LC Orientation Characteristics Treated on Organic Hybrid Overcoat Layer with Ion Beam Irradiation

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We have studied the liquid crystal (LC) orientation behavior on the organic hybrid overcoat layer with ion beam irradiation. Excellent LC alignments of the nematic liquid crystal (NLC) on the ion beam irradiated organic hybrid overcoat layers were observed in various intensities above 600 eV. Pretilt angles of the NLC on the organic hybrid overcoat layers for all ion beam energy intensities were observed from 0.2 to 0.5 degrees. Also, we used the atomic force microscopy (AFM) images for measuring the roughness of the organic hybrid overcoat layers with ion beam irradiation before and after. The surface of organic hybrid overcoat layers was leveled off by the ion beam irradiation. Finally, a good LC alignment thermal stability on the organic hybrid overcoat layer with ion beam irradiation can be achieved.

Keywords : Organic hybrid overcoat layer, Ion beam, Pretilt angle, AFM, Thermal stability

1. INTRODUCTION

Various LC alignment methods on the substrate surfaces are developed such as rubbed polymer surface, oblique evaporation SiO surface, stacked Langmuir-Blodgett surface, photo-aligned polymer surface with UV irradiation, and ion beam aligned polymer surface. LC alignment consisting of rodlike molecules on the rubbed polyimide surface is very important to obtain uniform alignment and fabrication of LCD[1-4]. The rubbing technique on the polyimide surface has been most widely used to align LC; it is relatively simple and reliable. The LC alignment of NLC on the polyimide surface is attributed to the stretched of the polymer chains by rubbing[1,4]. Rubbing method has some advantages as the uniform alignment and easy control of pretilt angle. However, the rubbing technique on the PI surface has a several disadvantages, such as electrostatic charge generation and creation of contaminating particles by the rubbing[5,6]. Recently, the rubbing-free alignment techniques for getting rid of some disadvantages of rubbing technique, such as UV alignment method[7] and ion beam alignment method[8-12] are investigated. Recently, we have reported the LC alignment characteristics for a NLC on the homogeneous over coat surface[13] and inorganic thin film surface[14] by ion beam irradiation. Recently, Hwang et al. have been reported that the LC alignment for a NLC on the PI surface with ion beam irradiation is attributed to the C-O bonds of the PIs broken of the C=O bonding[15]. Also, the dipole-dipole interaction between the LC molecules and the PI surface by ion beam irradiation is discussed.

In this paper, we report on the LC orientation characteristics for a NLC on the organic hybrid overcoat layer with ion beam irradiation. The LC alignment texture of the NLC, AFM image of the organic hybrid overcoat surface, pretilt angle generation, and annealing behavior were studied.

2. EXPERIMENTAL

In this experiment, the organic hybrid overcoat layer for the homogeneous alignment was used. The organic hybrid overcoat layers were uniformly deposited by spin coating on indium-tin-oxide (ITO) electrodes, prebaked at 80 °C for 10 minutes, and imidized at 220 °C for 1 hour. The thickness of the organic hybrid overcoat thin film was set at 100 nm.

Figure 1 shows the high-energy-density ion beam system, DuoPIGatron-type used in this experiment. The ion beam energy intensities were controlled from 600 eV and 3000 eV. The incident angle of ion beam exposure was 60 ° for measuring pretilt angles. Also, the ion beam condition of thin films for measuring AFM images were

controlled 45 ° and 1200~2400 eV. The irradiation time of the ion beam was 1 minute for all samples.

LC cells were fabricated as a sandwich type with anti-parallel structure, and the thicknesses of the cells were 60 ㎛. After fabricating the cells, the cells were filled with positive type NLC (Δn = 0.0987, MJ1929, from Merck Co.). LC alignment characteristics were observed by using the photomicroscope. The pretilt angle of the NLC was measured by crystal-rotation method (TBA 107, Tilt-Bias Angle Evaluation, from Autronic Co.) at room temperature. LC cells were annealed at 80 °C, 120 °C, 200 °C, and 250 °C for 10 minutes, for measuring thermal stability.

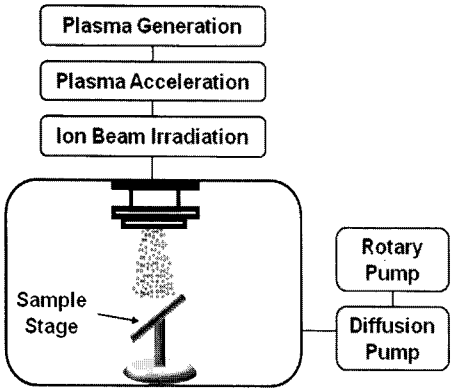


Fig. 1. Diagram of the DuoPIGatron-type ion beam system used.

3. RESULTS AND DISCUSSION

Figure 2 shows the microphotographs of NLC on the ion beam irradiated organic hybrid overcoat layer surfaces (in crossed Nicols). Excellent LC alignments of NLC on the organic hybrid overcoat layers with ion beam irrdiation were observed in various intensities above 600 eV. The black states show the uniform alignment in the crossed polarizer. The incident angles of the ion beam were 60 °, and the ion beam irradiation duration was 1 minute for all samples.

Figure 3 shows the measured results of the pretilt angle of the NLC on the ion beam irradiated organic hybrid overcoat layer surfaces in various intensities by crystal-rotation method. A shift of symmetric point from point 0 was measured on the overcoat layers with all intensities. Pretilt angles of the NLC on the ion beam irradiated organic hybrid overcoat layer surfaces were measured about 0.2~0.5 degrees. The low pretilt angle is due to the main chain of the organic hybrid overcoat layers with ion bean irradiation.

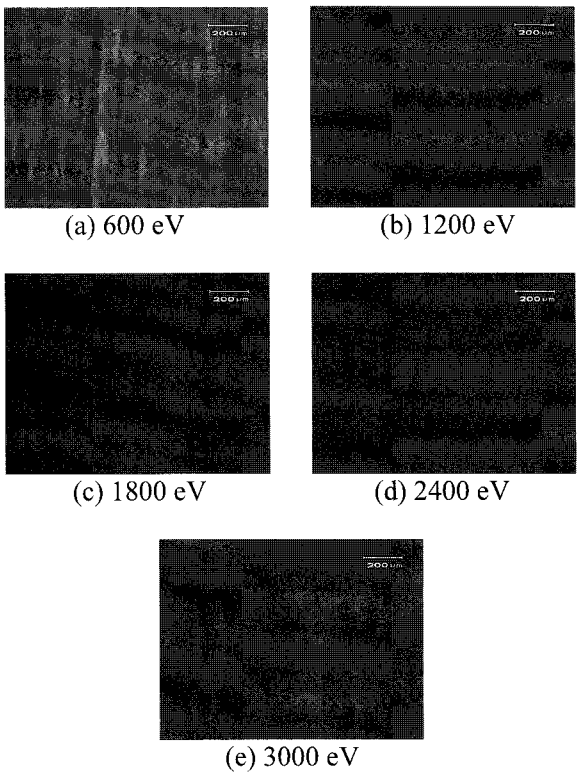


Fig. 2. Microphotographs of the NLC on the ion beam irradiated organic hybrid overcoat layer surfaces (in crossed Nicols).

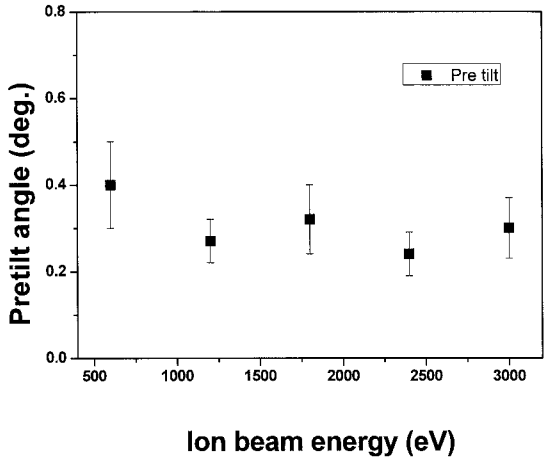
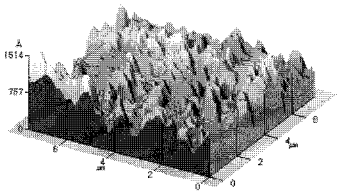


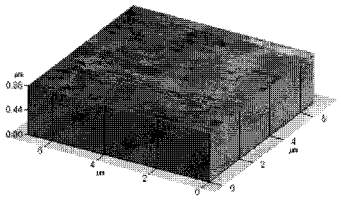
Fig. 3. Relationship between pretilt angle and ion beam energy in LC cells on the ion beam irradiated organic hybrid overcoat layers.

Figure 4 shows the AFM images on the ion beam irradiated organic hybrid overcoat layer surfaces before and after. Also, it shows the rms values of the hybrid overcoat layer surfaces. The rms value of the hybrid overcoat layer surface before ion beam irradiation was

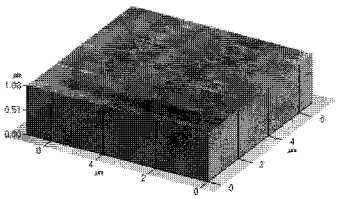
observed very large, while that of the layers after ion beam irradiation above 1200 eV were observed a few angstroms. It is considered that the surfaces of the organic hybrid overcoat layers were leveled off by the ion beam irradiation.



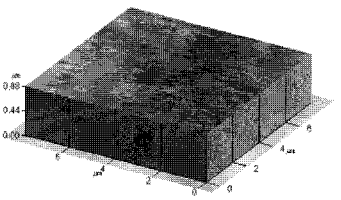
(a) before (rms : 507 Å)



(b) 45 °, 1200 eV (rms : 1.8 Å)



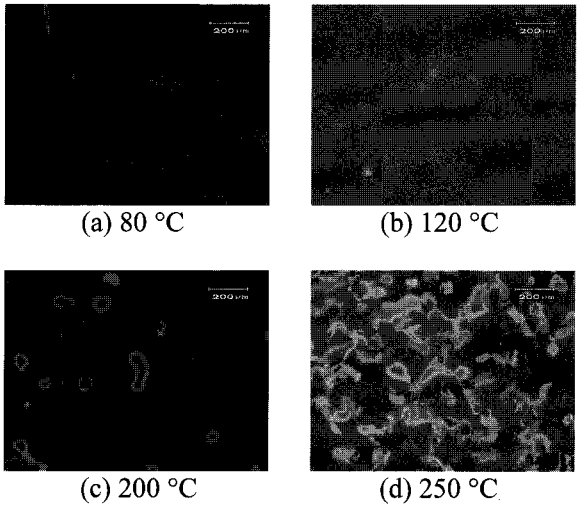
(c) 45 °, 1800 eV (rms : 2.1 Å)



(d) 45 °, 2400 eV (rms : 2.1 Å)

Fig. 4. AFM images on the ion beam irradiated organic hybrid overcoat layers in various ion beam energy densities.

Figure 5 shows the microphotograghs of aligned LC on the ion beam irradiated hybrid overcoat layer surfaces with ion beam exposure of 1800 eV / 45 ° for 1 minute in various annealing temperatures (in crossed Nicols). A good LC alignment with ion beam on the hybrid overcoat layer surfaces were observed under 200 °C, and the alignment defect of LCs were observed above an annealing temperature of 200 °C, as shown in Fig. 5. As a result, good thermal stability of LC alignment for NLC on the hybrid overcoat layer surface with ion beam irradiation can be achieved.



(a) 80 °C (b) 120 °C

(c) 200 °C (d) 250 °C

Fig. 5. Microphotographs of aligned LC on the ion beam irradiated hybrid overcoat surface for 10 minutes in various annealing temperatures (in crossed Nicols).

4. CONCLUSION

In conclusion, we have studied the LC alignment and pretilt angle generation for a NLC on the hybrid overcoat layer surface by ion beam irradiation. Pretilt angle of the NLC on the hybrid overcoat layer surfaces for all ion beam energy intensities are about 0.2~0.5 ° and these have a stabilization trend. The surfaces of organic hybrid overcoat layers were leveled off by the ion beam irradiation. A suitable LC alignment thermal stability on the hybrid overcoat layer surface with ion beam exposure can be achieved. We assume that the LC mechanism for NLC on the organic hybrid overcoat surface with ion beam irradiation is almost the same as the PI surface.

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