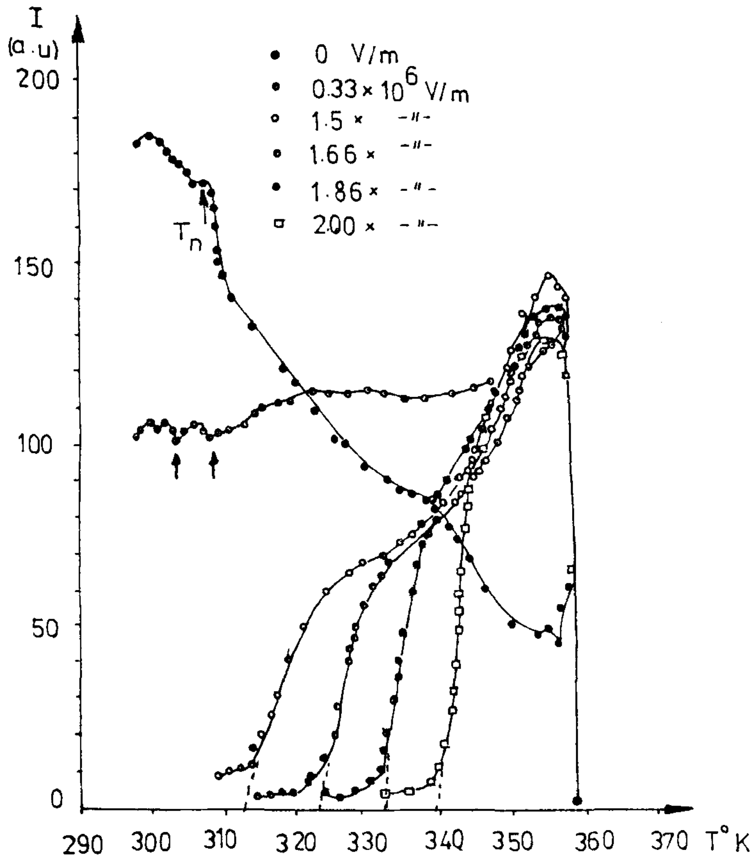

FIGURE 2 Depolarized light intensity traces obtained under different d.c. electric fields.

These results, including the curve obtained without applying an electric field are shown in Figure 2.

When this phenomenon is investigated at rather high fields ($E > 10^6$ V/m) the main texture changes are the following: planar and finally, homeotropic in the vicinity of the nematization temperature.

When rather high electric fields are applied the nematization temperature can easily be determined; it corresponds to an abrupt decrease in transmitted light under crossed polars and can be chosen as indicated in Figure 2.

When low fields are applied ($E < 10^6$ V/m), there is no dramatic decrease in light transmission at the nematization temperature, but only a minimum value on the DLI traces. This is a consequence of applying a rather high cooling rate, which was, as mentioned before at 3°C/min. The cooling rate was kept constant all through the experiment. If lower cooling rates are used, as for example 1°/min, the cholesteric-nematic phase transition is revealed by an abrupt decrease in light intensity.

Nevertheless, when low electric fields and rather low cooling rates are applied, the nematization temperature may be determined from the minima yielded by the DLI traces.

In Figure 1 critical fields corresponding to different nematization temperatures determined by using the above-mentioned method are indicated.

It may be seen that a very good agreement exists when these methods are applied.

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