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Orientation Patterns in Nematic Liquid Crystal

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It has been reported by Williams[1] that a periodic optical texture can be observed in certain nematic liquid crystals when an electric field is applied to transparent sandwich cells. There are two different versions of the molecular orientation for the field-induced domain in a sandwich cell. Meyer stressed the piezoelectric effects which cause the alternating regions of splay and bending as seen in Fig. 2-b in his paper.[2] On the other hand, Helfrich predicted a periodic distortion, which was illustrated in Fig. 2 of his report,[3] produced by a space charge electric field on the basis on his theory.[4]

We tried to observe patterns in nematic *N*-*p*′-anisilidene-*p*-*n*-butylaniline in the direction perpendicular to the electric field using a sandwich cell shown in Fig. 1. Observations were made in transmitted light under a polarizing microscope. The walls of the cell were rubbed with a cotton swab before placing the sample.

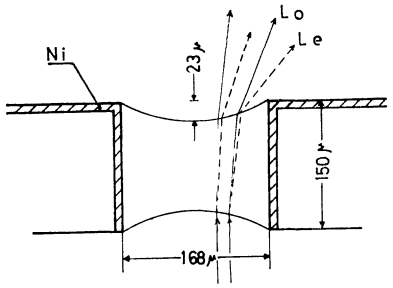

Fig. 1. Schematics of cell configuration and the shape of the sample. The electrodes were made with vacuum sublimated nickel on glass. The shape of the sample was determined with an interference microscope and a contact angle measurement apparatus. L_o and L_e mean the ordinary and extraordinary lights, respectively.

In the fieldless state the projection of the unique axis was aligned perpendicular to the wall near the electrode surface. It was gradually inclined with going away

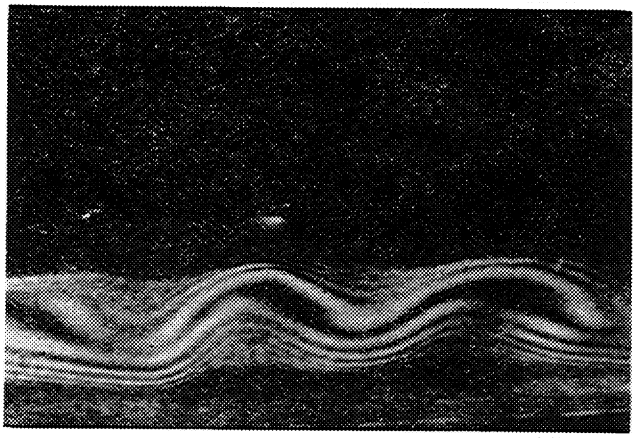

Fig. 2. Wave-like orientation pattern in *N*-p′-anisilidene-*p*-*n*-butylaniline at 25°C observed with crossed Nicols. Applied voltage was 5 V, the upper electrode being anode.

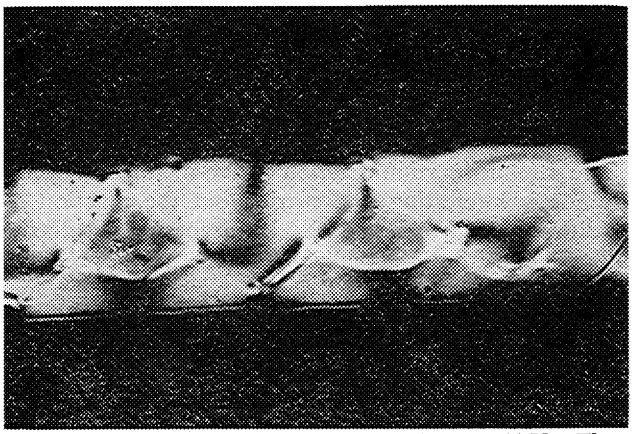

Fig. 3. Novel pattern in the nematic phase at 11 V. The cell was placed between the two parallel Nicols.

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1) R. Williams, *J. Chem. Phys.*, **39**, 384 (1963).
2) R. B. Meyer, *Phys. Rev. Lett.*,**22**, 918 (1969).
3) W. Helfrich, *J. Chem. Phys.*, **51**, 2755 (1969).
4) W. Helfrich, *ibid.*, **51**, 4092 (1969).

from the wall and finally aligned parallel to the wall. A white turbid part was seen at the center of the cell. The gradual change of the orientation could be seen by observing transmitted light which had been linearly polarized with a polarizer. When the direction of the electric vector of the incident light was rotated from perpendicular to parallel to the wall, a dark band moved from the wall to the center of the cell.

When an electric field ($\geqq$4.5 V) was applied, a wave-like orientation pattern appeared in the white turbid band. A typical pattern observed at 5 V is shown in Fig. 2. The pit in the pattern became deeper and reached the wall with the increase of the applied voltage up to 10 V. When the applied voltage exceeds 12 V, many lines were observed to move to and from the electrodes. This phenomenon corresponds to the dynamic scattering mode.[5] Several novel textures appeared between 10—12 V. An example is given in Fig. 3. The wave-like pattern observed in this experiment is much similar to one predicted by Helfrich.[3] Measurements of electric field distributions in the aligned nematic phase will give much information for the mechanism of the pattern formation.

5) G. H. Heilmeier, L. A. Zanoni, and L. A. Barton, *Proc. IEEE*, **56**, 1162 (1968).