Electro-Optical Properties of Polyoxetane based Liquid Crystalline Polymer/Low Molecular Weight Liquid Crystal

Chi Woong Jang, Oh Jeong Kwon, Ku Nam Kim*, Young Wan Kwon*, Tong Kun Lim, Jung Il Jin*

Quantum Optics Laboratory, Department of Physics, Korea University Sungbuk-ku, Seoul, 136-701 Korea Phone: +82-2-3290-3524, E-mail: cwjang@korea.ac.kr
***Department of Chemistry, Korea University, Sungbuk-ku, Seoul, Korea**

Abstract

We have synthesized a new material of polyoxetane based liquid crystalline polymer/liquid crystal (LCP/LC) for flexible memory or dynamic mode device and characterized the electro-optics behavior of this system. The microscopic dynamic behavior of main chain, side chain, and the low molecular weight LC were characterized by X-ray scattering and time resolved FTIR..

1. Objectives and Background

Recently, various kinds of LCP or LCP/LC have attracted considerable interest for flexible display devices by their characteristics of wide-view angle, high contrast, and no use for polarizers [1]. And enhancement in polymer structure of composite films and alternation of weight fraction of LC for fast response speed has been reported [2].

The operating mechanism of the system is as follows. When a low frequency electric field is applied, the ions move long distances and as a results push the main chains. This results in the randomization of the main chains in a scale of wavelength of light and the system scatters light strongly. On the other hand, when a high frequency electric field is applied, the ions do not move enough distance to disturb the main chains, and the system remain in a ordered state, nematic or smectic, which is a transmitting state.

We have synthesized a new LCP material containing Oxetane in the main chain to achieve better characteristics for the flexible memory mode as well as dynamic mode device operating in this principle, and characterized the electro-optical performan-ce of this system. We have also measured the dynamics of the every element of the system such as the main chain polymer, side chain mesogen as well as the low molecular weight LC to characterize the microscopic detail of the dynamics. Also X-ray scattering experiment performed on the system to characterize the static structure of the system at each stage.

2. Results

The chemical structure and physical properties of polyoxetane based LCP is shown in Fig. 1. The number of methylene group as a flexible alkyl spacer was 10. And nematic LC was commercially available E7 (MERCK) which was a nematic mixture.

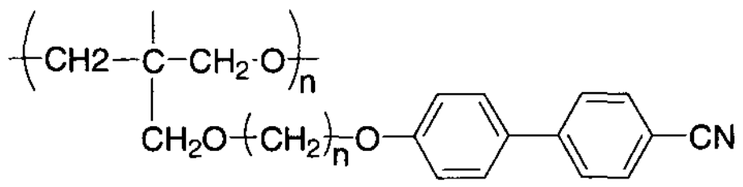

Figure 1: Liquid crystalline polymer(LCP) (n=10, T_g=9 □, T_{iso}=120□)

The phase transition behaviors and the aggregation state of the LCP/LC composite system were investigated on the basis of DSC measurement. The result is shown Fig. 2. Polarizing optical microscopic observation and the X-ray scattering experiment results are Fig. 3. The LCP was observed to be miscible with the LC over wide ranges of temperature, because chemical structure of LC is similar to the mesogenic side chain of LCP. When the E7 weight fraction increased, the T_g and T_{ISO} decreased. The X-ray scattering experimental result shows length of LCP and spacer were 29 Å and between 40~45 Å and 55 Å, respectively. In the case of a mixture of LCP/LC it was 36~38 Å. The above results indicate that LCPs

structure was intercalated layer with interdigitated layer form, and LCP/LC composite system form intercalated layer and reveal smectic A phase.

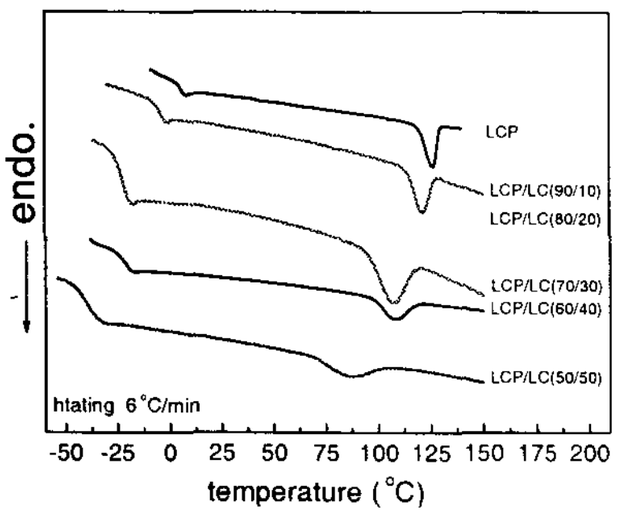

Figure 2: DSC curves of LCP

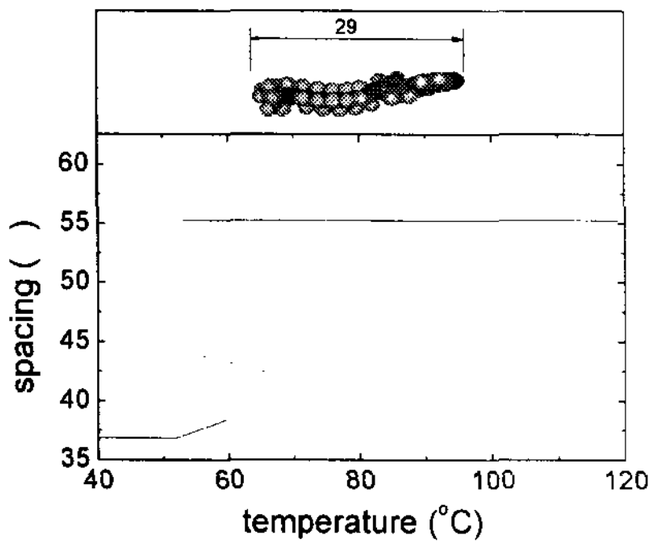

Figure 3: X-ray scattering results

For electro-optical measurements the rise and decay response time, τ_R and τ_D, was evaluated as the time period required for a 10~90% transmittance change. Fig. 4 shows the on-off switching behavior of the system under the applied AC field for the LCP/LC composite system (90/10 wt%). Light-scattering or transmitting state can be obtained by driving with electric field of low (10Hz) or high (300kHz) frequency, respectively. The τ_R was 4 second and the τ_D was 12 second. In the case of memory mode with E7 weight fraction 20%, the memory retention time was measured to be 91 second. Fig. 5 shows the plot of rise and decay response time as well as the retention time as a function of LC weight fraction.

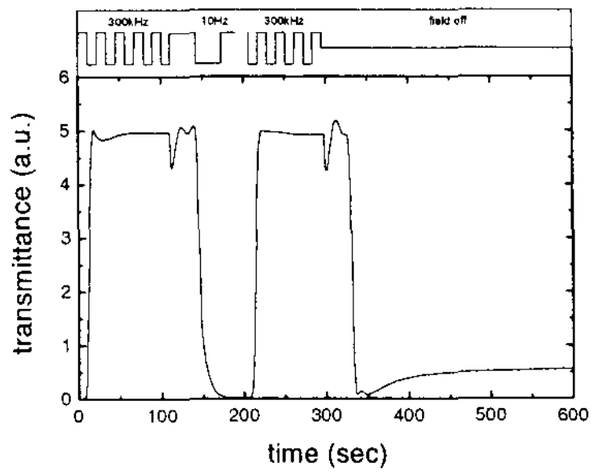

Figure 4: Electo-optical properties of the LCP/LC composite (90/10 wt%)

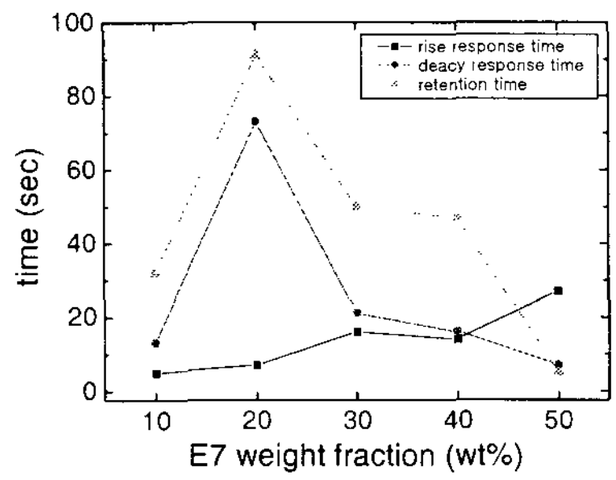

Figure 5: Rise and decay response times vs. retention time and E7 weight

3. Impact

A new LCP/LC material is synthesized, and the electro-optical properties of new type of cell for both memory and dynamic mode are characterized. Both X-ray scattering and time resolved FTIR experiments are performed on this new materials. These experiments will illuminate light on the behavior of the system in microscopic details both in static and dynamic structures.

4. Acknowledgements

This work was supported from Information Display R&D Center, one of the 21st Century Frontier R&D Program funded by the Ministry of Science and Technology of Korea.

5. References

[1] T. Kajiyama, H. Kikuchi, A. Miyamoto, S. Moritomi and J. C. Hwang, Chem. Lett., 817, 1989

[2] T. Kajiyama, H. Yamane, H. Kikuchi and J. C. Hwang, A. Chem. Soc., 190, 1996