8-4

The Electro-Optical Rotation of Vertically Aligned Nematic Liquid Crystal Layers *

W. Jung, K.N. Kang, and Y.B. Chae, Korea Inst. Sci. Tech. and Q.W. Choi, Seoul National University, Seoul, KOREA

Earlier works on the electro-optical properties of the homeotropically aligned nematic liquid crystal layers in the so-called deformation of vertically aligned phase (DAP) mode dealt with the crossed polarizer arrangement, and the voltage-dependent transmission was interpreted in terms of the phase difference between the ordinary and extraordinary rays introduced by the liquid crystal layers.(1,2) In the present work, the same phenomenon was investigated at various analyzer settings, and the results were analyzed in terms of the rotation of the plane of polarization and the ellipticity of the transmitted light.

The nematic liquid crystals with negative dielectric anisotropy, MBBA and EBBA, were homeotropically aligned between two tin oxide coated glass plates treated with lecithin. The abrupt onset of the optical transmission near the threshold voltage(Fig.1) were found indeed to correspond to the rotation of elliptically polarized light. At the first transmission peak, the transmitted light was nearly circularly polarized. Upon increasing the applied voltage, the transmitted light returned to linear polarization, and then back to circular polarization at the second peak before the beam became depolarized as the dynamic scattering mode set in. (Fig.2) Thus the electro-optical effect of the liquid crystal layer was similar to the rotation of a quarter-wavelength plate but the sense of the rotation alternated as the applied voltage increased.

* The work was supported in part by the research grant from Yonam Foundation.

In order to supplement these observations, the optical birefringence of the liquid crystal layers was studied by tilting the liquid crystal layers with respect to the incident polarized monochromatic beams in the absence of the electric field. In this way, the electro-optical rotation data was converted to the equivalent average tilt angle of the optical axis of the liquid crystal molecule with respect to the incident beam. The physical nature of the electro-optical birefringence was investigated by its dependence on the frequency of the applied ac field, on the thickness, and on the wavelength of the monochromatic light beams. (Fig. 3)

References:

(1) M.F. Schiekel and K. Fahrenschon, "Deformation of nematic liquid crystals with vertical orientation in electrical fields," Appl. Phys. Letters 19, 391-393(1971).

(2) M.F. Schiekel and K. Fahrenschon, "Multicolor matrix-displays based on the deformation of vertically-aligned nematic liquid crystal phases," 1972 SID International Symposium, June 6-8, 1972, San Franscisco, Digest of Technical Papers, P.98.

Figure captions:

Fig. 1. The optical transmission of vertically aligned MBBA layers with crossed polarizers as a function of applied voltage(at 50 Hz, 6328 A, layer thickness 7 um).

Fig. 2. The optical transmission of vertically aligned MBBA layers as a function of applied voltage at various analyzer settings(at 40 Hz, 6328 A, layer thickness 7 μm).

Fig. 3. The wavelength dependence of the optical tramsmission of monochromatic beam by vertically aligned MBBA layers as a function of applied voltage(layer thickness 7 μm).

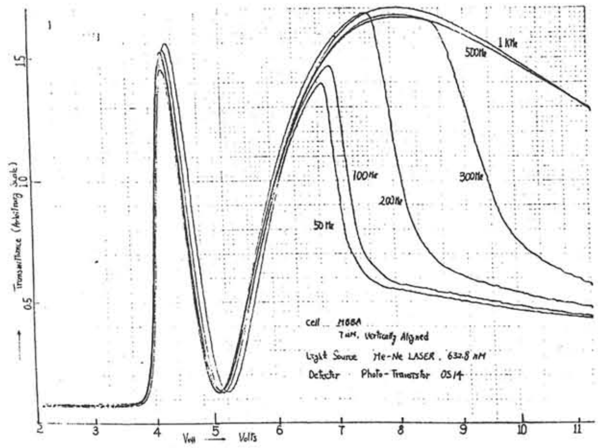

Fig. 1

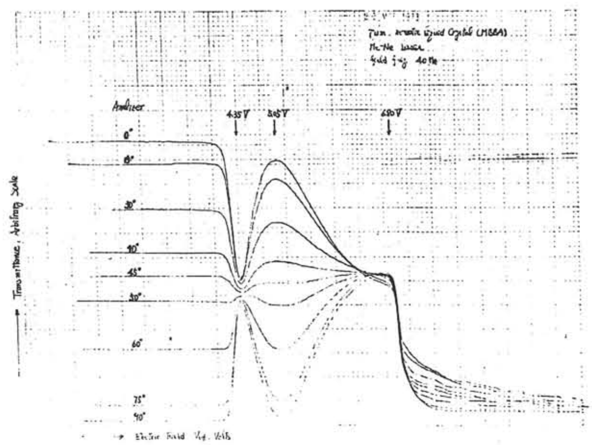

Fig. 2

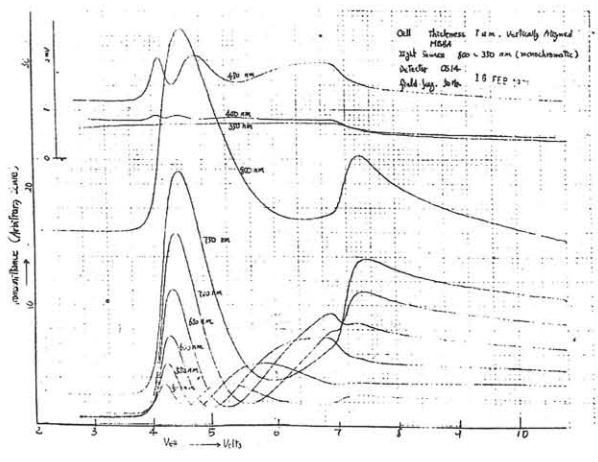

Fig. 3