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I. V. Kurnosov [a]

[a] Physico-Technical Institute of Low Temperatures, Kharkov, 164, Lenin Prospect, 47, USSR

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A NOVEL TECHNIQUE FOR DETERMINATION OF A CHOLESTERIC SCREW SENSE

I.V. KURNOSOV
Physico-Technical Institute of Low Temperatures, Kharkov, 164, Lenin Prospect, 47, USSR

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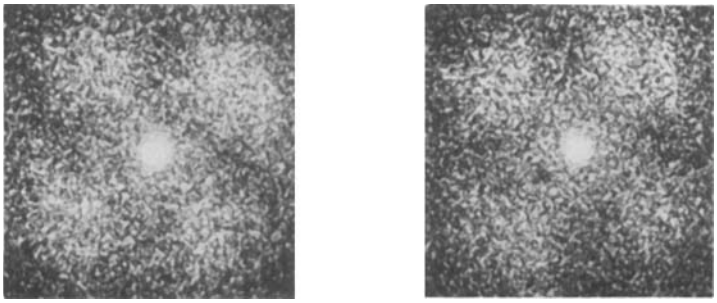
ABSTRACT - The effect of the rotation of a depolarized light scattering pattern from the ring domains in a mixture of cholesteryl chloride and cholesteryl nonanoate is observed. It is suggested to use the depolarized pattern rotation to determine the sense of helix in cholesteric liquid crystal, displaying the cholesteric-nematic transition.

A cholesteric liquid crystal (CLC) with positive dielectric anisotropy ($\Delta\varepsilon > 0$) can exhibit transition into the nematic phase at a certain critical electric (or magnetic) field[1,2]. Investigations were reported[3-5] of a CLC in the fields above the critical one, E_{CN}, of cholesteric-nematic (CN) transition. In particular, one can observe transient electrohydrodynamic instability with circular domains, giving rise to characteristic H_v and V_v light scattering patterns[4,5]. This letter presents some results on the observation of a transient H_v pattern rotation and suggests a novel technique to determine the sense of cholesteric twisting in a CLC with $\Delta\varepsilon > 0$.

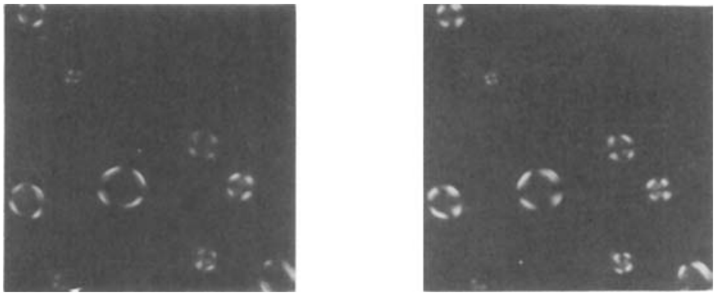
The liquid crystals used were a mixture of cholesteryl chloride (CC) and cholesteryl nonanoate (CN) in the weight ratio of 59:41. This cholesteric mixture with $\Delta\varepsilon > 0$ above $T_N = 42\ ^{\circ}C$ has the right-handed helix, below T_N - the left-handed one[2]. The H_v scattering patterns were recorded by the apparatus, similar to that described earlier[5]. In addition to recording light scattering patterns provisions were made for simultaneous examining the texture of the scattering portion of CLC by microscopy.

In case of a single reversing cycle of the DC electric field applied to a conventional electrooptic cell (with transparent SnO_2 coated substrates) filled with the CC-CN mixture at $E_+ < E_{CN}$ no significant changes can be detected in the H_v pattern of the field-induced striped domain texture[6]. (Here E_+ is the strength of the DC electric field at which the reversal of the field sign takes place). However, a series of reversing cycles at $E_+ \gtrsim E_{CN}$ causes the appearance of a new clover-leaf-type H_v pattern, shown in Fig. 1a; the overall distribution of the scattered light intensity being similar to that of the spherulitic scattering patterns[7,8]. Photomicrographs indicate that after a series of reversals the striped domains split into isolated defects which form closed looped domains (Fig. 2a). Thus the field-induced looped domains in the CC-CN mixture are rings made of the stripes of the finger-print texture and the process of its forma-



(a) (b)

Fig. 1. The H_V light scattering patterns obtained from the ring domain texture of the CC-CN mixture before the reversal (a) and after the reversal (b). $E_{\pm} = 1.4\ E_{CN}$, $T = 55\ ^{o}C$.



(a) (b)

Fig. 2. Photomicrographs of the ring domains of the CC-CN mixture before the reversal (a) and after the reversal (b). $E_{\pm} = 1.4\ E_{CN}$, $T = 55\ ^{o}C$, 140 ^{x}.

tion resembles that of bubble domains in the large pitch cholesterics[9,10].

Light scattering pattern studies of the field-induced ring domain texture have shown that the four-fould symmetry H_V pattern rotated to a small angle (Fig. 1a,b) after a single cycle of the field sign reversal prior to the appearance of the H_V pattern of the transient electrohydrodynamic instability[4,5]. The average value of rotation of the dark crosses when observed by a microscope appeared to be approximately 30°, while that of the H_V pattern was smaller. The direction of the transient H_V pattern rotation (and that of the dark crosses of the ring domains) was found to depend on the sign alternation sequence of the DC field applied and the sense of the cholesteric helix. Thus the difference between the direction of rotation for the right and the left helixes can be used as a simple method to determine the sense of cholesteric screw in CLC exhibiting CN transition.

For application of the method proposed while observing the texture of ring domains by a microscope one should change the sign of the field at the top electrode from positive to negative. In this case transient rotation of the dark crosses of the ring domains is directed counterclockwise for the CLC with the right-handed helix (in the CC-CN mixture at $T > T_N$). For the CLC with the left-handed helix the same cycle of the sign alternation causes the clockwise rotation of the dark crosses (in the CC-CN mixture at $T < T_N$). While changing the sign of the field at the top electrode from negative to positive the transient rotation of the dark crosses (and that of the H_v pattern) takes place in the opposite direction. As compared with the reported methods for the sense of the helix determination by circular dichroism[11], optical rotation[12], double disclination spiral[13], or by means of analysis of distortion of the scattered light intensity distribution[14], the proposed method (applicable to CLC displaying CN transition) has some advantages: no need of the Grandjean texture preparation and no preliminary substrates treatment, rather inexpensive instrumentation, and unambiguous estimate. In conclusion it should be noted that the direction of the dark cross branches of some rings does not coincide strictly with that of the polarizer and the analyzer, indicating the presence of the media distortion[15]. The average angle of rotation was found to be independent of the applied voltage in the range $E_{CN} < E_+$ and the blocking of electrodes with insulating layers did not eliminate the effect observed. Thus, we can exclude the transit of injected carriers from one electrode to another as a possible cause of the H_v pattern rotation.

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