유기절연막으로의 경사진 이온빔조사가 유기막 표면에서의 편광발생과 액정배향에 미치는 영향에 관한 연구

한정민*, 최대섭*, 황종선**
서일대학교 전기과*, 전남도립대학 신재생에너지전기과**

Study of Liquid Crystal Alignment and Polarization-dependence on organic surface with slanted ion beam irradiation

Han Jeong-Min*, Choi Dae-Sub*, Hwang Jong-Sun**
Dept. of Electrical Engineering, Seoil Univ.*,
Dept. of New & Renewable Energy Electrical Engineering, Jeonnam Provincial College**

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. We also discussed the electro-optical characteristic of twisted nematic (TN) LCD using ion beam irradiation on organic overcoat layer.

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

1. 서 론

The alignment of the liquid crystal (LC) molecules on the substrate surface is an important process in liquid crystal display (LCD) manufacturing. Generally, rubbing has been used to align LC molecules on a polyimide (PI) surface.[1-3] Recent studies have addressed LC alignmentand pretilt angle generation in various alignment layers usingion beam irradiation.[4-6] However, no study to date has used Brewster's Law to elucidate the polarization-dependence of LC alignment in ion beam irradiation.

2. 실 험

In this experiment, an organic insulation material (PIG-5411015, Chisso Co.) containing polyamic acid, epoxy resin, and methyl-3-methoxypropionate with solvent was used for the LC alignment layers. This material was uniformly prepared by spin-coating onto indium-tin-oxide (ITO) electrodes and imidized at 200°C for 60 min. The thickness of the organic overcoat film was set at 500Å The substrate surface was then exposed to ion-beam irradiation using a DuoPIGatron ion-beam system,[6]which is well-suited to large-area exposure with high-density plasma generation. 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 athickness of 60 μm. The cell was then filled with a mixture of positive-type n = 0.0987, MJ1001929, Merck Co.). We observed the alignment characteristics of the LCs with a photomicroscope.

3. 결과 및 고찰

Figure 1 shows the alignment of NLCs on an organic insulation thin-film surface subjected to ion beam irradiation at 45° for 1 min with various beam energies. The figure shows that in the ion-beam irradiation process, NLC alignment is related to the anisotropy of the polarized optical wave, such as ultraviolet (UV) or other rays, and not to the energy of the ion beam, which is isotropic. UV and other waves are generated when ion-beam equipment isoperated. According to Brew-ster's Law, p- and s-waves aregenerated by slanted reflections from materials. Other research has examined NLC alignment on the insulation layer using non-polarized UV light. Therefore ion-beam irradiation is a more effective method because unidirectional corrosion is driven by ion beam energy more rapidly than using only polarized long waves such as UV light. This is a very significant result in view of possible applications in mass-production processes.

We calculated Brewster's angle in specimens consisting of two layers.[7] One was the insulation layer, with a refraction ratio of 1.62, and the other was ITO glass with a refraction 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°. Although this calculation does not match the experimental data exactly, it does provide a good foundation for explaining the experimental results.

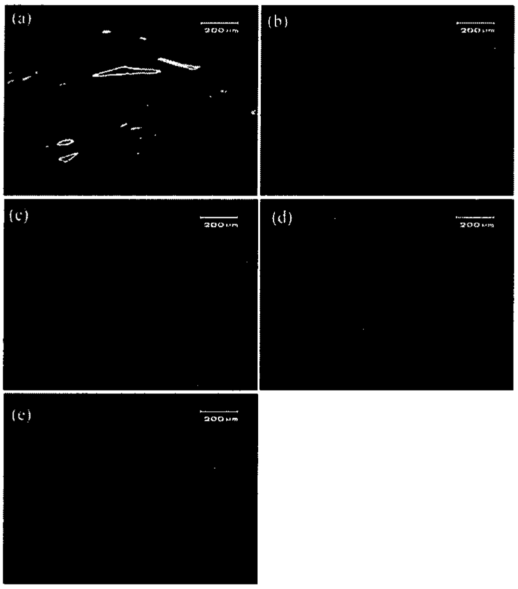

Figure 1. Microphotograph of NLCs after the organic thin film overcoat was exposed to ion-beam irradiation at 45° for 1 min with various ion beam energies (in crossed Nicols).
(a) 600eV, (b) 1200eV, (c)1800eV, (d)2400eV, and (e)3000eV

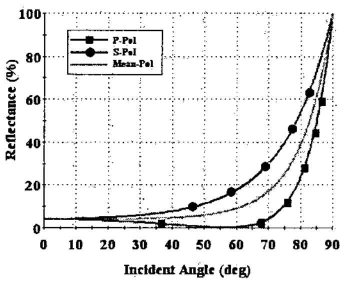

Figure 2. Calculated optical anisotropy generated at various irradiation angles.

4. 결 론

We have successfully studied LC alignment and the mechanism of ion beam irradiation on the surface of an organic insulation thin film for the first time. 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.

참고 문헌

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

[2] H. Yokoyama, S. Kobayashi, and H. Kamei, J. Appl. Phys., 61, 4501, (1987).

[3] D.-S. Seo, S. Kobayashi, and M. Nishikawa, Appl. Phys. Lett., 61, 2392, (1992).

[4] J. Stöhr, M. G. Samant, J. Lüning, A. C. Callegari, P. Chaudhari, J. P. Doyle, J. A. Lacey, S. A. Lien, S. Purushothaman, and J. L. Speidell, Science, 292, 2299, (2001).

[5] H.-C. Moon, H.-K. Kang, J.-Y. Hwang, Y.-P. Park, S.-H. Lim, Jin Jang, and D.-S. Seo,Jpn. J. Appl. Phys., 45, 7017, (2006).

[6] D.-H. Kang, S.-H. Kim, B.-Y. Kim, J.-Y. Kim, C.-H. Ok, Y.-H. Kim, J.-W. Han, J.-H. Kim, J.-Y. Hwang, B.-Y. Oh, J.-M. Han, S.-K. Lee, J.-W. Lee, B.-M. Moon, J.-H. Kim, and D.-S. Seo, Jpn. J. Appl. Phys., 46, 6601, (2007).

[7] E. Hecht, Optics 4th Edition, 348, (2002).