Polarization-dependence of liquid crystal alignment on an organic surface with ion beam irradiation

Dae-sub Choi, Jeong-Min Han

Department of Electrical Engineering, Seoil University

Abstract : We used Brewster's Law to examine the mechanism of liquid crystal (LC) alignment on an organic insulation layer when subjected to ion-beam irradiation. Brewster's Law implies that the maximum rate polarized ray on a slanted insulation layers on the substrate and it illustrates the dependence of polarization and themechanical structure on the ion beam irradiation process. The pretilt angle of nematic LCs on the organic insulation surface was about 1.13° for an ion beam exposure of 45° for 1 minute at 1800eV. This shows the dependence of LC alignment on the polarization ratio in a slanted organic insulation layer.

Key Words : liquid crystal alignment, ion beam, electro-optical characteristics, Polyimide, TN-LCD

1. INTRODUCTION

UV light exposure of the photopolymer layer has been studied as a non-contact alignment method and been shown to provide good LC alignment and thermal stability of the nematic liquid crystals (NLCs).[1-3] The effects of UV exposure on LC-alignment on a PI surface have been reported. Recent studies have addressed LC alignmentand pretilt angle generation in various alignment layers usingion beam irradiation.

2. EXPERIMENTAL

In this experiment, an organic insulation material was used for the LC alignment layers. The substrate surface was then exposed to ion-beam irradiation using a DuoPIGatron ion-beam system. The ion-beam parameters were as follows : energy 600 –3000 eV, exposure time 1 min, and ion beam current 1.84–2.51 mA/cm^2. A sandwich-type LC cell was fabricated with an anti-parallel structure and a thickness of 60 μm. The cell was then filled with a mixture of positive-type NLCs.

3. RESULTS AND DISCUSSION

Figure 1 shows the pretilt angles on anorganic insulation surface under various ion-beam irradiation conditions. The pretilt angle was strongly related to the irradiation angle of the ion beam. We calculated Brewster's angle in specimens consisting of two layers. One was the insulation layer, with a refraction ratio of 1.62,and the other was ITO glass with arefraction ratio of 1.5. Figure 2 shows that separation of the p- and s-waves started at ion-beam irradiation angles of about 30° and they were highly separated at 56.56–56.93°. It does provide a good foundation for explaining the experimental results.

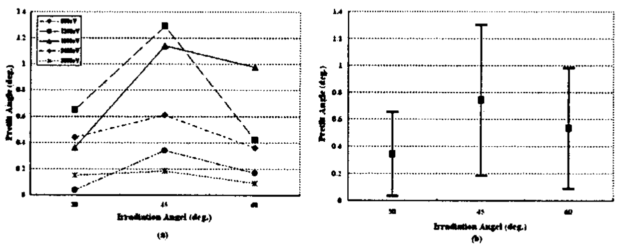

Figure 1. Pretilt angles as a function of ion beam intensity and irradiation angle. (a) Pretilt angles at various ion beam strengths and irradiation angles. (b) Pretilt angles generated with three different irradia-tion angles

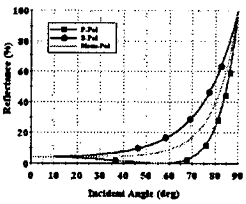

Figure 2. Calculated optical anisotropy generated at various irradiation angles

4. CONCLUSIONS

Good LC alignment can be achieved on an organic insulation thin film surface irradited by ion beams at 45°for 1 min with ion beam energies greater than 1200 eV. We have suggested the relationship between the irradiation angle and the direction of LC alignment using Brewster's Law.

REFERENCES

[1] J. M. Geary, J. W. Goodby, A. R. Kmetz, and J. S. Patel, J. Appl. Phys., 62, 4100, (1987)

[2] H. Matsuda, D.-S. Seo, N. Yoshida, K. Fujibayashi, and S. Kobayashi, Mol. Cryst. Liq. Cryst., 264, 23, (1995)

[3] D.-S. Seo and J.-Y. Hwang, Jpn. J. Appl. Phys., 39, 816, (2000)