

Title	Electrooptic Characteristics in Homeotropically Aligned Ferroelectric Liquid Crystal
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## Electrooptic Characteristics in Homeotropically Aligned Ferroelectric Liquid Crystal

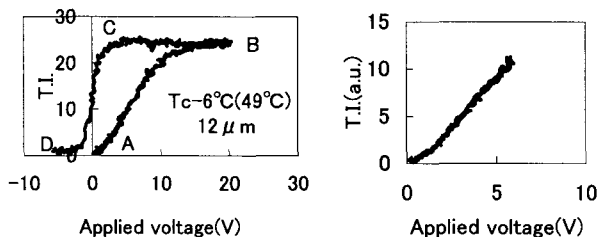
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The electrooptic effect in ferroelectrics liquid crystal (FLC) is extraordinarily fast in comparison with that in the Nematic liquid crystal, because the driving force in FLC is based on the spontaneous polarization  $P_s$  and the molecules orient by the torque  $P_s E$ . Although, so far, many types of electrooptic effects have been proposed in a planer aligned cell geometry, few studied using a homeotropically aligned cell was carried out. Ozaki et al. have proposed two types of electrooptic effect in the homeotropic cell of FLC. One of them is based on the deformation of the helical structure upon the application of an in-plane electric field in the homeotropically aligned FLC placed between closed polarizers [1].

In this study, the detailed characteristics such as a transmission light hysteresis and response speed are reported.

The FLC material used in this study was (2S,3S)-3-methyl-2-chloropentaoic acid 4', 4''-alkoxybiphenyl ester (3M2CPOOB) [2,3], which has a large spontaneous polarization ( $300\text{nC/cm}^2$  at  $35^\circ\text{C}$ ). The liquid crystal molecule is aligned homeotropically using a polyimide surfactant alignment. The cell was placed between crossed polarizers. The direction of the applied electric field makes an angle of  $45^\circ$  to the polarization direction of the polarizer. A light source was He-Ne laser light (632.8nm).



(a) Hysteresis curve      (b) Non-hysteresis curve  
 Fig. 1 Voltage dependence of TI

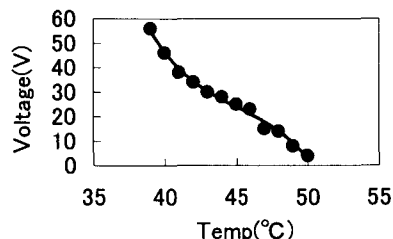


Fig. 2 Temperature dependence of the threshold voltage for non-hysteresis VI curve (3M2CPOOB)

Figure 1(a) shows voltage dependence of the transmission intensity (TI) as a function of the maximum voltage. It is found that, if the driving voltage is below the threshold, VI curve has no hysteresis as Fig. (b).

Figure 2 shows the temperature dependence of the threshold voltage, which does not cause hysteresis in the V-TI. curve. With decreasing temperature, the threshold voltage increases. The

threshold field for the unwinding of the helical structure  $E_c$  is represented  $E_c = \frac{\pi^4 K \sin^2 \theta}{4P_s p^2}$  where  $K$  is the elastic constant,  $\theta$  is the tilt angle and  $p$  is the pitch of the helical structure.  $K$ ,  $\theta$  and  $1/p$  increase with decreasing temperature. If the temperature dependence of these parameters is taken into account,  $E_c$  should increase at lower temperature as shown in Fig. 2.

Figure 3(a) shows the T.I. change upon applying a step-arise voltage. Figure 3(b) shows the voltage dependence of the response time at 48°C. When electric field is high, the response time  $\tau$  is approximately expressed as  $\tau \equiv \frac{\eta}{P_s \times E}$ , where  $\eta$  is rotary viscosity according to this relation,  $\tau$  is proportional to  $E^{-1}$ , that is, if electric field increases, the speed of response becomes fast.

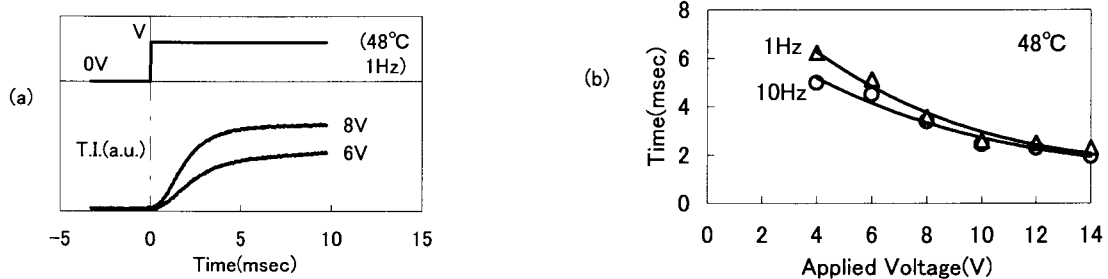


Fig. 3 (a) Transmission intensity change to step-rise voltage, (b) Voltage dependence of the response time

Figure 4 shows temperature dependence of the rise time in 3M2CPOOB. It is found that the rise time does not depend on the temperature except for the lower temperature below 35°C which is the transition temperature to the higher order phase.

In conclusions, the hysteresis characteristic depends in applied electric field and temperature.

The thresholdvoltage which does not cause hysteresis increases with decreasing of temperature.

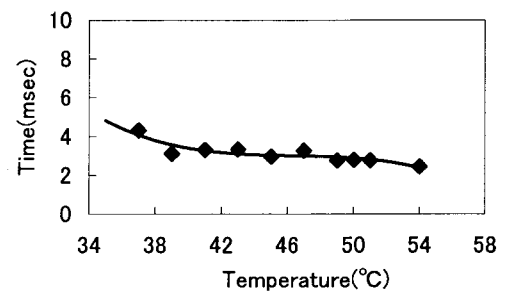


Fig. 4 Temperature dependence of the rise time at 10V.

## References

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