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Preliminary communication

Generation of pretilt angles in a nematic liquid crystal by transcription alignment on polyimide surfaces

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Pretilt angle generation in a nematic liquid crystal (NLC) by a transcription alignment technique, as used for non-rubbed polyimide (PI) surfaces with side chain, has been investigated. Monodomain alignment of the NLC in cells fabricated by transcription alignment on a PI surface was observed. The generated pretilt angle of the NLC is about 3·7°; it decreases with increasing rubbing time of the original substrate. It is considered that the generation of the NLC pretilt angle may be attributed to steric interaction due to the polymer side chain. It is also suggested that the LC alignment produced by the transcription alignment technique is attributable to a memory effect of the NLC on the PI surfaces.

The uniform alignment of liquid crystals (LCs) on treated substrate surfaces is very important in achieving high quality displays in LCD technology [1]; the rubbing method is a widely used technique for LC alignments. Pretilt angle formation, which is an important step in the alignment process, prevents the creation of reverse tilt disclinations in a twisted nematic (TN)-LCD. Pretilt angle generation in nematic liquid crystals (NLCs) by a unidirectional rubbing treatment on rubbed polyimide (PI) surfaces has been demonstrated and discussed by many investigators [2–11].

Recently, non-rubbing techniques for uniform LC alignment have been needed for thin film transistor (TFT)-LCDs. In a previous paper, we reported that the TFTs were damaged by static electricity induced during rubbing [12]. Also, we previously reported that uniform alignments of the NLC in cells on PI-Langmuir–Blodgett films were discussed in relation to non-rubbing techniques [13, 14]. Recently, Toko [15] reported on the electro-optical performance and pretilt angle generation in cells fabricated by transcription alignment on PI surfaces. Pretilt angles of the NLC of about 0·5° were generated on various PI surfaces with alkyl chains [15]. However, the pretilt angle needs to be about 2–3° in order to avoid reverse tilt disclination and for practical operation of the TN-LCD.

In this paper, we discuss pretilt angle generation in a NLC in cells fabricated by transcription alignment, used as a non-rubbing technique on a PI surface with a side chain. In this study, we used a PI film with side chains as a super (S) TN-LCD. The precursors were coated onto indium tin oxide (ITO) coated glass substrates by spin-coating, and imidized at 250°C for 1 h. The thickness of the PI films used was 500 Å. The fabrication process for the transcription alignment cells is shown in figure 1. The original substrates (PI films) were unidirectionally rubbed using a machine equipped with a nylon roller (Yo-15-N, Yoshikawa Chemical Industries Co., Ltd). The definition of the rubbing strength, RS, has been given in previous papers [5, 6]. The transcribed substrates used unrubbed PI films. The transcription alignment cells were fabricated with a rubbed PI surface (original substrate) and an unrubbed PI surface (transcribed substrate), and were heated at 101°C (where the NLC shows the isotropic phase) for LC injection. The NLC used in this experiment was a fluorinated type mixture with clearing temperature $T_C = 91$°C (ZLI-4792, E. Merck). The cell was cooled to room temperature, and the LC changed into the nematic phase from the isotropic phase. The NLC molecules were aligned along the rubbing direction of the rubbed PI surface (original substrate). The original substrate was then separated from the transcribed substrate. The transcribed substrate was stacked upon another transcribed substrate to form the transcription alignment cell, and the nematic phase

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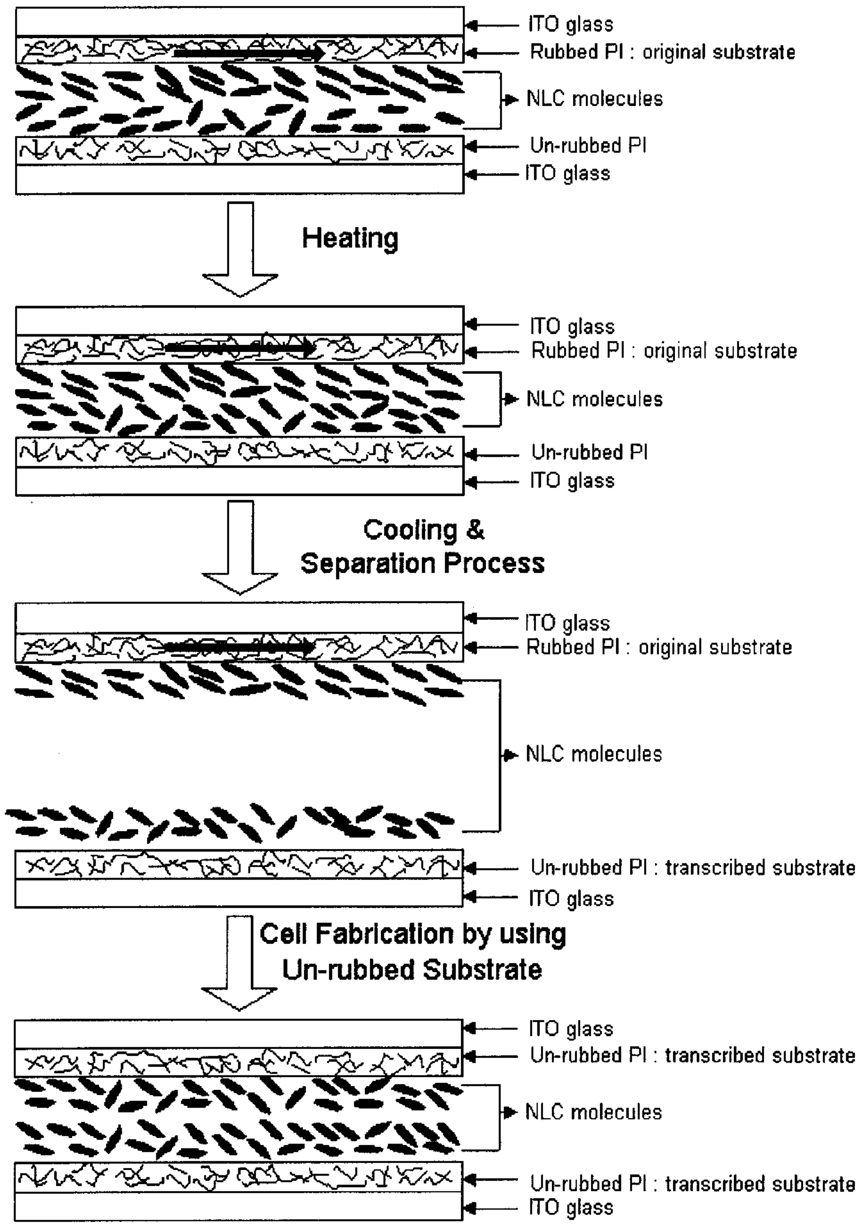

Figure 1. The fabrication process for transcription alignment cells.

of the LC material was injected into the transcription alignment cell. All LC layers were 60 μm thick. The pretilt angles of the NLC in the nematic phase were measured by the crystal rotation method [16] at room temperature.

Figure 2 is a photomicrograph of aligned NLC in a cell fabricated by the transcription alignment technique on a PI surface (in crossed nicols); it demonstrates monodomain alignment of the NLC. The NCL molecules are aligned along the transcribed direction due to a memory effect of the NLC on the PI surface. In this study the characteristics of LC alignment match results by Toko [15]. An example of transmission versus incident angle, for pretilt angle measurement by the crystal rotation method in a cell fabricated by transcription alignment on a PI surface, is shown in figure 3. The table gives the pretilt angles of the NLC in cells fabricated by transcription alignment with different rubbing times of the original substrate on PI surfaces. A pretilt angle of 1·2–3·7° is generated on the original substrate with a given rubbing time. It is sufficient to avoid reverse tilt disclination and for the practical operation of a TN-LCD. It is seen that the pretilt angle of the NLC decreases with increasing rubbing time of the original substrate. We consider that the pretilt angle of the NLC may be attributed to steric interaction due to the side chain of the polymer on the PI surface [8, 10]. Finally, we consider that the LC alignment in cells fabricated by

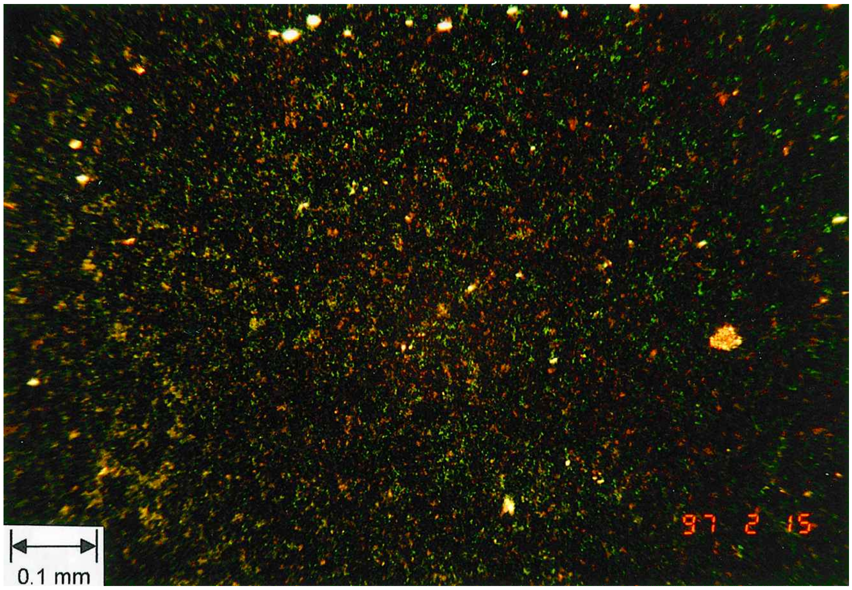

Figure 2. Photomicrograph of aligned NLC in a cell fabricated by transcription alignment on a PI surface.

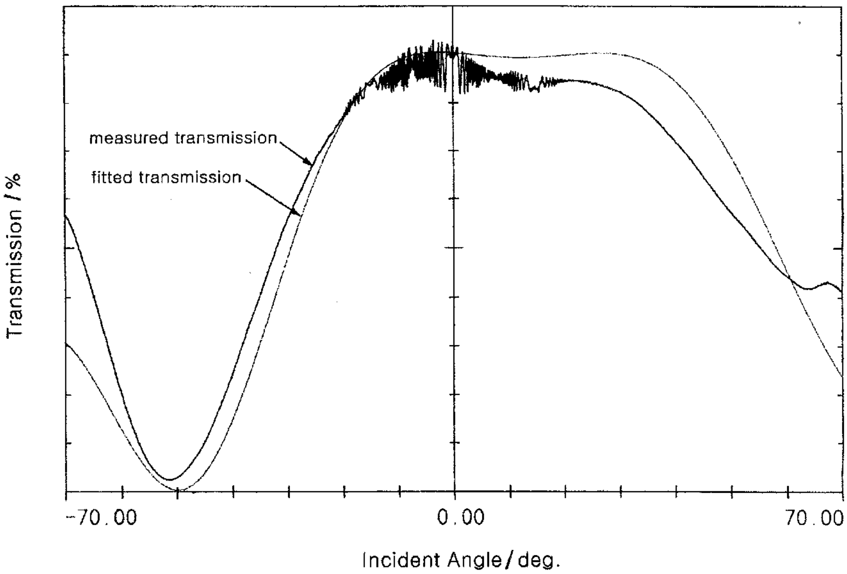

Figure 3. Example of transmission versus incident angle for pretilt angle measurement by the crystal rotation method in a cell fabricated by transcription alignment on a PI surface.

Table. Pretilt angles of the NLC in cells fabricated by the transcription alignment technique on PI surfaces.

Rubbing times of original substrate	Pretilt angles/°
1 period	1·2 ~ 3·69°
3 periods	0·25 ~ 2·28°

transcription alignment on PI surfaces is attributable to a memory effect of the NLC.

In conclusion, we have investigated pretilt angle generation in a NLC by transcription alignment on PI surfaces with side chain. Monodomain alignment of the aligned NLC in cells fabricated by transcription alignment on a PI surface was observed. The generated pretilt angle of the NLC is about 3·7° in cells with one rubbing period of the original substrate. We consider that the pretilt angle of the NLC fabricated by transcription alignment is attributable to steric interaction due to the polymer side chain. Finally, we suggest that LC alignment obtained by the transcription alignment technique is attributable to a memory effect of the NLC on the PI surfaces.

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References

[1] Cognard, J., 1982, *Mol. Cryst. liq. Cryst.*, **78,** Suppl. 1, 1.

[2] Geary, J. M., Goodby, J. W., Kmetz, A. R., and Patel, J. S., 1987, *J. appl. Phys.*, **62,** 4100.

[3] Kuniyasu, S., Fukuro, H., Maeda, S., Nakaya, K., Nitta, M., Ozaki, N., and Kobayashi, S., 1988, *Jpn. J. appl. Phys.*, **27,** 827.

[4] Myrvold, B. O., and Kondo, K., 1994, *Liq. Cryst.*, **17,** 437.

[5] Seo, D.-S., Muroi, K., and Kobayashi, S., 1992, *Mol. Cryst. liq. Cryst.*, **213,** 223.

[6] Seo, D.-S., Kobayashi, S., and Nishikawa, M., 1992, *Appl. Phys. Lett.*, **61,** 2392.

[7] Nishikawa, M., Miyamoto, T., Kawamura, S., Tsuda, Y., Bessho, N., Seo, D.-S., Iimura, Y., and Kobayashi, S., 1995, *Mol. Cryst. liq. Cryst.*, **275,** 15.

[8] Seo, D.-S., Yoshida, N., Kobayashi, S., Nishikawa, M., and Yabe, Y., 1995, *Jpn. J. appl. Phys.*, **34,** 4876.

[9] Becker, M. E., Kilian, R. A., Kosmowski, B. B., and Milynsky, D. A., 1986, *Mol. Cryst. liq. Cryst.*, **130,** 167.

[10] Sugiyama, T., Kuniyasu, S., Seo, D.-S., Fukuro, H., and Kobayashi, S., 1992, *Jpn. J. appl. Phys.*, **29,** 2045.

[11] Seo, D.-S., Oh-ide, T., Matsuda, H., Isogami, T., Muroi, K., Yabe, Y., and Kobayashi, S., 1993, *Mol. Cryst. liq. Cryst.*, **231,** 95.

[12] Matsuda, H., Seo, D.-S., Yoshida, N., Fujibayashi, K., and Kobayashi, S., 1995, *Mol. Cryst. liq. Cryst.*, **264,** 23.

[13] Seo, D.-S., Matsuda, H., Oh-ide, T., and Kobayashi, S., 1993, *Mol. Cryst. liq. Cryst.*, **224,** 13.

[14] Seo, D.-S., Kobayashi, S., Kang, D.-Y., and Yokoyama, H., 1995, *Jpn. J. appl. Phys.*, **34,** 3607.

[15] Toko, Y., 1996, in Proceedings of the 16th International Liquid Crystal Conference, Kent State University, 24–28 June 1996, **B1P.53,** p. 58.

[16] Scheffer, T. J., and Nehring, J., 1977, *J. appl. Phys.*, **48,** 1783.