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Kyung-Hoon Jung [a], Ji-Hae Moon [a], Dong-Mee Song [a] & Dong-Myung Shin [a]

[a] Dep. of Chem. Eng, Hong-Ik University, Seoul, Korea

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Application of Photo-Alignment Technique through the Modification of the Polyimide Surface with Chalcone Derivatives to Vertically Aligned LCD

KYUNG-HOON JUNG, JI-HAE MOON, DONG-MEE SONG and DONG-MYUNG SHIN

Dep. of Chem. Eng, Hong-Ik University, Seoul, Korea

The photo-alignment with the linear-polarized UV (LP-UV) light was applied to the surface modified polyimide film with chalcone derivatives for the vertical alignment of liquid crystal molecules. The LP-UV light irradiation caused either dimerization or isomerization of chalcone derivatives. The long alkyl-chains attached on the chalcone derivatives were aligned homeotropically and so are LC-molecules.

Keywords VA-LCD; photo-alignment; DOCDA-DAP; chalcone;

INTRODUCTION

The photo-alignment technique was introduced for the reduction of contamination that reduce the contrast ratio and the static electricity buildup that cause cross-track shorts or failure of thin-film transistors [1]. For the application of photo-alignment technique to VA-LCD, polyimide film was used as an alignment layer, which is composed of DOCDA-DAP [5-(2,5-dioxotetrahydrofuryl)-3-methyl-3-cyclohexene-1,2-dicarboxylic anhydride/1,4-diaminophenol]. Generally, polyimdes exhibit high anchoring energy and good thermal stability. The chalcone dervatives were introduced on the surface of the PI film through

chemical modification. The chalcone dervatives react fast with irradiation of UV light. The anisotropy of the PI film was induced by irradiating LP-UV light [2,5]. This study is designed for the elucidation of surface effects on liquid crystal alignment mechanism.

EXPERIMENTAL

The PI film(4 wt%) was spin coated on a substrate [3]. After curing at 250 ℃ for 10 min on the hotplate, the thickness of the coated PI film was about 50 nm. By Willamson synthesis [4], the surface of PI film was modified with the chalcone derivatives at mild temperature for 5 min [6]. The reaction was followed by FT-IR spectra. The LP-UV light with the intensity of 20 mW/cm^2 was irradiated on the surface of PI film for 2 min. A cell was fabricated by injecting LC (BL001) into a pair of substrates over T_{NI} of the LC.

RESULTS AND DISCUSSION

Figure 1 shows the change modified with the chalcone moiety on the PI film. C=C peak of chalcone was confirmed at 1600 cm^{-1}. Upon irradiation of LP-UV light on the surface of modified PI film, it is expected that the chalcone derivatives are either dimerized or isomerized. The alkyl-chains attached to the chalcone derivatives tend to orient homeotropically. Figure 2(a) shows that the characteristic peak of the chalcone derivative is decreased due to photochemical reaction of the chalcone derivatives. Figure 2(b) shows that absorbance corresponding to the LC director is almost constant. Thereby the alignment direction of the LC-molecules was homeotropic. The PI surface morphology was observed by using atomic force microscopy (AFM). Figure 3 shows the micro-groove structure was formed

perpendicularly to the polarization axis of LP-UV. The pretilt angle of LC (BL001) molecules was measured by using the crystal rotation method. Figure4 shows the transmitted intensity through the LC (BL001) cell fabricated with the chalcone-introduced PI film between the crossed polarizers as a function of the cell rotation angle. It is clear that the LC (BL001) molecules are homeotropically aligned. The pretilt angle measured is about 89°

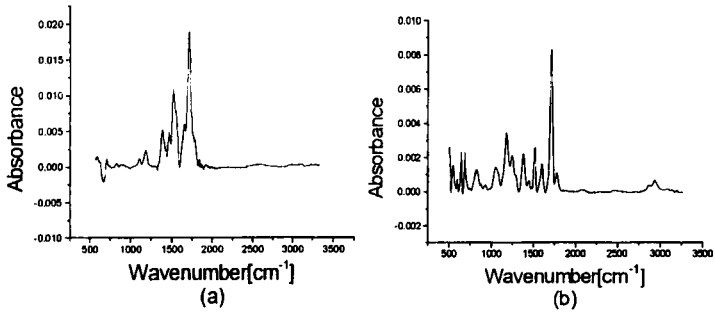

FIGURE1. The IR spectra of (a) DOCDA-DAP polyimide before modification (b) DOCDA-DAP polyimide modified with chalcone.

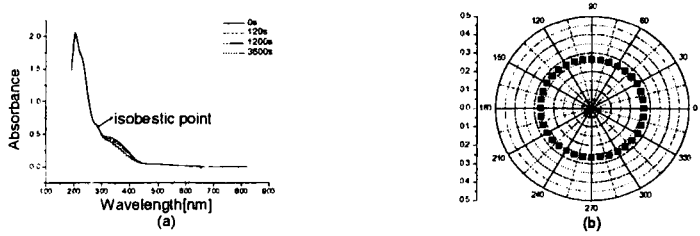

FIGURE2. (a) Change in the UV spectra of DOCDA-DAP polyimide modified with chalcone by LP-UV light irradiation time. (b) The polar plot of azimuthal angular dependence of dichroism at the absorption peak of LC (BL001) cell containing 0.1 wt% of dichroic dye.

FIGURE3 Change in the atomic force microscopy of DOCDA-DAP polyimide; (left) after modification (right) after LP-UV light irradiation.

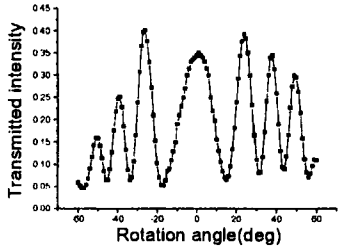

FIGURE4 Transmitted intensity for LC (BL001) cell with the LP-UV-treated chalcone-introduced PI film between crossed polarizers.

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