Electro-Optical Performances of In plane Switching(IPS) Cell on the Inorganic Thin Film by DuoPiGatron Ion Source

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Abstract: We studied the nematic liquid crystal (NLC) alignment capability by the IB(Ion beam) alignment method on a NDLC(Nitrogen Diamond Like Carbon) as a-C:H thin film, and investigated electro-optical performances of the IBalined IPS(In plane switching)cell with NDLC surface. A good LC alignment by IB exposure on a NDLC surface was achieved. Monodomain alignment of the IB aligned IPS cell can be observed. The good electro-optical (EO) characteristics of the IB aligned IPS cell was observed with oblique IB exposure on the NDLC as a-C:H thin film for 1min.

Key Words: NDLC, ion beam, response time, LC alignment, pretilt angle

1. INTRODUCTION

Liquid crystal displays (LCDs) are widely used as information display devices such as monitors in notebooks, desktops, and LCD TV. A rubbing method has been widely used to align liquid crystal (LC) molecules on the polyimide (PI) surface. [1–2]. Rubbed polyimide 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. Thus we strongly recommend a non-contact alignment technique for future generations of large, high-resolution LCD.

In this article, we report on LC alignment and pretilt angle generation with IB exposure on the surface of NDLC(Nitrogen diamond like carbon) as a-C:H:N thin-film deposited by r.f magnetron sputtering, and EO characteristics of the ion beam aligned IPS cell with oblique IB exposure on the NDLC as a alignment layer.

2. EXPERIMENT

The a-C:H:N (NDLC) thin films were prepared by RF magnetron co-sputtering equipped with a 5 N-purity Carbon target. The glass substrates were first cleaned with standard cleaning procedures and then rinsed in deionized water. Cleaned substrates were loaded in the central region of the substrate holder located about 50mm away from the targets. The sputtering chamber was initially evacuated by a turbo molecular pump to the base pressure of about 7.5×10⁻⁴ Pa. For the NDLC films deposition, the working pressure was maintained at about 0.67 Pa with Ar-ambient gas. Prior to the film deposition, pre-sputtering was performed for 10 min to remove any contamination on the target surface. The thickness of the NDLC thin film layer was about 20nm. The IB system is shown in Fig. 1. The IB power was used 1200eV.

![Fig. 1. Ion beam exposure system](image)

The gap of the ion beam aligned LC cell was 60μm, and the cell thickness of the Ion beam aligned IPS cell was about 4μm. The LC cell was filled with a nematic liquid crystal. To determine LC alignment condition, a polarization microscope was used and pretilt angle was measured crystal rotation method at room temperature. Voltage-Transmittance (V-T) and response time characteristics of the UV aligned TN-LCD were measured by a LCMS-200 equipment.

3. RESULT AND DISCUSSION
The LC pretilt angle observed with IB exposure on the NDL
thin film as a function of N$_2$ gas percent are shown in Fig. 2. It is shown that the LC pretilt angle generated was about 3 in the all-incident angle on the NDL thin film when N$_2$ gas was 2 and 4 sccm. However, LC pretilt angle generated show decrease with increasing N$_2$ gas percent. So, NDL thin film with low pretilt angle was used in the IPS cell.

![Graph showing pretilt angle vs. N$_2$ gas percent](image1)

**Fig. 2.** Generation of pretilt angles in NLC with IB exposure on NDL thin film surfaces for 1 min as a function of N$_2$ gas percent.

Figure 3 shows a good transmission of light as a function of applied voltage across IPS cells made of NDL thin film as alignment layers. A stable V-T curve of IB aligned IPS cell on the NDL thin film was measured.

![Graph showing transmission vs. voltage](image2)

**Fig. 3.** Voltage-transmittance characteristics of the IB aligned IPS cell on NDL thin film

Figure 4 shows the response time characteristics of the IB aligned IPS cells made of NDL thin films, as alignment layers. A stable curve for IB aligned IPS cell on the NDL thin films is shown.

![Graph showing response time](image3)

**Fig. 4.** Response time (RT) characteristics of the IB aligned IPS cell on NDL thin film

Figure 5 shows the Capacitance-Voltage characteristics of the ion beam aligned IPS cell. The residual charge characteristics of ion beam aligned IPS cell using the new type ion beam system have a little the increased value of the residual charge was very small.

![Graph showing capacitance-voltage characteristics](image4)

**Fig. 5.** Capacitance-voltage characteristics of ion beam aligned IPS cell with NDL thin film

### 4. Conclusions

In conclusion, we studied about LC alignment effect and the controllability of pretilt angle in a new alignment layer of the NDL thin film deposited by rf magnetron sputtering and investigated electro-optical performances of the IB aligned IPS cell with NDL thin film surface. We achieved a good alignment characteristics on the NDL thin film when N2 gas is from 2 sccm to 10 sccm at the sputtering. Also, we obtained high pretilt angle on the NDL, and then NLC alignment capabilities show decrease with increasing N2 gas percent. Finally, the EO characteristics of the IB aligned IPS cell with NDL thin film are good.

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### REFERENCES
