Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Electrohydrodynamics of Hybrid Aligned Nematics

O. G. Akhmetshin [a] , V. A. Delev [a] & O. A. Scaldin [b]
[a] Physics Department, Bashkir State University, 450074, Ufa, Russia
[b] Physics Department, Bashkir Research Center, Russian Academy of Sciences, 450025, Ufa, Russia
Version of record first published: 04 Oct 2006.

To cite this article: O. G. Akhmetshin , V. A. Delev & O. A. Scaldin (1995): Electrohydrodynamics of Hybrid Aligned Nematics, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 265:1, 315-319

To link to this article: http://dx.doi.org/10.1080/10587259508041702

Mol. Cryst. Liq. Cryst. 1995, Vol. 265, pp. 315–319
Reprints available directly from the publisher
Photocopying permitted by license only

ELECTROHYDRODYNAMICS OF HYBRID ALIGNED NEMATICS

O.G.Akhmetshin, V.A.Delev and O.A.Scaldin[1]

Physics Department, Bashkir State University, 450074 Ufa, Russia
[1]Physics Department, Bashkir Research Center, Russian Academy of Sciences, 450025 Ufa, Russia

Abstract It has been found that at the electrohydrodynamic convection in the hybrid aligned nematics the oblique rolls are formed. These patterns are not stationary. The dependencies of the threshold voltage, drift velocity of rolls and oblique angle on the frequency of the AC electric field have been measured.

INTRODUCTION

It is well known when a low-frequency AC electric field is applied across a thin layer of nematic liquid crystal (NLC) with planar or homeotropic uniform orientation of the director **n**, normal or oblique rolls occur. These cases of electrohydrodynamic (EHD) convection in the NLC are well studied now both theoretically and experimentally[1,2].

Recently, some experimental and theoretical investigations of EHD convection in the twisted nematics have been carried out[3].

In this paper for the first time we report some results of our investigations on the EHD convection in the nematic liquid crystals with the hybrid alignment.

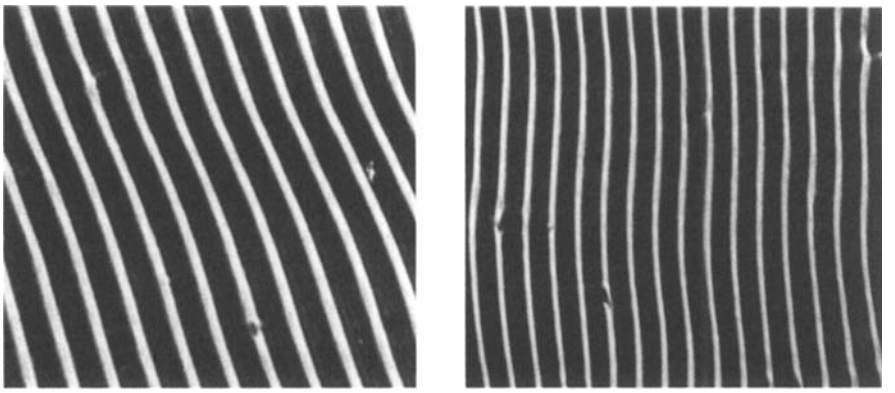
EXPERIMENTAL

In the present study, the nematic liquid crystal with negative dielectric anisotropy (MBBA) was used. The experimental setup consisted of two glass substrates covered by transparent electrodes with the

distance between plates fixed by mylar spacers. The NLC-cell thickness was varied between 20 μm and 100 μm. The horisontal sizes of the cell were 10×15 mm. The main experiments were performed with the nematic layer thickness of 20 μm, so that the aspect ratios were 500×750. One of the electrodes induced the uniform planar alignment that was obtained by the rubbing along some direction. The homeotropic alignment on the other one was obtained spontaneously by the evaporation of chrome on the its surface. The AC electric field was applied across the NLC-cell. Electrooptical measurements have been carried out with a polarizing microscope "Amplival Pol.U". The NLC sample conductivity was $\sigma \simeq 10^{-10}\ \Omega^{-1}$. The NLC-cell temperature was stabilized at 25°C.

RESULTS AND DISCUSSION

It has been observed that oblique rolls pattern appears at a certain threshold voltage U_c in the NLC with hybrid alignment (Fig. 1a). The threshold dependence of the AC electric field frequency is shown



a) b)

FIGURE 1. Microphotographs of the domain structures in hybrid aligned MBBA: oblique rolls at U=6.6 V and f=20 Hz (a), normal rolls at U=31 V and f=140 Hz (b).

in Figure 2. We observed that this pattern are not stationary and drifts with velocity **v**. It seems to be the pretilt of director **n** in the hybrid cell leads to nonstationary of rolls. In particular, it was predicted theoretically by Zimmermann[4]. The dependence of drift

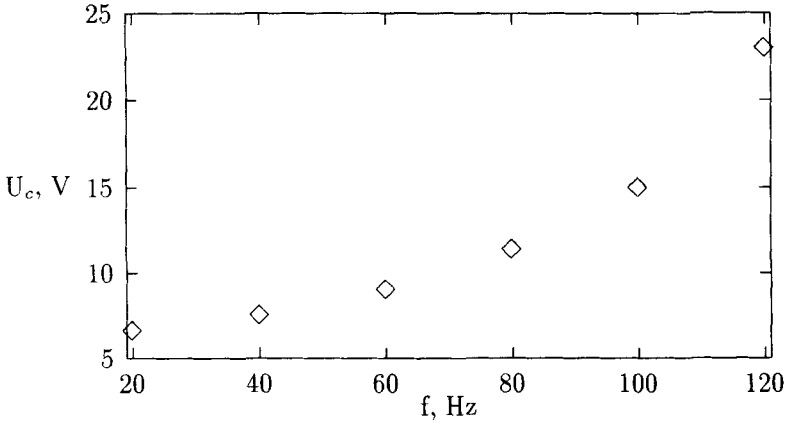


FIGURE 2. Dependence of the threshold voltage U_c on the AC electric field frequency f.

velocity on the AC electric field frequency is represented in Figure 3. Polarized-optical analysis shows that at the EHD threshold the director **n** in the NLC layer has an angle φ with the plane of initial alignment. Since the initial orientation of **n** is degenerated, in experiments the NLC sample divides on the two systems of oblique rolls along θ and -θ respectively. The boundaries between these oblique roll systems are disclinations. When frequency of an AC electric field is increasing the oblique angle of rolls is decreasing (Fig. 3b). We observed that oblique rolls become normal at about 130 Hz (See Fig. 1b).

With increasing voltage above the threshold U_c the rolls began to oscillate and defect turbulence or fluctuating Williams domains appears. At further increasing of the applied voltage the dynamic scattering mode is observed.

Thus, in the case of hybrid aligned nematics the drift oblique rolls are observed at the EHD convection.

CONCLUSION

The EHD convection in hybrid aligned nematics has been investigated. The drift oblique rolls have been observed at certain values of the threshold voltage U_c. The drift of rolls seems to be related with the pretilt of director **n**. It has been found that the oblique angle of rolls decreases with increasing of the AC electric field frequency and

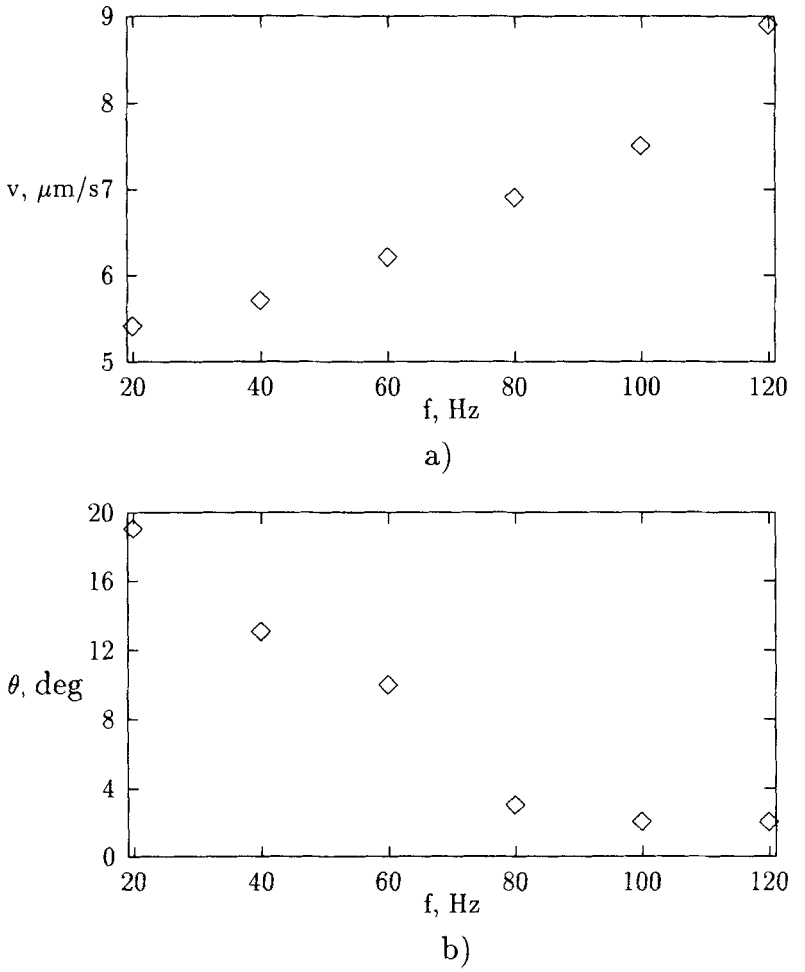


FIGURE 3. Dependence of the drift velocity of rolls **v** on the AC electric field frequency f (a); dependence of the oblique angle of rolls θ on the AC electric field frequency (b).

rolls become normally oriented to the orientation of the director at some frequency. The drift velocity of the rolls increases with the frequency of AC electric field.

ACKNOWLEDGMENT

Financial support of this work by the Russian Foundation for Fundamental Investigations (Grant No 94-02-05528a) is gratefully acknowleged.

REFERENCES

1. L.M.Blinov, Electrooptical and Magnetooptical Properties of Liquid Crystals (John Wiley, New York, 1983).

2. E.Bodenschatz, W.Zimmermann and L.Kramer, J. Phys. France, 49, 1875 (1988).

3. A.Hertrich, A.P.Krekhov and O.A.Scaldin, J. Phys. II France 4, 239 (1994).

4. W.Zimmermann, in Nematics : Mathematical and Physical Aspects, Klumer Academic publishers, (Dordrecht 1991). NATO ASI Series.