EO Performances of the Ion Beam Aligned TN-LCD on a Diamond-Like-Carbon Thin Film Surface

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Abstract

Electro-optical (EO) performances of the ion beam aligned twisted nematic (TN)-liquid crystal display (LCD) with oblique ion beam exposure on the DLC thin film surface were studied. An excellent voltage-transmittance (V-T) curve of the ion beam aligned TN-LCD was observed with oblique ion beam exposure on the DLC thin film surface for 1 min. Also, a faster response time for the ion beam aligned TN-LCD can be achieved with oblique ion beam exposure on the DLC thin film surface for 1 min can be achieved.

1. Introduction

Thin film transistor-liquid crystal displays (TFT-LCDs) are widely used in notebook computers and desktop monitors. A rubbing method has been widely used to align LC molecules on a polyimide (PI) surface. LC's are aligned due to the induced anisotropy on the substrate surface[1-5]. Rubbed PI surfaces have suitable characteristics such as uniform alignment and a high pretilt angle. However, the rubbing method has some drawbacks, such as the generation of electrostatic charges and the creation of contaminated particles[5]. Thus, rubbing-free techniques for LC alignment are strongly needed in LCD technology. Recently, the LC alignment effects by using the photodimerization[6-12] and photo-dissociation[13-18] have been reported. Most recently, the LC aligning capabilities achieved by IB exposure on the DLC thin film layer have been successfully studied by P. Chaudhari et al[19]. This article will report on the EO characteristics of the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film surface.

2. Experiment and Results

The DLC thin films were coated on indium-tin-oxide (ITO) coated glass substrates by remote plasma enhanced chemical vapor deposit ioning (RPECVD). The glass substrates were pre-sputtering due to the Ar plasma in chamber. The DLC thin film was applied using C_2H_2 : He gas for 1 min. The He and C_2H_2 gas were floating 3 sccm and 30 sccm in the chamber at room temperature, respectively. The thickness of the DLC layer was 5~8 nm. The IB (Kaufman type Ar ion gun) exposure system is shown in Fig. 1. The IB energy used was 200 eV. The incident angle of ion beam was 45 degrees. The cell thickness of the ion beam aligned TN-LCD was 5 ?m. The LC cell was filled with a fluorinated type mixture of MJ97359 (Tc=87℃, from Merck). Also, the rubbing aligned TN-LCD was fabricated. LC alignment ability was observed using the microphotographs. Voltage-transmittance and response time characteristics of the ion beam aligned TN-LCD were measured by a DMS (Display Measurement System, from Autronic) equipment.

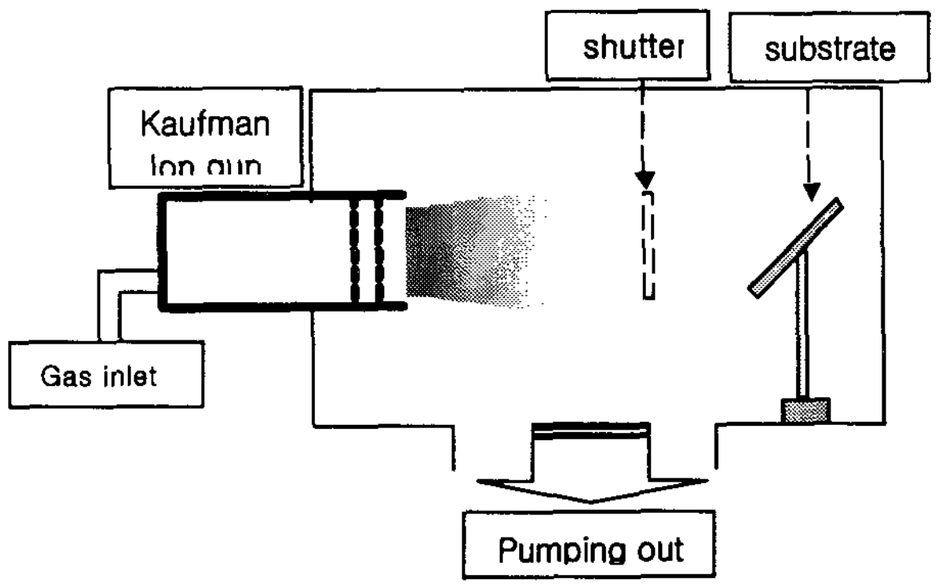
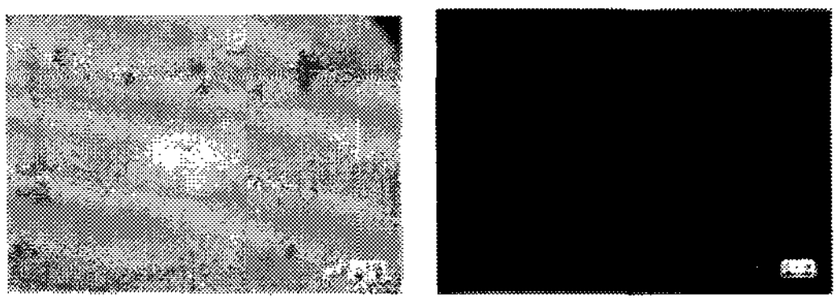


Figure 1 Ion Beam exposure system

Figure 2 shows the microphotographs of the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film layers for 1 min (in crossed Nicols). Monodomain alignment of the ion beam aligned TN-LCD can be observed.



(a) Off-state (b) On-state

Figure 2 Microphotographs of the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film layers for 1 min (in crossed Nicols).

Figure 3 shows the V-T curves of the ion beam aligned TN-LCDs with oblique ion beam exposure on the DLC thin film surface. An excellent V-T curve can be achieved in the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min. The transmittances of the ion beam aligned TN-LCD on the DLC thin film surface decreased by increasing the ion beam exposure time. Consequently, this system suggests that the best ion beam exposure time needed to achieve good V-T characteristics of the ion beam aligned TN-LCD is about 1 min. Also, the threshold voltage of the ion beam aligned TN-LCD with ion beam exposure of 1 min on the DLC thin film surface is almost the same as that of the rubbing aligned TN-LCD on the PI surface.

Figure 4 shows the response time characteristics of the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface. It reveals that the response time characteristics of the ion beam aligned TN-LCD on the DLC thin film surface improved by decreasing ion bean exposure time. A low transmittance level was measured in the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 2 min. Therefore, stable response time characteristics for the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min, can be produced. From these results, it is contended, herein, that the ion beam exposure time needed to achieve a good V-T curve and response time characteristics is about 1 min, as shown in Fig. 3 and 4.

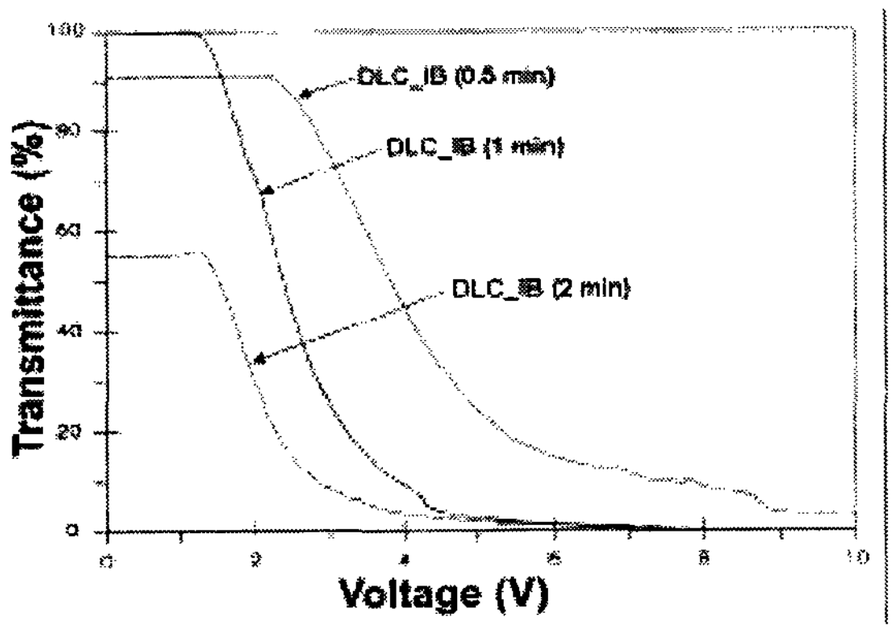


Figure 3 V-T curves of the ion beam aligned TN-LCDs with oblique ion beam exposure on the DLC thin film surface.

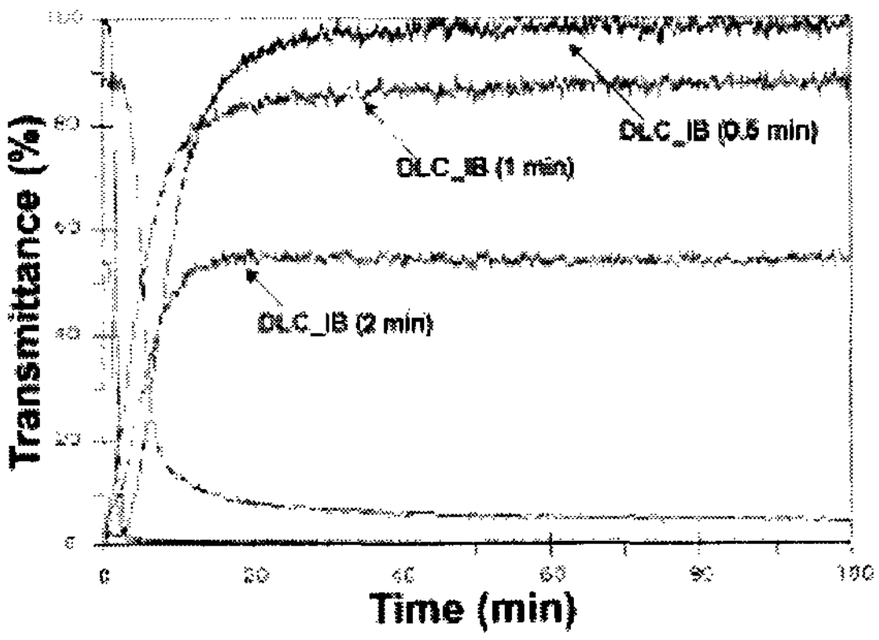


Figure 4 Response time characteristics of the ion beam aligned TN-LCDs with oblique ion beam exposure on the DLC thin film surface.

Table 1 shows the response times for the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film surface and for the rubbing aligned TN-LCD on a PI surface. The fast response time of the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film surface for 1 min. Optically measured at about 18.3 ms. From these results, it can be concluded that the response time of the ion beam aligned TN-LCD on the DLC thin film

surface is almost the same as that of the rubbing TN-LCD on the PI surface.

Table 1 Response times for the ion beam aligned TN-LCD on the DLC thin film surface and the rubbing aligned TN-LCD on a PI surface.

Alignment Layer	Response time τ_r (ms)	τ_d (ms)	τ (ms)
DLC_IB (0.5 min)	11.7	11.9	23.6
DLC_IB (1 min)	2.3	16.0	18.3
DLC_IB (2 min)	1.9	9.5	11.4
Rubbed PI	8.4	26.0	34.4

3. Conclusion

The EO characteristics of the ion beam aligned TN-LCD with oblique ion beam exposure on the DLC thin film surface were studied. A good V-T curve was observed for the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min. Also, a faster response time of about 18.3 ms, can be achieved for the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min.

4. Acknowledgement

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5. References

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