Journal of the Korean Institute of Electrical and Electronic Material Engineers, Vol. 20, No. 3, p. 245, March 2007.

논 문 20-3-10

Liquid Crystal Aligning Capabilities Treated on Organic Overcoat Thin Films by Ion Beam Irradiation Method

Jeong-Min Han[1], Byoung-Yong Kim[1], Jong-Yeon Kim[1], Young-Hwan Kim[1], Jin-Woo Han[1], Jeoung-Yeon Hwang[1], Sang-Keuk Lee[1], Dong-Hun Kang[1], Chul-Ho Ok[1], and Dae-Shik Seo[1,a]

Abstract

The liquid crystal display (LCD) applications treated on the organic overcoat thin film surfaces by ion beam irradiation was successfully studied. The good LC aligning capabilities treated on the organic overcoat thin film surfaces with ion beam exposure of 60° for 2 min above ion beam energy of 1200 eV can be achieved. But, the alignment of defect of NLC on the organic overcoat surface at low energy of 600 eV was measured. The pretilt angle of NLC on the organic overcoat thin film surface with ion beam exposure of 60° for 2 min at energy of 1800 eV was measured about 1 degree. Finally, the good thermal stability of LC alignment on the organic overcoat thin film surface with ion beam exposure of 60° for 2 min until annealing temperature of 200 ℃ can be measured.

Key Words : Organic overcoat, Ion beam exposure, Alignment, Nematic liquid crystal

1. INTRODUCTION

The LC alignment effect for a nematic liquid crystal (NLC) on a substrate surface is important process in LCD manufacturing. Generally, a rubbing method has been widely used to align the LC molecules on polyimide (PI) surface[1-5]. Rubbed PI surfaces have suitable characteristics such as uniform alignment and stable pretilt angle. However, the rubbing method has some drawbacks such as the generation of electrostatic charges[6] and the creation of contaminating particles. The cleaning of LC cell is required to remove the electrostatic charge and particles. Thus we strongly recommend a non-contact alignment technique for future generations of high resolution LCD. For non-contact alignment technology, the good LC aligning capabilities and stable thermal stability for a NLC achieved by UV irradiation on the photopolymer layer have been successfully studied[7-9]. Also, the LC alignment effects on the polyimide (PI) thin film surface with UV irradiation have been reported [10]. In LCD manufacturing, the organic over coat materials for insulation layer of color filter with acryl ate was widely used. The organic overcoat materials for LC alignment layer have not yet been reported. Therefore, we approach that the organic overcoat material can use to insulation layer for color filter and LC alignment layer in this research.

1. Department of Electrical & Electronic Engineering (C-724), College of Engineering, Yonsei University (134 Shinchon-dong, Seodaemoon-ku, Seoul 120-749, Korea)

a. Corresponding Author : dsseo@yonsei.ac.kr

Received : 2007. 1. 12
Accepted : 2007. 2. 13

2. EXPERIMENTAL

In this study, we report on LC alignment effects for a NLC treated on the organic overcoat thin film surfaces by ion beam irradiation.

In this experiment, the organic overcoat material with polyimide (JSR Co.) was used as LC alignment materials. The organic overcoat was uniformly prepared by spin-coating on indium-tin-oxide (ITO) electrodes (20 mm x 20 mm) and imidized at 140 ℃ for 30 min. The

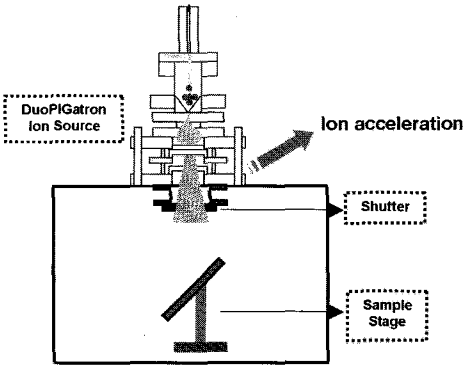


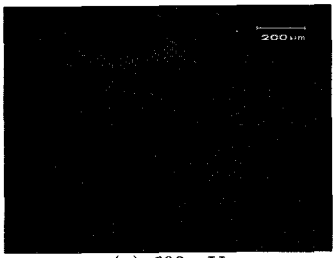
Fig. 1. Schematic diagram of ion beam exposure system using a DuoPIGatron type ion source.

thickness of the organic overcoat film was set at 500 Å. Also, the substrates surfaces were exposed by ion beam for ion beam sample.

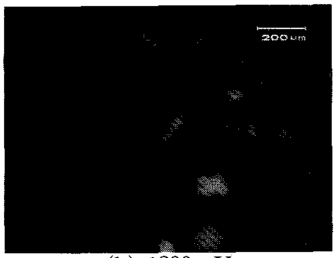
The used DuoPIGatron type ion beam system is shown in Fig. 1. The used DuoPIGatron type ion beam system, which can be advantageous in a large area with high plasma generation. The ion beam parameters were as follows: energy of 600~3000 eV, exposure time of 1 min and ion beam current of 1.84~2.51 ㎃/㎠. The LC cell was fabricated as a sandwich type with anti-parallel structure, and the thickness of the cell was 60 um. After fabricating the cell, a mixture of positive type NLC (Δn = 8.2, MJ1001929 from Merck Co.). LC alignment characteristics were observed using a photomicroscope. The pretilt angle of NLC was measured by crystal-rotation method (TBA 107, Tilt-Bias Angle Evaluation, from Autronic Co.) at room temperature. The annealing time was used at 10 min.

3. RESULTS AND DISCUSSION

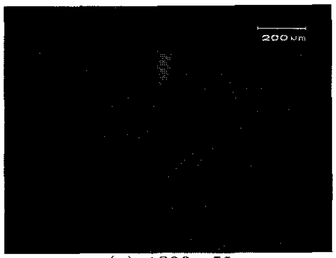
Figure 2 shows the microphotograph of NLC treated on the organic overcoat thin films with ion beam irradiation of 60° for 2 min for various ion beam energies (in crossed Nicols). The fine LC alignment for a NLC on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min above the ion beam energy of 1200 eV can be measured. But, the alignment



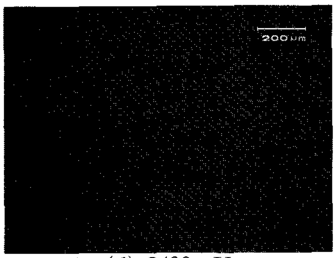
(a) 600 eV



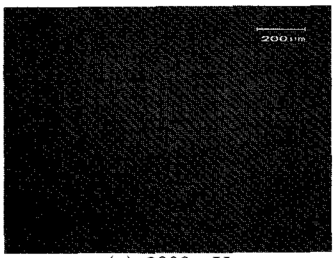
(b) 1200 eV



(c) 1800 eV

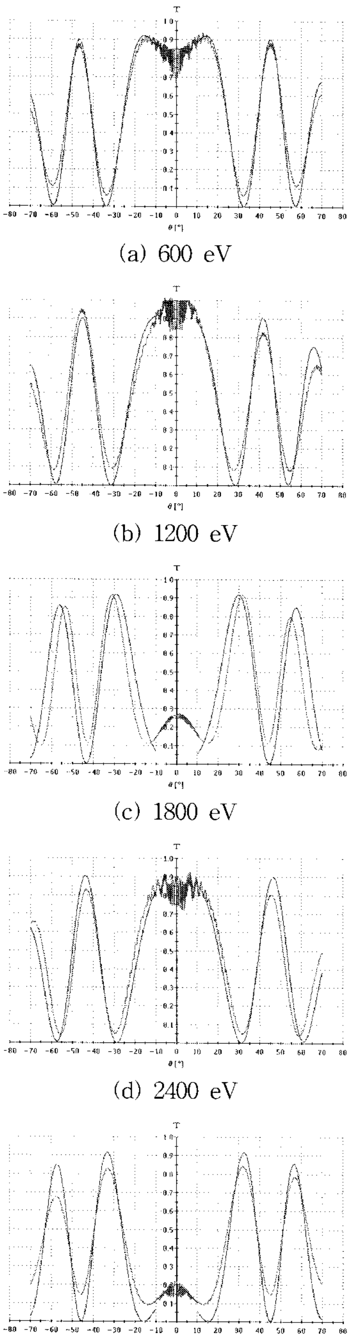


(d) 2400 eV



(e) 3000 eV

Fig. 2. Microphotograph of NLC treated on the organic overcoat thin films with ion beam irradiation of 60° for 2 min for various ion beam energies (in crossed Nicols).



(a) 600 eV

(b) 1200 eV

(c) 1800 eV

(d) 2400 eV

(e) 3000 eV

Fig. 3. A plot of the transmittance and incident angle on pretilt angle measurements treated on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min at various ion beam energies.

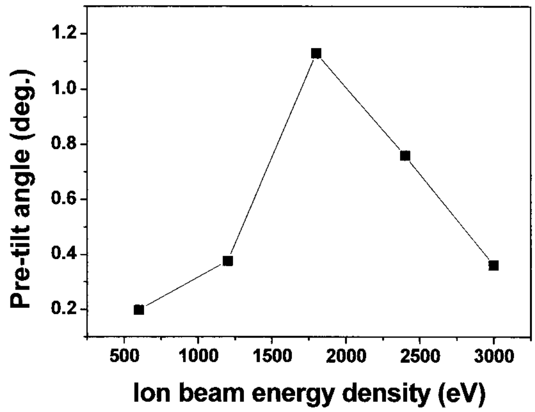
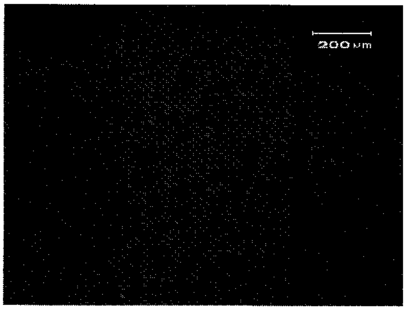


Fig. 4. Pretilt angles for a NLC on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min as a function of ion beam energy.

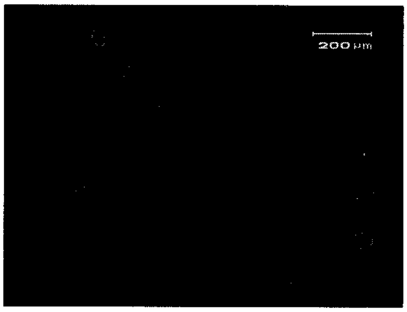
defect of NLC on the organic overcoat thin film surface with ion beam irradiation at ion beam energy of 600 eV was observed. Therefore, the good LC alignment for a NLC on the organic overcoat thin film surface with high density of ion beam irradiation can achieved.

Figure 3 shows the plot of the transmittance and incident angle on pretilt angle measurements treated on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min at various ion beam energy density. It is shown that the homogeneous alignment of NLC was measured.

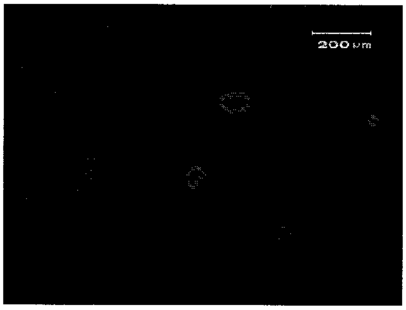
Figure 4 shows the pretilt angles for a NLC on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min as a function of ion beam energy density. The pretilt angle of NLC on the organic overcoat thin film surface with ion beam irradiation of 1800 eV for 2 min was measured about 1 degree. But, low pretilt angles of NLC on the organic overcoat thin film surface with ion beam exposure at energy of 600, 1200, 2400, and 3000 eV. From these results, we consider that the ion beam-aligned organic overcoat thin films could be applied to in- plane switching (IPS) mode which of LC rotates horizontally.



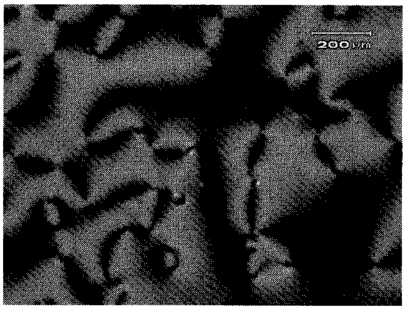
(a) 25 ℃



(b) 150 ℃



(c) 200 ℃



(d) 230 ℃

Fig. 5. Microphotographs of aligned LC on the organic overcoat thin film surface with ion beam irradiation of 60° for 2 min at various annealing temperatures (in crossed Nicols).

The microphotographs of aligned LC on the organic overcoat thin film surface with ion beam irradiation of 60° for 2 min at various annealing temperatures (in crossed Nicols) is shown in Fig. 5. The good LC alignment on the organic overcoat thin film surface with ion beam exposure of 60° for 2 min at energy of 1200 eV was measured until an annealing temperature of 200 ℃. and the alignment defect of LCs were partly observed above an annealing temperature of 230 ℃. As a result, good thermal stability of LC alignment for NLC on the organic overcoat thin film surface with ion beam energy can be achieved.

4. CONCLUSION

In this study, LC aligning capabilities treated on the organic overcoat thin film surfaces with ion beam irradiation was successfully studied. The good LC aligning capabilities treated on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min above the ion beam energy of 1200 eV can be achieved. The pretilt angle for a NLC on the organic overcoat thin film surface with ion beam irradiation of 1800 eV was measured about 1 degree. Therefore, homogenous alignment of NLC on the organic overcoat thin film surfaces with ion beam irradiation of 60° for 2 min was observed. Finally, the good thermal stability of LC alignment on the organic overcoat thin film surface with ion beam irradiation of 60° for 2 min can be measured.

REFERENCES

[1] D.-S. Seo, S. Kobayashi, and M. Nishikawa, "Study of the pretilt angle for 5CB on rubbed polyimide films containing trifluoro-methyl moiety and analysis of the surface atomic concentration of F/C(%) with an electron spectroscope for chemical analysis", Appl. Phys. Lett., Vol. 61, p. 2392, 1992.

[2] B. O. Myrvold and K. Kondo, "A population distribution model for the alignment of nematic liquid crystals", Liq. Crystals., Vol. 17, p. 437, 1994.

[3] D.-S. Seo, K. Araya, N. Yoshida, M. Nishikawa, Y. Yabe, and S. Kobayashi, "Effect of the polymer tilt angle for

generation of pretilt angle in nematic liquid crystal on rubbed polyimide surfaces", Jpn. J. Appl. Phys., Vol. 34, p. L503, 1995.

[4] D.-S. Seo and S. Kobayashi, "Effect of high pretilt angle for anchoring strength in nematic liquid crystal on rubbed polyimide surface containing trifluoromethyl moieties", Appl. Phys. Lett., Vol. 66, p. 1202, 1995.

[5] R. Arafune, K. Sakamoto, S. Ushida, S. Tanioka, and S. Murata, "Importance of rubbing-induced inclination of polyimide backbone structures for determination of the pretilt angle of liquid crystals", Physical Review., Vol. 58, p. 5914, 1998.

[6] H. Matsuda, D.-S. Seo, N. Yoshida, K. Fujibayashi, and S. Kobayashi, "Estimation of the static electricity and optical retardation produced by the rubbing polyimide and polyamide films with different fabrics", Mol. Cryst. Liq. Cryst., Vol. 264, p. 23, 1995.

[7] D.-S. Seo and J.-Y. Hwang, "Liquid crystal aligning capabilities using a new photo-dimerization method on a poly(4'-methacryloyloxy chalcone) surface", Jpn. J. Appl. Phys., Vol. 39, p. 816, 2000.

[8] J.-Y. Hwang, D.-S. Seo, J.-Y. Kim, and T.-H. Kim, "Aligning capabilities of nematic liquid crystal on photopolymer-based-(phenyl)maleimide homopolymers", Jpn. J. Appl. Phys., Vol. 42, p. 194, 2003.

[9] J.-Y. Hwang, D.-S. Seo, O. Kwon, and D. H. Suh, "Electro-optical characteristics of photo-aligned TN-LCD on PM4Ch surfaces", Liq. Crystals., Vol. 27, p. 1045, 2000.

[10] D.-S. Seo and J.-M. Han, "Generation of pretilt angle in NLC and EO characteristics of photo-aligned TN-LCD with oblique non-polarized UV light irradiation on polyimide surface", Liq. Crystals., Vol. 26, p. 959, 1999.