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Electrooptic Effects of Thick Freely Suspended Ferroelectric Liquid Crystal Film and Cell

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Electrooptic effects of thick freely suspended ferroelectric liquid crystal films and conventional cells that are thicker than helical pitch have been studied. A very slow molecular motion was observed in the case of the thick films that have no solid surface.

Keywords: Ferroelectric Liquid Crystal; Electrooptic Effect; Thick Freely Suspended Film and Cell

INTRODUCTION

Ferroelectric Liquid Crystal (FLC) has fluidity and layered structure, so that freely suspended (FS) films of it can be made in air successfully. In the freely suspended ferroelectric liquid crystal (FSFLC) films, a molecular reorientation is induced by application of an electric field parallel to the film. Electrooptic effects due to the molecular reorientation

of thin FSFLC film have been reported in previous papers.[1,2] In this study, an electrooptic effect of a thick FSFLC film that was thicker than helical pitch was measured comparing to a homeotropically aligned conventional cell.

EXPERIMENTAL

A ferroelectric liquid crystal (Chisso,CS-1029) whose helical pitch was 2 μ m at 25℃was used in this study. All experiments were carried out at 25℃.

The FSFLC film was prepared in a hole of a glass plate of 0.15 mm in thickness. A diameter of the hole was 1.5 mm. Two electrodes were settled on the glass plate, and electric field can be applied to the FSFLC film in parallel. A gap between the two electrodes was 2 mm. Homeotropically aligned cells were also made in order to compare with the FSFLC films. The electrooptic measurements of these two kinds of samples were carried out. Figure 1 shows an experimental setup. A He-Ne laser beam (λ = 632.8nm) impinged on the sample with incident angle of 8° and was perpendicular to the applied field after passing through a polarizer. The analyzer and the polarizer crossed each other. The polarization direction made an angle of 45° with respect to the incident plane. Transmission light intensity was detected by photodiode.

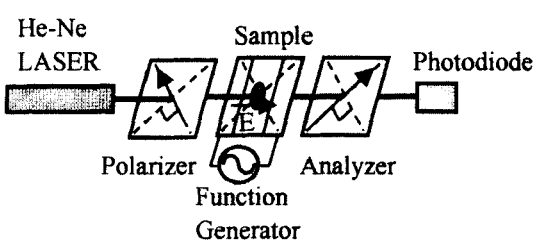
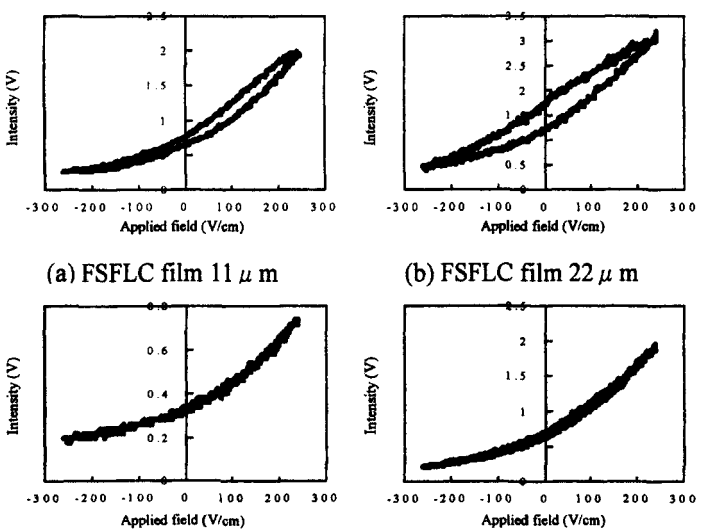


FIGURE 1 Experimental setup.

RESULTS AND DISCUSSION

Figure 2 shows electrooptical responses to a slow (freq.= 0.01Hz) triangular alternate field. Figure 2 (a) and (b) are responses of the FSFLC films, and (c) and (d) are responses of the cells, respectively. Transmission light intensity is not saturated and is successive in high field areas, so that a helical structure is not disappeared by the applied field. It must be noted that hysteresis has been observed in the FSFLC films, but not in the cells.

According to previous papers[3,4] on a thin FSFLC film that was thinner than helical pitch, the hysteresis had been observed in a cell that has solid surface. The hysteresis was explained by influence of the interface.

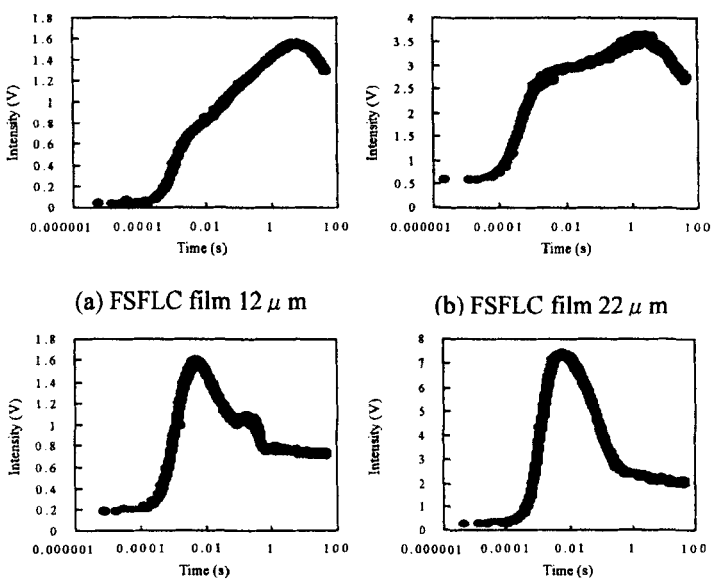


(a) FSFLC film 11 μ m (b) FSFLC film 22 μ m

(c) cell 12 μ m (d) cell 25 μ m

FIGURE 2 Response to a triangular electric field.

Further, figure 3 shows the response to a field inversion. The important point to note is a difference of response speed between the two samples. The responses of the cells are finished by a second, but one in the FSFLC films is not finished. This slow response shown in the results of the FSFLC films seems to relate with hysteresis observed in figure 2 (a) and (b). These results suggest that there is a restriction factor in the molecular reorientation process. Origin of the restriction is not influence of the glass substrate, and has been not clarified yet. However, one possibility is to assume that appearance of kinks of the orientation along the helical axis is origin of the restriction.



(a) FSFLC film 12 μ m

(b) FSFLC film 22 μ m

(c) cell 12 μ m

(d) cell 25 μ m

FIGURE 3 Response to a field inversion.

SUMMARY

Electrooptic effects of thick FSFLC films and cells which were thicker than helical pitch were measured. The results were different from ones of thin films and cells in that a very slow response was observed in the case of the films. This means that there is a restriction factor of molecular motion in the free surface.

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