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Preliminary communication

Generation of high pretilt angle in a nematic liquid crystal with single oblique polarized UV light irradiation on polyimide surfaces

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We propose and investigate obtaining high pretilt nematic alignment using a new photo-alignment method: single oblique polarized ultraviolet (UV) light irradiation on polyimide (PI) surfaces. It was found that the monodomain alignment in a nematic liquid crystal (NLC) is obtained with PI surfaces having side chains. We successfully observed that the generated high pretilt angles of the NLC are about 6° with an angle of incidence of 5° ~ 80° on the PI surface. Also, the generated pretilt angle of NLC is about 6° with an UV light irradiation of 30 min for angle of incidence of 5°, and decreases with increasing UV light irradiation time. High pretilt orientation of the NLC is successfully observed in cells with a single oblique UV light irradiation on PI surfaces.

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The successful operation of liquid crystal displays (LCDs) requires uniform alignment and controlled pretilt of LCs on treated substrate surfaces. Most LCDs with pretilted homogeneous LC alignment are prepared using rubbed PI surfaces. The leading LCD technology is based on twisted nematic (TN)-LCDs; the pretilt angle prevents creation of reverse tilt disclinations in TN-LCD [1]. The generation of pretilt angle in NLC on various alignment layers by unidirectional rubbing has been demonstrated and discussed by many investigators [2–6]. Rubbed polymer surfaces have been widely used for aligning LC molecules. Recently, rubbing-free techniques for LC alignment have been needed in thin film transistor (TFT)-LCD fabrication. In a previous paper, we reported that the TFTs are damaged by the induced static electricity produced during rubbing [7]. The photo-alignment method for LC alignment is expected to achieve high resolution LCDs.

Recently, Gibbons *et al.* [8] have reported a new method for LC alignment using polarized laser light. It was shown that NLCs in an illuminated region can be oriented perpendicular to the direction of the electric field polarization of the laser, and remain aligned in the absence of laser radiation. Also, the pretilt angle on a Langmuir–Blodgett film has been controlled by regulation of the fraction of *trans*-azobenzene unit using light wavelength tuning [9].

LC alignment with polarized UV light irradiated on a poly(vinyl)cinnamate surface is reported by some researchers [10–12]. The photo-polymerization reaction of a photo-polymer with polarized light has been shown to induce uniaxial orientation of NLCs on poly(vinyl)cinnamate surfaces.

Recently, LC alignment with polarized UV light irradiated on PI surfaces has been reported by some researchers [13–17]. The photo-depolymerization of PI main chains parallel to the electric field of deep UV light (257 nm) causes an anisotropic dispersion force [13]. The dependence of photo-generated pretilt angle on PI curing and polarized UV light irradiation conditions was discussed by Wang & West [16]; the photo-generated pretilt angle is strongly influenced by the PI curing temperature and UV light irradiation condition. More recently, Yamamoto *et al.* have reported LC alignment by oblique irradiation of non-polarized UV light on a PI surface [18]. The generated pretilt angle of NLC is about 0.8° on a PI surface with side chains. However, this pretilt is not enough to avoid reverse tilt disclination in a TN-LCD. Recently, we have reported the generation of pretilt angle in NLC with oblique non-polarized UV light irradiation on a PI surface with side chain; the generated pretilt angle is about 3° [19].

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In this study, we report monodomain alignment and high pretilt angle of the NLC in cells with single oblique polarized UV light irradiation on a PI surface with side chain.

In this experiment, the molecular structure of the polymer used is shown in figure 1. The PI films were coated on indium tin oxide (ITO) coated glass substrates by spin-coating, and were imidized at 250°C for 1 h. The thickness of the PI layers was about 500 Å. Figure 2 shows the system of UV light irradiation used in this study. The substrates were irradiated for 5–40 min using UV light at a wavelength of 365 nm (power: 1 kW). The LC was assembled in sandwich-type cells with an anti-parallel UV irradiation direction. All the sandwich-type cells had a LC layer thickness of 60 μm. After assembly, the cells were filled with NLC (fluorinated type mixture: $T_c = 87°$ for TFT-LCD) in the nematic phase; and then the cell were annealed for 10 min in the isotropic phase. In order to measure pretilt angles, we used the crystal rotation method and measurements were made at room temperature.

Figure 3 shows a microphotograph of an aligned NLC in a cell with oblique polarized UV light irradiation of 5° on a PI surface with side chain (under crossed Nicols). Monodomain alignment of the NLC was observed. We also observed that the aligned NLC was perpendicular to the UV polarization. Therefore, the observed alignment is consistent with photo-depolymerization of the polymer on single oblique polarized UV light irradiation PI surfaces.

Figure 4 shows the pretilt angle of the NLC in these cells as a function of incident angle for 30 min irradiation. It is shown that the NLC pretilt angles generated are around 6° with an angle of incidence of 5°–80° on the PI surface. The high pretilt angle of the NLC is generated near an incident angle of 60°–70°. The pretilt angle of the NLC in cells with an angle of incidence of 5° on PI surface, as a function of UV light irradiation time, is shown in figure 5. The pretilt angle of NLC increases with increasing irradiation time up to 20 min; it then decreases with increasing irradiation time. It is considered that the photo-depolymerization increases with increasing irradiation time on the PI surface.

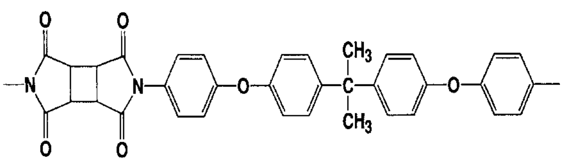

Figure 1. Molecular structure of the polymer.

Figure 3. Microphotograph of aligned NLC in a cell with single oblique polarized UV light irradiation on PI surface with side chain (under crossed Nicols).

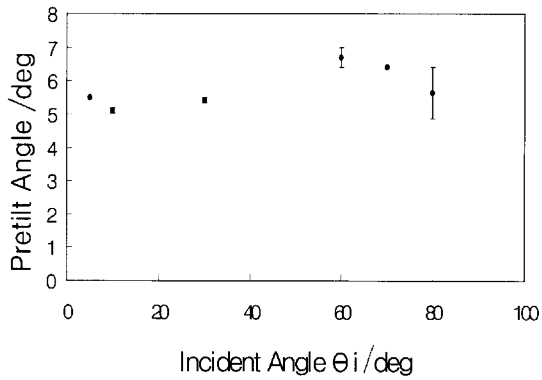

Figure 4. Pretilt angle of the NLC in cells with single oblique polarized UV light irradiation on PI surfaces as a function of incident angle for 30 min irradiation time.

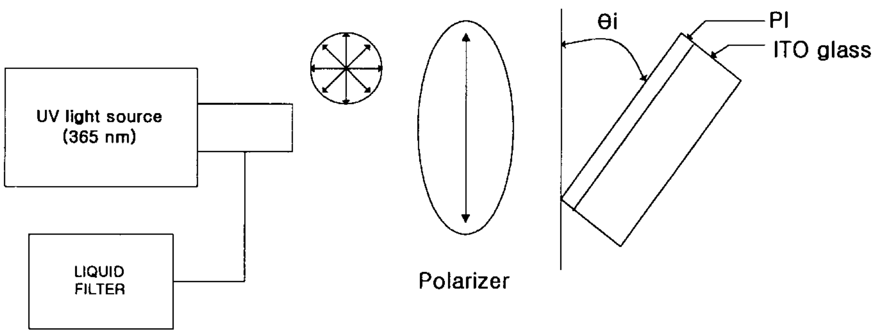

Figure 2. UV light irradiation system.

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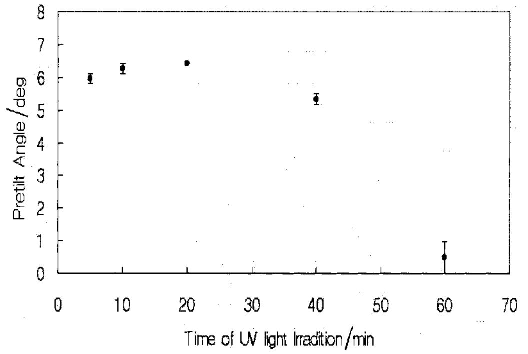

Figure 5. The pretilt angle of NLC in cells with an angle of incidence of 5° on PI surface as a function of UV light irradiation time.

Lien *et al.* reported that the pretilt angle of the NLC decreases on increasing the single polarized UV light (254 nm) irradiation time on a PI surface; the deep UV light irradiation leads to a more polar surface [16, 17]. We think that the decreased pretilt of the NLC may be attributed to a more polar surface due to increase in photo-polymerization of the polymer with UV light irradiation. Finally, we suggest that the method of single oblique polarized UV light irradiation is very useful in controlling the high pretilt angle of a NLC on a PI surface.

In conclusion, we have investigated the photo-alignment method in cells with single oblique polarized UV light irradiation on a side chain PI surface. It was found that monodomain alignment in NLC is obtained in a cell in this way. We observed that high pretilt angles of the NLC are generated near UV incident angles of 60°–70°. Also, the high pretilt angle of the NLC may be attributed to generation of a more polar surface due to increasing photo-polymerization of the polymer with UV light irradiation on PI surface.

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References

[1] Schadt, M., and Helfrich, W., 1982, *Appl. Phys. Lett.*, **18**, 127.
[2] Geary, J. M., Goodby, J. W., Kmetz, A. R., and Patel, J. S., 1987, *J. appl. Phys.*, **62**, 4100.
[2] Sugiyama, T., Kuniyasu, S., Seo, D.-S., Fukuro, H., and Kobayashi, S., 1990, *Jpn. J. appl. Phys.*, **29**, 2045.
[3] Seo, D.-S., Muroi, K., and Kobayashi, S., 1992, *Mol. Cryst. liq. Cryst.*, **213**, 223.
[4] Seo, D.-S., Kobayashi, S., and Nishikawa, M., 1992, *Appl. Phys. Lett.*, **61**, 2392.
[5] Seo, D.-S., Araya, K., Yoshida, N., Nishikawa, M., Yabe, Y., and Kobayashi, S., 1995, *Jpn. J. appl. Phys.*, **34**, L503.
[6] Nishikawa, M., Bessho, N., Natsui, T., Ohta, Y., Yoshida, N., Seo, D.-S., Iimura, Y., and Kobayashi, S., 1996, *Mol. Cryst. liq. Cryst.*, **275**, 15.
[7] Matsuda, H., Seo, D.-S., Yoshida, N., Fujibayashi, K., and Kobayashi, S., 1995, *Mol. Cryst. liq. Cryst.*, **264**, 23.
[8] Gibbons, W., Shannon, P., Sun, S.-T., and Swetlin, B., 1991, *Nature*, **351**, 39.
[9] Sakuragi, M., Tamaki, T., Seki, T., Suzuki, Y., Kawanishi, Y., and Ichimura, K., 1992, *Chem. Lett.*, 1763.
[10] Schadt, M., Schmitt, K., Jozinkov, V., and Chigrinov, V., 1995, *Jpn. J. appl. Phys.*, **31**, 2155.
[11] Schadt, M., Seiberle, H., Schuster, A., and Kelly, S. M., 1995, *Jpn. J. appl. Phys.*, **34**, 3240.
[12] Hashomoto, T., Sugiyama, T., Katoh, K., Saitoh, T., Suzuki, H., Iimura, Y., and Kobayashi, S., 1995, *SID 95 Dig.*, 877.
[13] Hasegawa, M., and Taira, Y., 1994, *IDRC 94 Dig.*, 213.
[14] West, J. L., Wang, X., Ji, Y., and Kelly, J. R., 1995, *SID 95 Dig.*, 703.
[15] Wang, X., Subacious, D., Laventovich, O., and West, J. L., 1996, *SID 97 Dig.*, 654.
[16] Wang, X., and West, J. L., 1997, *SID 97 Dig.*, 65.
[17] Lien, A., John, R. A., Angelopolos, M., Lee, K. W., Takano, H., Tajima, K., and Takenaka, A., 1995, *Appl. Phys. Lett.*, **61**, 3108.
[18] Yamamoto, T., Hasegawa, M., and Hatoh, H., 1996, *SID 96 Dig.*, 642.
[19] Seo, D.-S., Hwang, L.-Y., and Kobayashi, 1997, *Liq. Cryst.*, **23**, 923.