러빙천의 종류에 의한 네마틱 액정의 배향 및 프리틸트각의 발생

서 대 식
숭실대학교 공과대학 전기공학과

Effect of the Rubbing Fabric for Liquid Crystal Alignment and Pretilt Angle Generation

Dae-Shik Seo
Department of Electrical Engineering, College of Engineering, Soongsil University

Abstract - We have studied the effect of the rubbing fabric for liquid crystal alignment and pretilt angle generation in nematic liquid crystals (NLC), 4-cyano-4-n-penthylbiphenyl (5CB), on rubbed polyimide (PI) surfaces. The pretilt angle of 5CB for nylon and rayon fabric is larger than that of cotton fabric in weak rubbing on rubbed PI surfaces. We conclude that the pretilt angle of 5CB is strongly related to the rubbing fabrics on rubbed PI surfaces.

1. Introduction

Uniform alignment of liquid crystals (LCs) on treated substrate surfaces is important in LCD technology. Most LC devices with pretilted homogeneous LC alignment are prepared using rubbed PI surfaces.[1-3] The pretilt angle prevents the creation of disclinations in twisted nematic (TN)-LCD. In previous papers, that the generation of the pretilt angle in NLC on various alignment layers by unidirectional rubbing was demonstrated and discussed. For aligning LC molecules, the rubbed PI surfaces have been widely used, but the detailed mechanism of LC alignment by rubbing is not yet fully understood.

The effect of the rubbing fabric for the pretilt angle on alignment layers by unidirectional rubbing is not yet reported. Recently, we reported on the estimation of static electricity and induced optical retardation produced in alignment layers by rubbing with different rubbing fabrics.[4] It was demonstrated that the static electricity and the optical retardation produced in PI surface rubbed with nylon fabric were much larger than in those rubbed with cotton fabric.

In this paper, we report the effect of rubbing fabrics for LC alignment and pretilt angle generation in 5CB for the three kinds of rubbing fabrics on various alignment layers.

2. Experimental

Four orientation films were investigated:
PI-A : highest polarity with without side chain
PI-B : medium polarity with side chain;
PI-C : with side chain and homeotropic alignment material;
PA : highest polarity without side chain.

The PI and polyamide (PA) films were coated on indium-tin-oxide (ITO) coated glass substrates by spin-coating. The PI films were imidized at 250°C for one hour. The PA was imidized at 150°C for one hour. The PI and PA films were rubbed with one of three fabrics using a machine equipped with a roller. The definition of the rubbing strength, RS, was given in previous papers.[1,2] The LC was assembled in the cells with antiparallel-rubbed surfaces for measuring the pretilt angle.

The rubbing fabrics used were:
Cotton : with cellulose structure, natural fiber;
Rayon : with cellulose structure, synthetic fiber;
Nylon : with polyamide structure, synthetic fiber.

The LC layer was $60\pm0.5\mu m$. We used the crystal rotation method to measure the pretilt angle.

3. Results and Discussion

Figure 1 (a), (b), and (c) shows the pretilt angles in NLC for the three kinds of rubbing fabrics as a function of RS. In Fig. 1 (a), the pretilt angle of 5CB increases with the RS for all three kinds of the rubbing fabrics on PI-A surfaces. It is shown that the pretilt angle of 5CB for nylon and rayon fabric is larger than that of cotton fabric. Figure 1 (b) shows that the pretilt angle increases rapidly at RS=180mm and decreases slowly with the RS for nylon and rayon fabrics on PI-B surfaces. The pretilt angle of 5CB for cotton fabric increases rapidly at 280mm and decreases with the RS on PI-B surfaces. The pretilt angle of 5CB for nylon and rayon fabrics is larger than that of cotton fabric in weak rubbing on PI-C surfaces. Figure 1 (c) shows that the pretilt angle of 5CB for nylon and rayon fabrics increases rapidly at RS=100mm and saturates on PA surfaces. The pretilt angle of 5CB for cotton fabric increases with the RS and decreases at RS=300mm on PA film. From these results, we suggest that the pretilt angle of 5CB increases with hard rubbing fabric and weak rubbing. Therefore, we conclude that the generation of the pretilt angle of 5CB depends strongly on the hardness of the rubbing fabric.

Fig. 1 Generation of pretilt angles in NLC for the three kinds of the rubbing fabrics on three alignment layers as a function of RS.
(a) PI-A; (b) PI-B; (c) PA.

3. Conculsion

We investigated the effect of the rubbing fabric for LC alignment and pretilt angle generation in NLC, 5CB, on various alignment layers. The pretilt angle of 5CB for nylon and rayon fabric is larger than that of cotton fabric in weak rubbing on rubbed PI surfaces. We conclude that the pretilt angle 5CB is strongly related to the hardness of the rubbing fabrics on rubbed PI surfaces.

[References]

[1] D.-S.Seo, K.Muroi, and S.Kobayashi, "Generation of the pretilt angles in nematic liquid crystal, 5CB, media aligned polyimide films orepared by spin-coating and LB techniques : effect of rubbing", Mol.Cryst.Liq.Cryst., **Vol. 213**, 223, 1992.

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

[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**, L503, 1995.

[4] H.Matsuda, D.-S.Seo, N.Yoshida, K.Fujibayashi, S.Kobayashi, and Y.Yabe, "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**, 23, 1995.