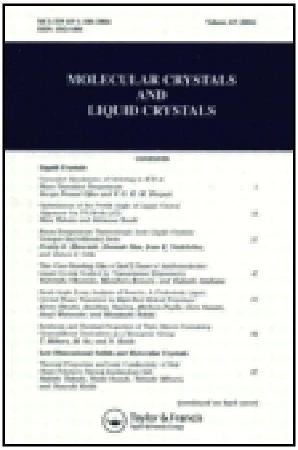

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The Effect of Magnetic Field on Electrohydrodynamic Instability Threshold in Liquid Crystals

Yu. G. Magakova [a], L. K. Vistin [a] & I. A. Kleinman [a]
[a] Institute of Crystallography of the Academy of Sciences of the U.S.S.R., Leninsky Prospect 59, Moscow, 117333, U.S.S.R.
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The Effect of Magnetic Field on Electrohydrodynamic Instability Threshold in Liquid Crystals

YU. G. MAGAKOVA, L. K. VISTIN and I. A. KLEINMAN
Institute of Crystallography of the Academy of Sciences of the U.S.S.R., Leninsky Prospect 59, Moscow 117333, U.S.S.R.

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In this paper we continue investigations started in Refs. 1 and 2 studying the effect of a magnetic field on electrohydrodynamics of liquid crystalline complex ethers with dielectric constant anisotropy close to zero. The investigations were made with 100 μm thick layers having initial planar "trist" structure of B and C mixtures described in Ref. 2.

Figure 1 shows dependences of optical layer transmittance on the intensity of the magnetic field (H) directed normal to bearing surfaces, and in the absence of an electric field in the absence of an electric field (curves I and II). For some threshold values $H = H_{th}$ all the samples showed an increased transmission arising due to Fredericks transition.[3]

DISCUSSION

Assuming a strong interaction between nematic molecules and bearing surfaces, in the case of planar orientation, and a weak interaction in the case of a "twist" structure, one can evaluate the angle of moleculo-rotation in the central part of layer 4. Here we assume that the modulus of elasticity is $K \cong 10^{-7}$ dyne, and anisotropy of magnetic susceptibility is $\Delta\chi \cong 10^{-7}$ SGS-unit. In planar samples the maximum angle of molecular rotation for $H \geqslant 1.5\ H_{th}$ is not more than 30°. In the "twist" structure samples, for the same H, molecules of the mean part of the layer rotate at 90°, i.e. in this case the Fredericks transition is realized.

Under our experimental conditions we can't yet observe changes arising in the layer under the action of a magnetic field. But analyzing the results of similar experiments[5] one can assume the presence of Kapustin–Williams in the layer.

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The electric voltage (U) applied parallel H on "twist" structure samples does not change value H_{th}, but reduces the transmission (curves III–II, Figure 1). For voltages above electrohydrodynamic instability threshold this is due to the presence of light scattering centres. Some decrease in transmission for voltages below threshold can be treated as follows. The electric field, by affecting the nematic molecules with a small negative dielectric anisotropy, increases the coupling of molecules with bearing surfaces owing to orientation perpendicular to the electric field force lines.

In planarly oriented samples an increase in U (the absence of magnetic field) causes some growth of transmission due to disordering of the initial structure (curve 1, Figure 2). The joint action of electric and magnetic fields above the electrohydrodynamic instability threshold leads to "anomalous" increase of transmission. Simultaneously, the dependence of transmission intensity on U becomes characteristic of a sample without the magnetic field (curves 2–5, Figure 2). The "anomalous" growth of the transmission seems to be caused by some ordering of the nematic structure in the magnetic field,

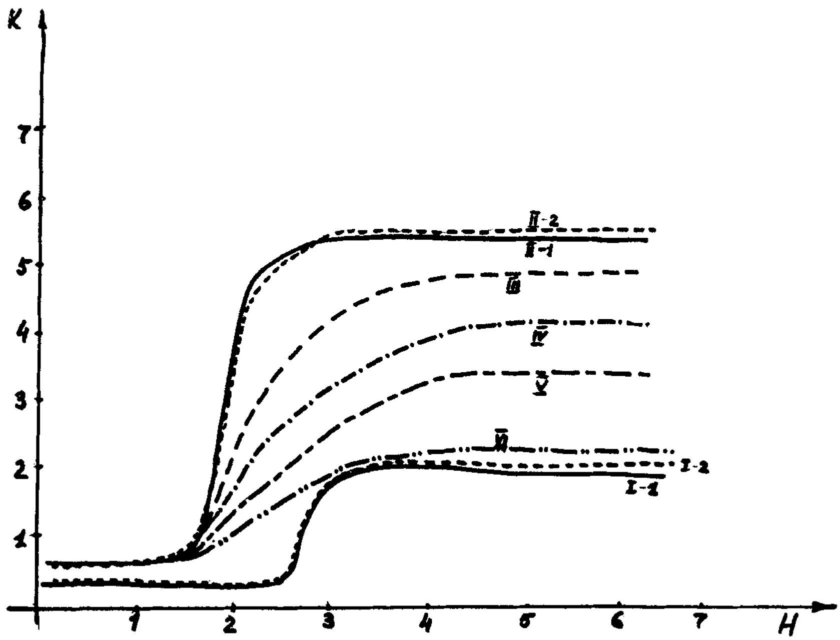

FIGURE 1 Light transmission versus magnetic field voltage: curves 1) planarly oriented samples in the absence of electric field; curves II—samples with "twist" structure in the absence of electric field (I—mixture B, 2) mixture C); curves III–VI—samples with "twist" structure of mixture B under the action of electric field, respectively, 8; 15; 30; 50 V.

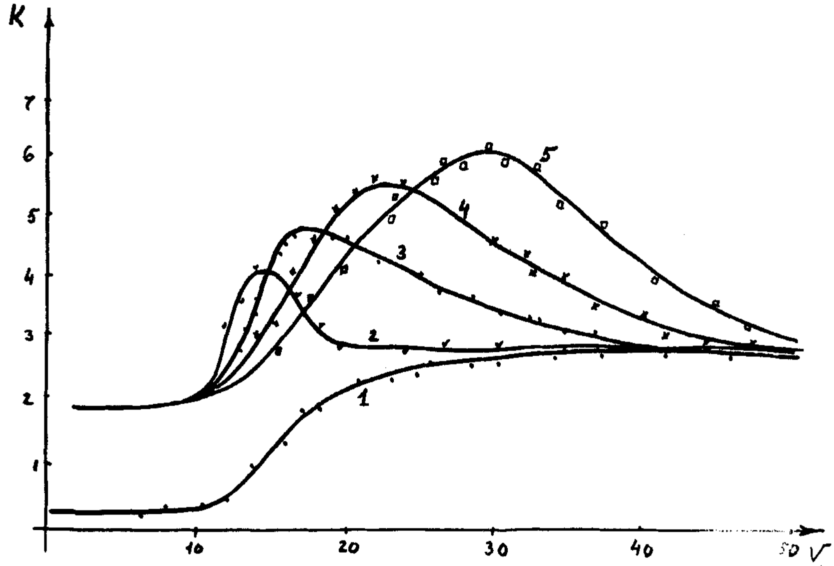

FIGURE 2 Light transmission versus applied electric field intensity: for mixture C: curve I—voltcontrast characteristic in the absence of magnetic field; curves 2–5—under the action of magnetic field voltage, respectively, 2; 3; 4.2; 5.5 kOe.

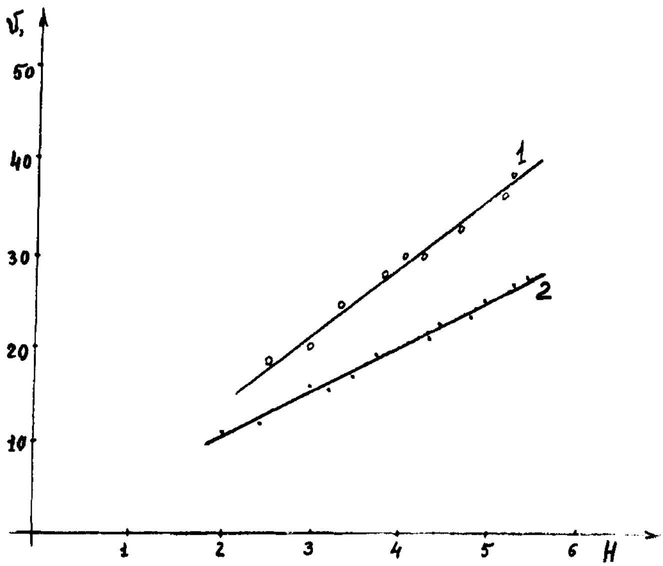

FIGURE 3 The position of transmission "anomaly" maxima versus voltcontrast characteristics for the given values of magnetic field intensity: 1) mixture B; 2) mixture C.

and the rotation of molecules on some angle towards lines of field forces. If this is true, one can admit the shift of dynamic light scattering threshold (but not electrohydrodynamic instability). The proposed model can be supported by two experimental results. First, the process of "anomalous" clearing was observed at $H < H_{th}$ (curve 2, Figure 2), and the shift of anomalous maximum towards U increasing with the growth of H occurring by a linear law (Figure 3) with increased values of transmission.

However, the shift of dynamic scattering threshold can't be considered as proved, because as shown above, the experimental procedure we used does not permit a visual observation of changes in the nematics. Further improvement of the experimental arrangement would make it possible to confirm (or reject) the validity of the above assumptions by means of visual observations.

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