Electro-optical Characteristics of the One-side Rubbing TN-LCD on Polyimide Surface with Ion-beam Irradiation

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(Received July 9 2008, Accepted October 10 2008)

The electro-optical (EO) characteristics of the one-side rubbing twisted nematic (TN) - liquid crystal display (LCD) on the polyimide (PI) surface with one-side ion beam (IB) irradiation were successfully studied. The good LC alignment for the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation was observed. The suitable transmittance-voltage curves for the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation were measured. Also, the good response time characteristics of the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation were measured. The fast response time can be achieved for the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation.

Keywords : Polyimide, TN-LCD, One-side rubbing, Ion beam, Voltage-transmittance

1. INTRODUCTION

Rubbing treatment method that rubbed PI surface to align liquid crystal molecules on ITO coated substrate surfaces has been used to fabrication of LC devices. Liquid crystal molecules are aligned by induced anisotropy on the PI surfaces with rubbing process[1-6]. Rubbed polymer surfaces have suitable characteristics for uniform alignment. However, the rubbing method has some disadvantages such as the electrostatic charges and the contaminating particles from rubbing fabric on polyimide surface[7,8]. In LCD panel at applied voltage, the electrostatic charges destroyed the thin film transistor (TFT) device and generated the pinhole on the polyimide film. Therefore, we recommend the rubbing less liquid crystal alignment technique on alignment layer for high-resolution LCD.

LC aligning capabilities can be achieved by ion beam (IB) irradiation on the inorganic[9,10] and organic[11-14] layer and UV irradiation[15,16] on the PI surface have been reported. Also, we considered the possible mechanisms were proposed to explain the alignment of LC molecules on the rubbed PI surfaces, which is based on an intermolecular interaction between LC molecules and polymer chains in the stretched film[1,3,5]. The liquid crystal aligning capabilities for the one-side rubbing TN-LCD on the PI surfaces with IB irradiation has not been reported yet. In this research, we report the EO characteristics of the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation.

2. EXPERIMENTAL

In this experiment, the polymer for the homogeneous (SE-7492 from Nissan Chemical Engineering Co.) was used. The polymers were uniformly prepared by the spin coating on indium-tin-oxide (ITO) electrodes and imidized at 250 ℃ for 1 hour. The thickness of the polyimide film was set at 500 Å. Rubbing strength is set up for medium.

Figure 1(a) shows the high-energy-density IB system, DuoPIGatron-type used in this experiment. The ion beam energy intensity was 1800 eV and the incident angle of ion beam exposure was used 45 ° incident angle. The IB irradiation time is used for 1 min. In fabrication of the TN-LCD, we used the mixture of the positive type NLC (Δn = 8.2, MJ1001929, from Merck Co.). And, the cell gap was used 5 μm. The LC alignment characteristics were observed using the photomicroscope. In addition, the voltage- transmittance and response time characteristics for the TN-LCDs were measured by LCD EOMS (Electro-optical Measurement) equipment.

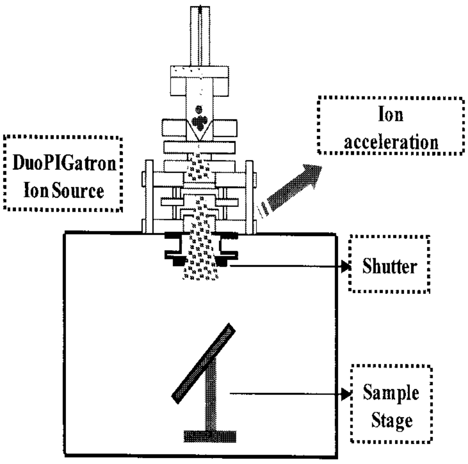
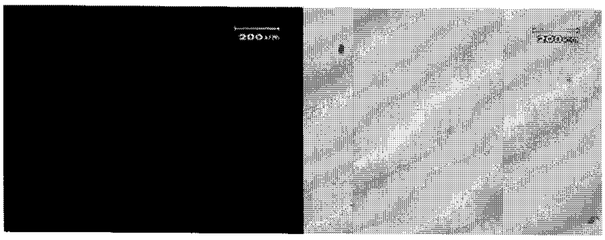


Fig. 1. Schematics diagram of the DuoPIGatron-type IB irradiation system.

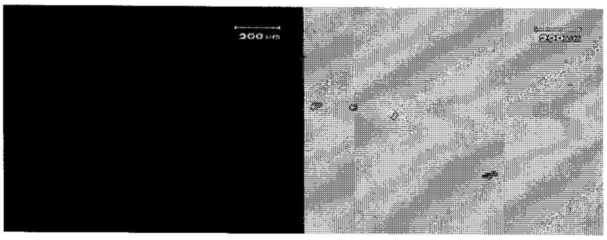
3. RESULTS AND DISCUSSION

Figure 2 shows the microphotographs of the two types of TN-LCDs on the PI surface (in crossed Nichols). The applied voltage is used 5 V. The monodomaine LC alignment for the both-side rubbing TN-LCDs on the PI surface can be achieved as shown in Fig. 2(a). As shown in Fig. 2(b), the monodomaine texture for the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation was observed.



on-state off-state

(a) Rub-Rub TN-LCD



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(b) Rub-Ion beam TN-LCD

Fig. 2. Microphotographs of the TN-LCDs on the PI surface (in crossed Nichols). TN-LCDs prepared by (a) both-side rubbing TN-LCD and (b) one-side rubbing TN-LCD on the PI surface with one-side IB irradiation.

Figure 3 shows the *V-T* characteristics for two types of the TN-LCDs on the PI surface. Excellent *V-T* curve for the rubbing TN-LCD on the PI surface was obtained. Also, good *V-T* curves for the one-side rubbing TN-LCD on the PI surface by one-side IB irradiation was obtained. Table 1 shows the threshold voltage for two types of the TN-LCDs on the PI surface. The threshold voltage of one-side rubbing TN-LCD on the PI surface by one-side IB irradiation was about 1.43 V. The threshold voltage of the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation is large than that the both-side rubbing TN-LCD on the PI surface. It is considered that the high threshold voltage is attributed to low pretilt angle.

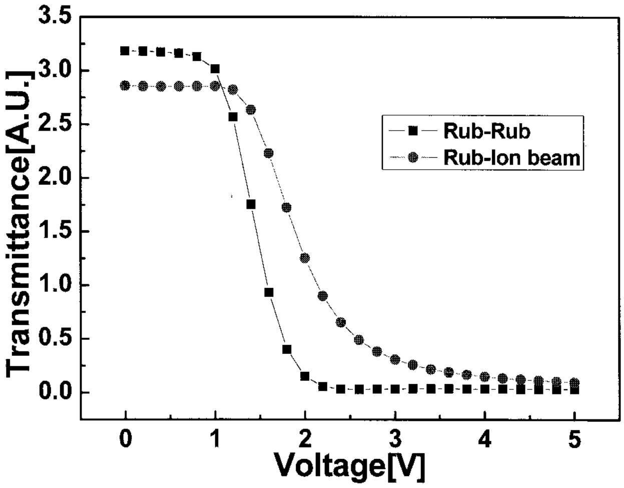

Fig. 3. Transmittance characteristics as a function of applied voltage for two types of the TN-LCDs on the PI surface.

Table 1. Threshold voltages for two types of the TN-LCDs on the PI surface.

	Threshold voltage (V)
Rub-Rub TN-LCD	1.07
Rub-IB TN-LCD	1.43

Figure 4 shows the response time characteristic for two types of the TN-LCDs on the PI surface. The good response time characteristics for two types of the TN-LCDs on the PI surfaces were measured. Table 2 shows the response time for two types of the TN-LCDs on the PI surface. The rising time was 1.21 ms, and the decay time was 12.3 ms for both-side rubbing TN-LCD. Also, the rising time was 1.62 ms, and the decay time was 7.24 ms for a one-side rubbing TN-LCD with one-side IB irradiation. The fast rising time was measured in the both-side rubbing TN-LCD on the PI surface. However, fast decay time can be achieved by one-side rubbing TN-LCD on the PI surface with one-side IB irradiation. We suggest that the rising response time is attributed to the pretilt angle on the PI surface, and the decay time is strongly attributed by anchoring strength between the LC molecules and the PI surface.

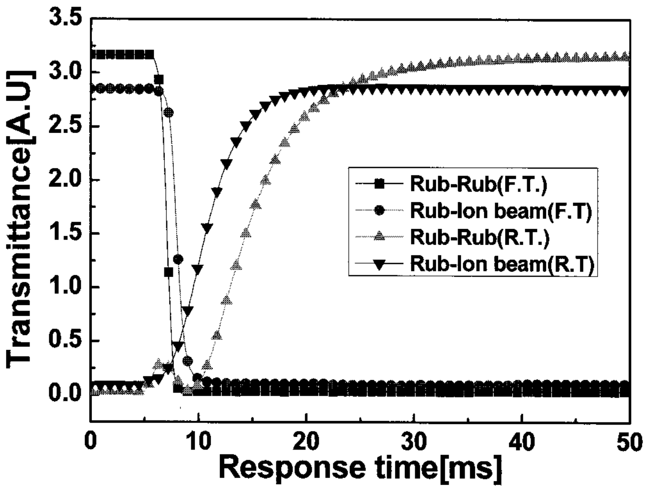

Fig. 4. Response time characteristics for two types of the TN-LCDs on the PI surface.

Table 2. Response times for two types of the TN-LCDs on the PI surface.

	Rising Time (ms)	Decay time (ms)	Response Time (ms)
Rub-Rub TN-LCD	1.21	12.3	13.5
Rub-IB TN-LCD	1.62	7.24	8.86

4. CONCLUSION

In conclusion, the EO characteristics of the two types of TN-LCD on the PI surface were investigated. The excellent LC alignment for the one-side rubbing TN-LCD on the PI surface by one-side IB irradiation was observed. Also, suitable transmittance-voltage curves for the rubbing TN-LCD on the PI surface with one-side IB irradiation were measured. Also, the good response time characteristics of the one-side rubbing TN-LCD on the PI surface with one-side IB irradiation were measured. Finally, we assumed that the response time is attributed to the anchoring strength between the LC molecules and the PI surface.

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