Effect of Polyimide on the Liquid Crystal Alignment for the Photo-Alignment Layers of Coumarin based Photopolymer/Polyimide Blends

Shi-Joon Sung, Ki-Yun Cho, and Jung-Ki Park

Dept. of Chemical and Biomolecular Engineering, Korea Advanced Institute of Science and Technology,

373-1 Kusong-dong, Yusong-ku, Taejon, 305-701, Korea, pjk@mail.kaist.ac.kr

Abstract

We prepared the blend alignment layers made from coumarin based photopolymer and polyimides for liquid crystal(LC) alignment using linearly polarized ultraviolet(UV) exposure. The alignment properties of LC were found to depend on the type of polyimide in the blend alignment layers. The degree of photereaction of polyimide was important factor for LC alignment direction on the blend alignment layers.

1. Objective and Background

In order to align liquid crystal(LC) molecules, the process of rubbing the surface of polyimide film is usually adopted in manufacturing liquid crystal didsplay(LCD). However, this process has the problems such as generation of static charge, dust, or scratches caused by rubbing. Therefore the establishment of a rubbing-free method is an important target due to its possibility of overcoming the problems in rubbing process. LC alignment using ultraviolet(UV) exposure is a promising candidate for non-rubbing method.[1] The photo-alignment layers made from photoreactive polymers such as polyvinylcinnamate[2] and coumarin[3] show good LC alignment, but the thermal stability of the alignment layer is poor. In order to enhance the thermal stability of alignment layer, we previously reported using polyimide to enhance the thermal stability of alignment layers of polyvinylcinnamate.[4]

In this work we adopted the polyimide to coumarin based photopolymer. We blended two different polyimide with coumarin based photopolymer.. We investigated the effect of polyimide on the liquid crystal alignment properties. Here we report the enhancement of thermal stability of LC alignment on blend alignment layer. We also compared the degree of photoreaction of polyimides and coumarin based photopolymer and related the difference to the direction of LC alignment on blend alignment layers.

2. Results

We prepared the blend alignment layers made from polymethacrylate with coumarin side chains and polyimides for liquid crystal alignment using linearly polarized UV exposure. We used two different polyimides such as 4,4'-(hexafluoro-isopropylidene) diphthalic anhydride-3,5-diamino-benzoic acid(6FDA-DBA) and pyromellitic dianhydride-4,4'-oxydiamiline(PMDA-ODA). The blend ratio of coumarin and polyimide was 70:30 and 50:50. We prepared the alignment layer by spin coating and irradiated polarized UV light.

We used UV spectroscopy in order to check the wavelength for photoreaction for coumarin and polyimide, and we selected two different UV filter for selected phototeaction for blend alignment layers. ORIEL 59800 was used for both photoreaction of

coumarin and polyimide, and ORIEL 59610 was used for photoreaction of couamrin.

We irradiated polarized UV using two different UV filters and check the LC alignment properties for each UV filters. When we used ORIEL 59800 filter, the blend alignment layers shows good thermal stability over 200°C regardless of type of polyimides. However, the LC alignment direction was parallel to polarization direction of UV for PMDA-ODA/coumarin and perpendicular for 6FDA-DBA/coumarin. The LC alignment direction was known to be important factor for generation of pretilt angle and so we check the pretilt angle of LC for two blend systems. The pretilt angle of PMDA-ODA/coumarin was about 2.3° but that of 6FDA-DBA/coumarin was about 0o. The perpendicular LC alignment direction to polarization of 6FDA-DBA/coumarin might be attributed to the higher photo-decomposition of 6FDA-DBA in blend alignment layer compared with PMDA-ODA.

In order to inhibit the photo-decomposition of polyimide we irradiated polarized UV using ORIEL 59610 filter. In this case the LC alignment direction of 6FDA-DBA/coumarin blend was parallel to polarization direction and the pretilt angle of LC was about 2°. From these results we found that the degree of photoreaction of polyimides in blend alignment layer had an effect on the LC alignment direction and we could control the LC alignment direction by adjusting the photoreaction of polyimides in blend alignment layers.

3. Impact

The alignment direction of LC was important factor for higher pretilt angle and it was changed by controlling the photoreaction of polyimide in blend alignment layer. Polyimides are generally used for photo-alignment layers due to their higher thermal stability, and the selection of polyimide and UV filters for polarized UV might be the important factors for good LC alignment properties.

4. Acknowledgements

This work was supported by the Center for Advanced Functional Polymers at KAIST. This work was also partially supported by the Brain Korea 21 Project.

5. References

[1] Luo, F. C., *Liquid Crystals, vol.1 (Singapore: World Scientific)*, p.397 (1990)

[2] Schadt, M., Schmitt, M., Kozinkov, V., Chigrinov, V., *Jpn. J. Appl. Phys.*, **7**, 2155 (1992)

[3] M. Schadt, H. Seiberle, A. Schuster, *Nature*, **381**, 212 (1996)

[4] H.T.Kim, J.W.Lee, S.J.Sung, J.K.Park, *Mol. Cryst. Liq. Cryst.* **338**, 99 (2000)

[5] M.Nishikawa, B.Taheri, and J.L.West, *SID 98 Digest*, 131 (1998)