Tilt Angle Generation in NLC on Homeotropic Polymer Surface with Ion Beam Irradiation as a Function of Incident Angle

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We have studied the tilt angle generation on the homeotropic polyimide (PI) surface using a low intensity ion beam source as a function of incident angle. An excellent LC alignment of nematic liquid crystal (NLC) on the PI surface with ion beam exposure for all incident angles was observed. The tilt angle of NLC on the homeotropic PI surface for all incident angles was from 90 to 88 degree was observed. Also the tilt angle of NLC on the homeotropic PI surface with ion beam exposure of 400 eV had a tendency to increase as ion beam energy incident angle become more instance from 45 degree. Finally, a good LC alignment thermal stability on the homeotropic PI surface with ion beam exposure can be achieved.

Keywords : Homeotropic, Low intensity, Pretilt angle, Incident angle

1. INTRODUCTION

Liquid Crystal Displays (LCDs) are widely used in TV, notebook computer, monitor, and etc. LC alignment uniformity is very important in LCD manufacturing process[1-3]. The rubbing technique has been widely used to align LC, generally. But rubbing technique has a several disadvantages, such as generation electrostatic charge and creation of contaminating particles[4,5]. Also this technique has a difficulty of applying for large and flexible substrates.

Thus we have recommended a rubbing-free alignment techniques for getting rid of some disadvantages of rubbing technique, such as UV alignment technique[6] and ion beam alignment technique[7].

Recently, we reported LC alignment effects of the ion beam aligned homogeneous PI surface[8] and inorganic thin film surface[9]. However, LC alignment effects of the ion beam aligned homeotropic PI surface were insignificant.

In this paper, we studied LC aligning capabilities of a NLC on homeotropic PI surface with ion beam exposure and influence of exposed angle of the tilt angle.

2. EXPERIMENT

In this experiment, the polymer for the homeotropic alignment (AL1H659 from JSR Co.) was used. The polymers were uniformly prepared by the spin coating on indium-tin-oxide (ITO) electrodes and imidized at 220 °C for 1 hour. The thickness of the PI film was set at 500 Å.

Figure 1 shows the high-energy-density ion beam system, DuoPIGatron-type used in this experiment. The ion beam energy intensity was 400 eV and the incident angle of ion beam exposure was 15 °, 30 °, 45 °, 60 °, and 75 °. The LC cell was fabricated as a sandwich type with anti-parallel structure, and the thickness of the cell was 70 μm. After fabricating the cell, a mixture of the negative type NLC (Δn = 0.077, MJ98468, from Merck Co.). LC alignment characteristics were observed by using the photomicroscope. The tilt angle of the NLC was measured by crystal-rotation method (TBA 107, Tilt-Bias Angle Evaluation, from Autronic Co.) at room temperature.

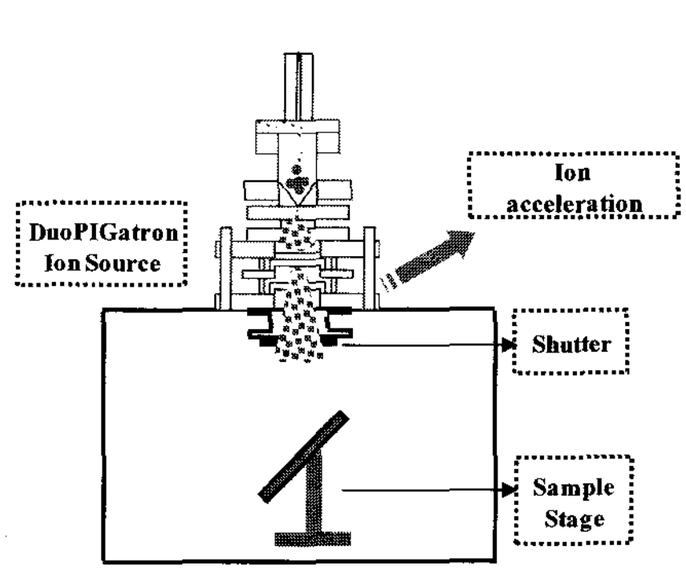
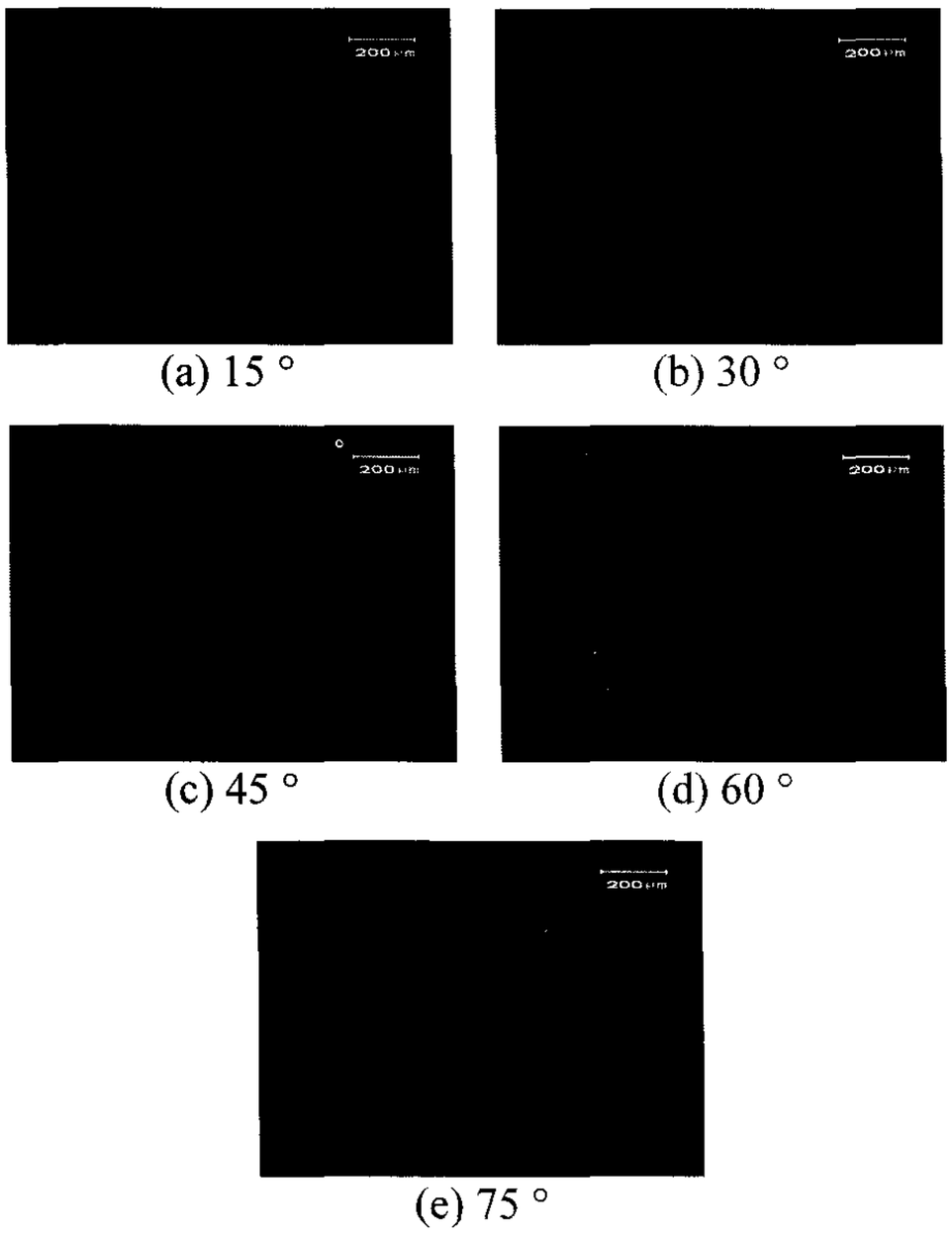


Fig. 1. DuoPIGatron-type ion beam system.

Also, LC cells were annealed at 150 °C, 175 °C, 200 °C, and 225 °C for 10 min, for measuring thermal stability.

3. RESULTS AND DISCUSSION

Figure 2 shows the microphotograph of the NLC on the homeotropic PI surface exposed to ion beam of various incident angles (in crossed Nicols). Excellent LC alignments were observed on the homeotropic PI surface to an exposed ion beam with an intensity of 400 eV which showed the good alignment effect. And ion beam incident angles were exposed at 15 °, 30 °, 45 °, 60 °, and 75 °. The ion beam irradiation duration was just 10 seconds.



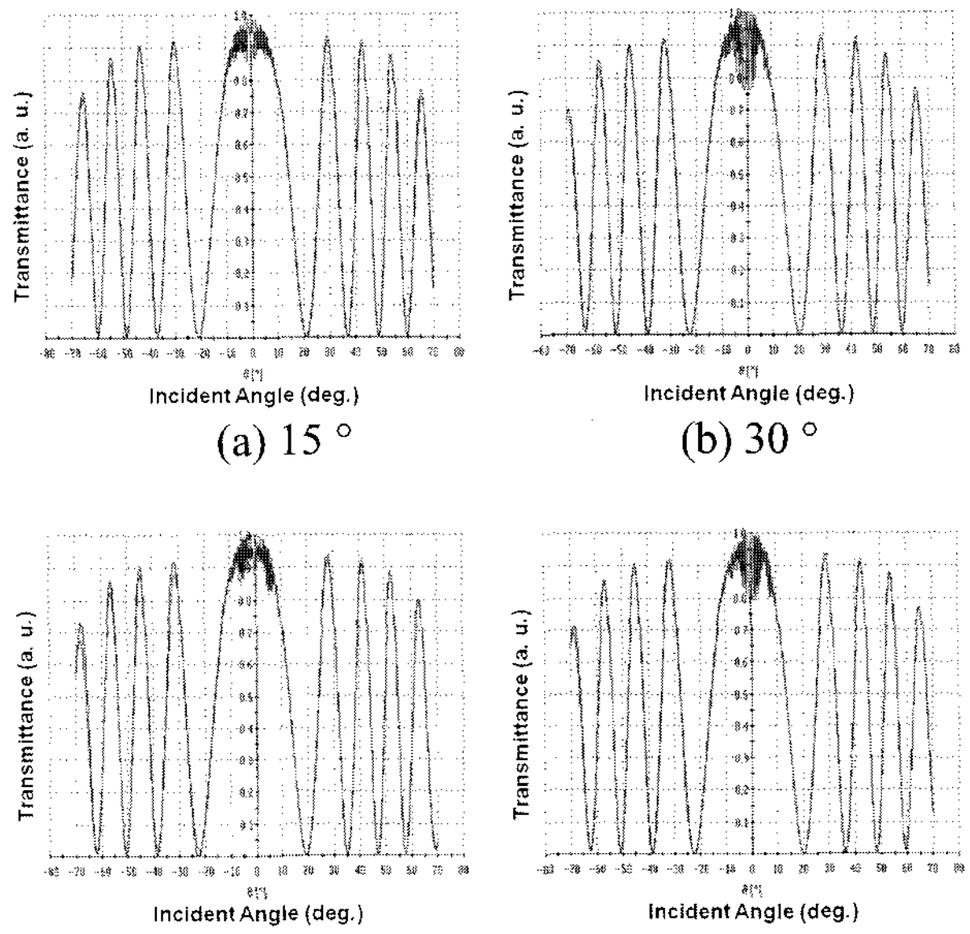
(a) 15 ° (b) 30 °

(c) 45 ° (d) 60 °

(e) 75 °

Fig. 2. Microphotographs of NLC on homeotropic PI surfaces exposed to ion beam of various incident angles (in crossed Nicols).

Figure 3 shows the measured results of the tilt angle of the NLC on homeotropic PI surfaces exposed to ion beam of various incident angles by crystal-rotation method. A shift of symmetric point from point 0 was measured on the PI surface with all incident angles. The



(a) 15 ° (b) 30 °

(c) 45 ° (d) 60 °

(e) 75 °

Fig. 3. Relationship between transmittance and incident angle in LC cells on the ion beam exposed homeotropic PI surface.

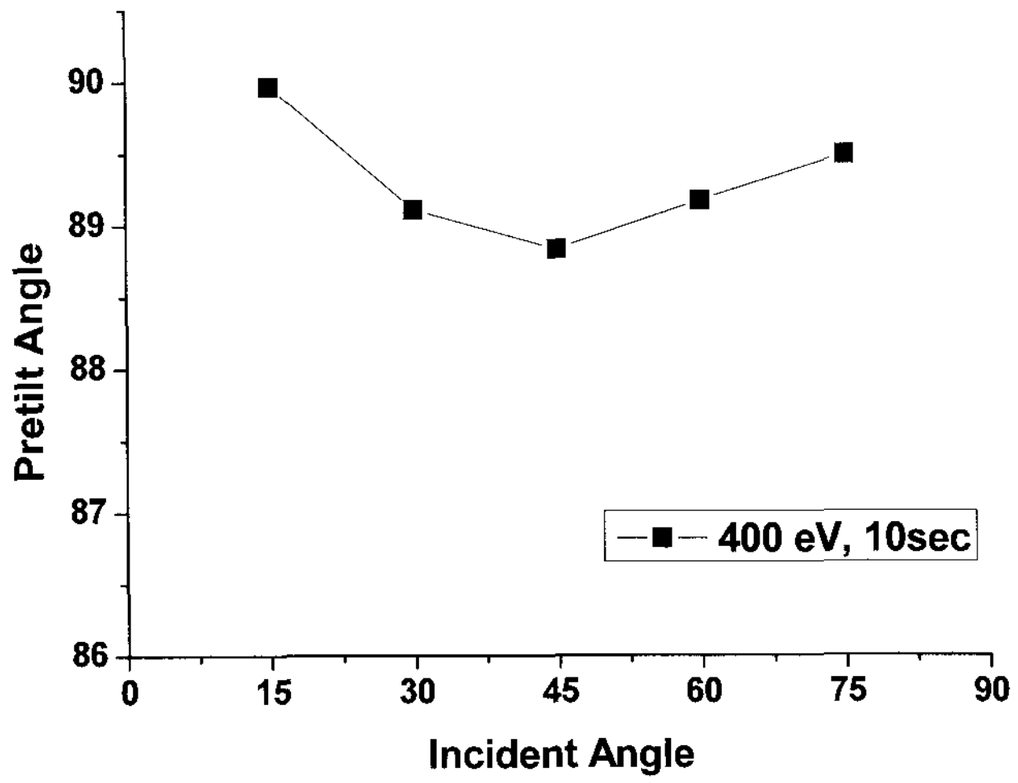
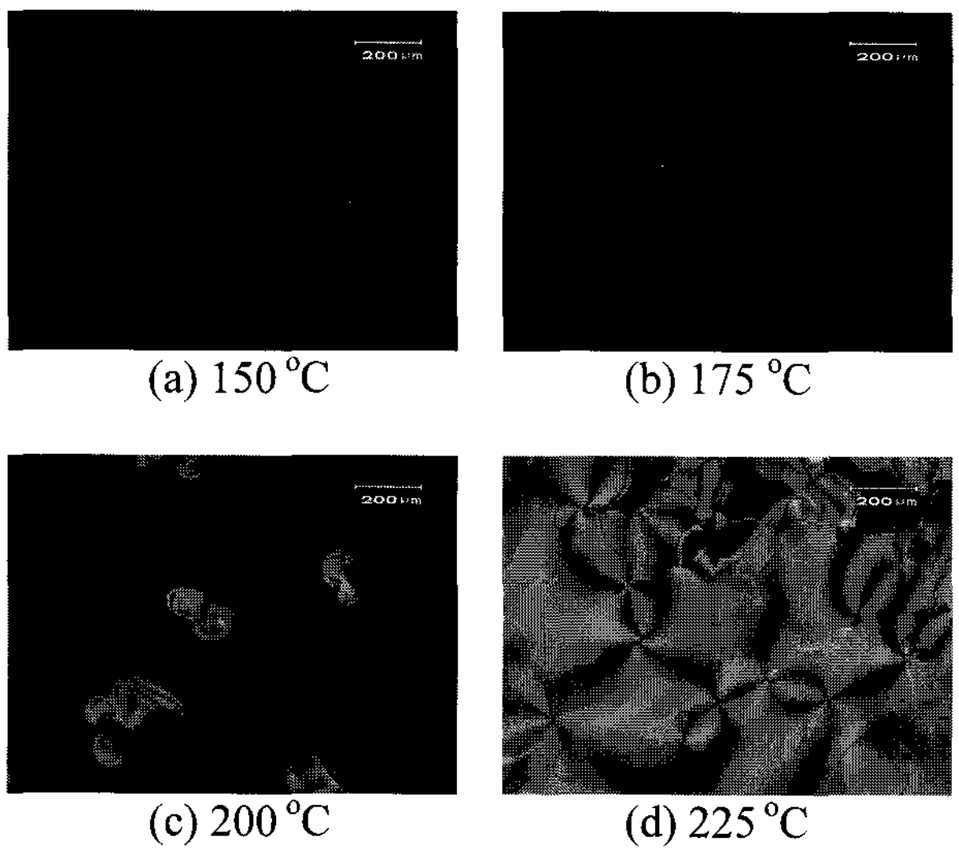


Fig. 4. Relationship between pretilt angle and incident angle on the ion beam exposed homeotropic PI surface.

tilt angle of the NLC on the ion beam exposed PI surfaces was measured about 90~88 degree.

Figure 4 shows the relationship between pretilt angle and incident angle on the ion beam exposed homeotropic PI surface. The tilt angle of NLC on the homeotropic PI surface with ion beam exposure of 400 eV had a tendency to increase as ion beam energy incident angle become more instance from 45 degree.

Figure 5 shows the microphotograghs of aligned LC with ion beam exposure on the hometropic PI surface with ion beam exposure of 400 eV / 45 ° for 10 min at various annealing temperatures (in crossed Nicols). A good LC alignment with ion beam on the homeotropic PI surface was observed until 175 °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 homeotropic PI surface with new ion beam energy can be achieved.



(a) 150 °C (b) 175 °C

(c) 200 °C (d) 225 °C

Fig. 5. Microphotographs of aligned LC with ion beam exposure on the hometropic PI surface with ion beam exposure for 10 min at various annealing temperatures (in crossed Nicols).

4. CONCLUSION

In conclusion, we have studied the LC alignment and tilt angle generation for NLC on the homeotropic PI surface by ion beam method. The tilt angle of NLC on the homeotropic PI surface for all incident angles is about 90~88 ° and this has a stabilization trend. Also the tilt angle of NLC on the homeotropic PI surface with ion beam exposure of 400 eV had a tendency to decrease as ion beam energy incident angle become more instance from 45 degree. Finally, a good LC alignment thermal stability on the homeotropic PI surface with ion beam exposure can be achieved.

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