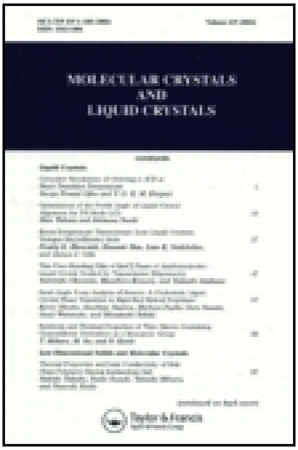

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Electrooptic Bistability of Ferroelectric Liquid Crystal Cell Prepared Using Obliquely Evaporated SiO Films

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The mechanism of the occurrence of the almost perfect bistability in the electrooptic response of a ferroelectric liquid crystal EO device with obliquely evaporated SiO films is explained by suggesting a model claiming that there is no depolarization field due to the carrier transportation of the SiO films and their very thinness. The validity of this assumption was confirmed by observing the phase relation between the switching currents and the applied triangular-voltage waveforms; in the case where SiO films were utilized, the switching current was shown to occur in the phase with the applied voltage, whereas for a cell with conventional polyimide films there occurred an advance in the phase between the current and the voltage.

Keywords: ferroelectric liquid crystal, bistability, obliquely evaporated SiO, depolarization field

INTRODUCTION

The Surface-stabilized ferroelectric liquid crystal (SSFLC) electrooptic device attracts the researcher's interest in terms of its remarkable features, such as memory (bistability) capability, fast response speed, and its excellent viewing angular characteristic.[1,2]

The authors' research group showed that perfect bistability in an FLCD can be achieved by using ultrathin films such as polyimide LB films[3,4,5] or CTC-doped electrical transportable films[6] for the FLC molecular orientation; the films featured by their electrical conductivity or ultrathinness play a role in eliminating the depolarization field in terms of discharging the charges accommodating the interfacial regions due to the accumulation of the ionic charges or that of the induced charges in the orientation layers in terms of the switching of an FLC with a fairly large spontaneous polarization.[7,8]

Along with the utilization of organic materials for the molecular orientation, the obliquely evaporated SiO films have been shown to be useful to fabricate an FLCD.[9,10] However no explicit explanation for the utility of the SiO films has been given up to now as far as the authors know.

Kimura *et al.* developed a technique to estimate the magnitude of the depolarization field by observing the phase relation between the switching current and the applied triangular-voltage waveform.[11]

This research work has been conducted with the aim of giving an explanation for the utility of SiO films by adopting the method developed by Kimura *et al.* As a result, a cell with SiO films for molecular orientation showing good bistability was shown to have no depolarization field.

EXPERIMENTAL

The FLC, ZLI-3654 (Merck), was used in a form of the SSFLC cell prepared by using 85-degree obliquely evaporated SiO films of 50 nm thick for the molecular orientation. For a comparison a cell with the rubbed conventional polyimide films was also prepared which did not reveal good stability.

The switching currents of the sample cells were observed by applying triangular-voltage waveforms whose frequency ranged from 0.02 Hz to 1000 Hz.

RESULTS AND DISCUSSION

Figure 1 shows an example of the switching current together with the EO response of a cell with SiO orientation films for a triangular-voltage waveform at 1 Hz. Both the switching current and the EO response are shown to start at the instant just before the polarity of the triangular-voltage waveform changes. This fairly good phase coincidence between the current (or EO response) and the electric field provides direct evidence for the absence of the depolarization field, which was exactly confirmed by Kimura *et al.* using a cell with polyimide LB films.[11] However, at the higher frequency region there occurs a delay in the switching current due to the viscosity of the LC medium and a complexity in the switching process.[11]

For a comparison, the same measurement has been done on a cell with the rubbed conventional polyimide orientation films which are characterized by their electrically insulative nature with thickness of 50 nm. The result is shown in Figure 2. There occurs a remarkable advance in the reverse current against the phase of the applied triangular-voltage waveform. This phenomenon suggests the existence of the depolarization field.

Figure 3 (A) and (B) compares the memory capabilities of the cells. The former is an example of the trace of the EO performance of a cell with the obliquely evaporated SiO films showing a good bistability for a bipolar pulse waveform; whereas the latter is that for a cell with the rubbed PI films that shows a poor memory capability.

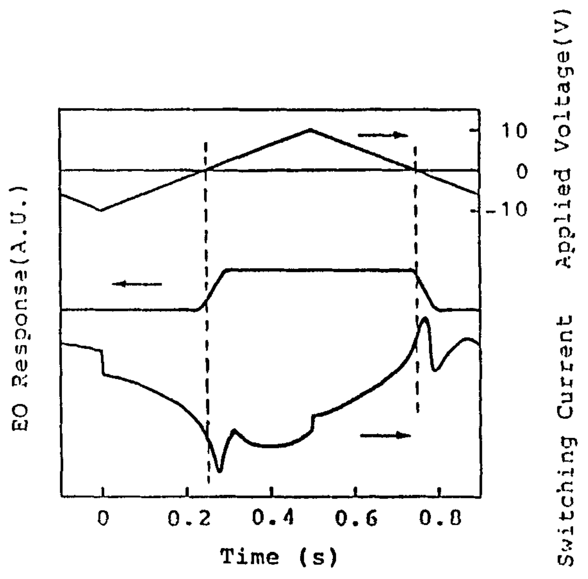

FIGURE 1 The EO response and switching current for a triangular waveform. FLC, ZLI-3654, is aligned with obliquely evaporated SiO films.

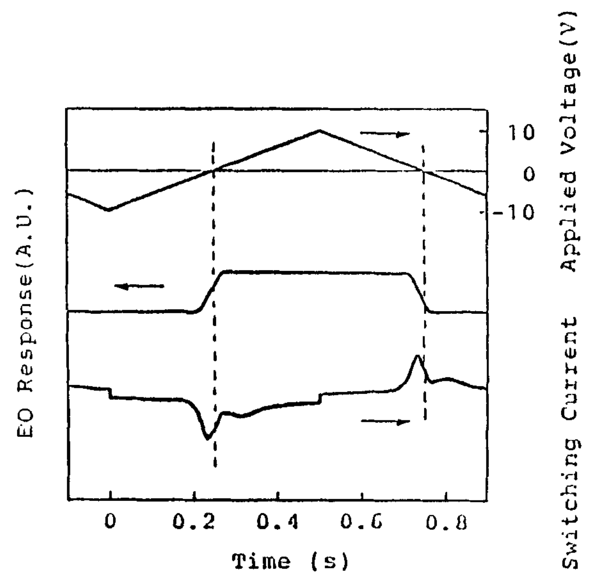

FIGURE 2 The EO response and switching current for a triangular waveform. FLC, ZLI-3654, is aligned with rubbed polyimide films.

CONCLUSIONS

The achievement of the good bistability which appeared in the cell prepared by using obliquely evaporated SiO films can be explained by considering that the obliquely evaporated SiO films are regarded as conductive layers for their porosity

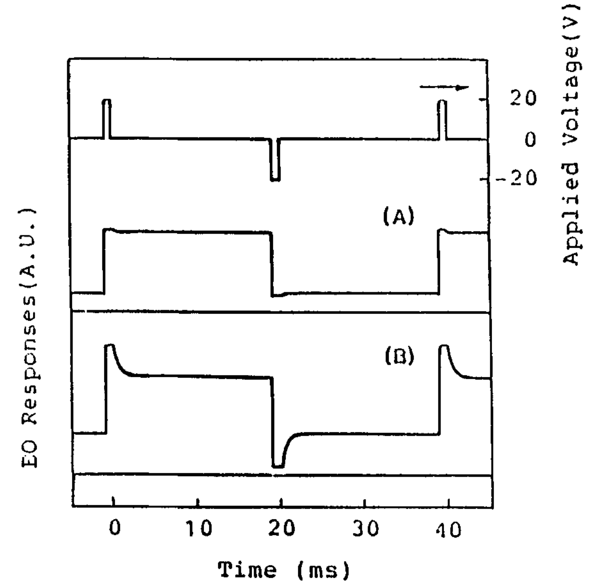

FIGURE 3 Optical response of a SSFLCDs of 1.5 μm thick using (A) obliquely evaporated SiO and (B) rubbed polyimide films.

and roughness and thus they play a role in eliminating the depolarization field that deteriorates memory capability.

It was shown that the utilization of obliquely evaporated SiO films for aligning liquid crystals is useful to realize a good memory capability in an FLCD.

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