# EO Performances for Ion-beam Aligned TN-LCD on a DLC Thin Film Layer

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Electro-optical (EO) characteristics of the ion beam (IB) aligned twisted nematic (TN)-liquid crystal display (LCD) with oblique ion beam exposure on the diamond-like carbon (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 with oblique ion beam exposure on the DLC thin film surface for 1 min can be achieved.

*Keywords* : Diamond-like carbon, Ion beam alignment, EO characteristics

## 1. INTRODUCTION

Thin film transistor (TFT) - liquid crystal displays (LCDs) have become one of the fastest growing information display devices in recent years. They 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. 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 contaminating particles[1]. Thus, rubbing-less techniques for LC alignment are strongly needed in LCD technology.

Recently, the LC alignment effects by using the photodimerization[2~5] and photodissociation[6] have been reported. Most recently, the LC aligning capabilities by IB exposure on the DLC thin film layer have been successfully studied by P. Chaudhari, et al[7].

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. EXPERIMENTAL

The DLC thin films were coated on indium-tin-oxide (ITO) coated glass substrates by remote plasma enhanced chemical vapor deposition (RPECVD). The glass substrates were pre-sputtering due to the Ar plasma in chamber. The DLC thin film was deposited using the $C_2H_2$:He gas for 10 min. The $C_2H_2$ and He gas were floating 3 sccm and 30 sccm in chamber at room temperature, respectively. The thickness of the DLC layer was 10 nm. The ion beam (Kaufman type Ar ion gun) exposure system is shown in Fig. 1. The ion beam energies used were 200 eV. The cell thickness of the ion beam aligned TN-LCD was 5 μm. The LC cell filled with a fluorinated mixture type NLC without a chiral dopont (Tc=87℃, MJ97359, from Merck Co.). Also, the rubbed polyimide(PI) cell was fabricated to be compared with LC cell by ion beam exposure on the DLC thin film. LC alignment ability was observed using a photomicroscope.

Lastly, the voltage-transmittance and response time characteristics of the ion beam aligned TN-LCD were measured by a DMS (Display Measurement System, from Autronic Co.) equipment.

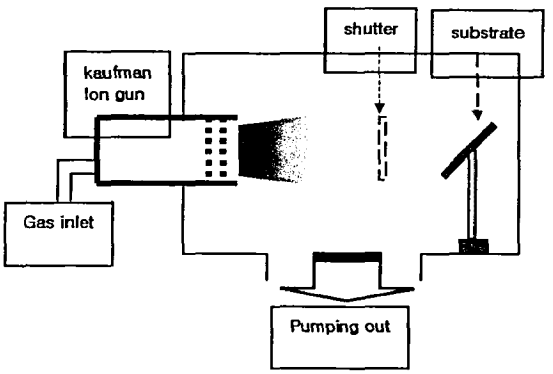


Fig. 1. Ion beam exposure system used.

## 3. RESULTS AND DISCUSSION

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

Fig. 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 beam 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 are about 1 min, as shown in Fig. 3 and 4.

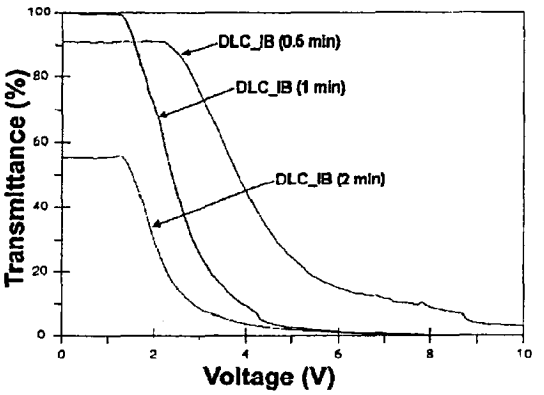


Fig. 3. V-T curves of the ion beam aligned TN-LCDs with oblique ion beam exposure on the DLC thin film surface.

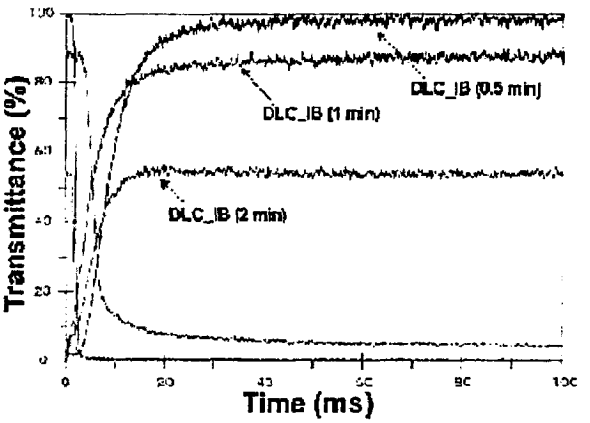


Fig. 4. Response time characteristics of the ion beam aligned TN-LCDs with oblique ion beam exposure on the DLC thin film surface

## 4. CONCLUSION

In conclusion, we studied 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 and response time were observed for the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min. Finally, the EO characteristics of the ion beam aligned TN-LCD with ion beam exposure on the DLC thin film surface for 1 min are almost the same as those of the rubbing aligned TN-LCD on the PI surface.

## ACKNOWLEDGMENTS

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