카이랄 바나나액정에서의 전광변조 실험

Chiral Electo-Optic Modulations in Liquid Crystalline Phases of Bent-Shaped Molecules

Fumito ARAOKA[1], Ahyoung KIM[2], Byoungchoo PARK[2], J. W. WU[2] and Hideo TAKEZOE[1]
[1] Department of Organic and Polymeric Materials, Tokyo Institute of Technology, Japan
[2] Department of Physics, Ewha Womans University, Korea
jwwu@mm.ewha.ac.kr

Ferro/antiferroelectricty of liquid crystalline phase of bent-core molecules has attracted great attention since the first discovery of antiferroelectric switching in achiral bent-shaped molecules by Watanabe et al. in 1996. This materials show interesting properties usually observed in chiral system, for example, chiral textures, ferro/antiferrroelectricity, strong SHG activity and linear optical activity. Recently, many kinds of bent-shaped liquid crystalline molecules have been synthesized and studied. However, few works picking up their optical activities have been reported.

In this study, we made a mixture of P-8OPIMB and P-8-PIMB6*(85:15). Sample texture showed large one-chiral predominant domains and a contrast by rotating sample cell. At first, we measured UV-VIS spectra for the 70% chiral B4 phase of the mixture of the achiral and the chiral bent -shaped molecules. And also macroscopic CD/ORD spectra were measured by using CD/ORD spectrometer. CD spectrum showed sharp peak around at 400 nm. And ORD peak also appeared around in this region. These two peaks mean an existence of strong optical activity and also shows an existence of chiral structure of the B4 phase.

To investigate the nonlinear optical effect, the linear EO modulation(Pockels effect) of one chiral domain in this B4 phase mixture was measured. Experimental set-up is shown in [Fig.2]. First, the modulated intensity was measured as a fuction of the applied field (up to 34.5 Vpp) at f=999Hz. The result shows a good linearity. From the slope, we could get an information about the effective Pockels coefficients r_{eff}. Second, we could get the modulated intensity and the dc intensity as a function of optical bias determined by Soleil-Babinet compensator(Γ) with applied modulation voltage 34.5 Vpp (where, $\gamma=45^\circ$, $\beta=0^\circ$). Third, we measured the dc and modulated intensity as a function sample rotation angle(θ) (where, $\Gamma=90^\circ$, $\gamma=45^\circ$, $\beta=0^\circ$). The results show a sinusoidal dependence similar to those of optical bias dependence measurements[Fig3]. All of these results are the strong evidences of pure electronic EO effect. The solid curve is the theoretical fit to dc intensity, the dotted(longer one) curve is to the modulated intensity with considering x factor and the other dotted(shorter one) curve is to the modulated intensity without considering x, respectively.

In this B4 phase of banana LCs, the effect of induced optical activity (concerned with x) is so large, we have to consider the nonlinear optic effect by introducing x, y in this system. We could

ge the dispersion relations of x, y, Δn_0 , ρ and effective pockels coefficient r_{eff} from the data by using computer fitting. The maximum r_{eff} value is about 21.6 pm/V at 488.0 nm and the value of Δn_0 is 0.126. These are comparable with the value of chiral system of organic materials. These electro-optical signals were observed only in short visible wavelength region where the large peaks of CD spectrum exist. The origin of dispersion could be considered as the effect from the optical activity caused by the chiral structure in the B4 phase of the bent-shaped molecules

This work is supported by BK21 and KOSEF 98-0702-04-01-3. Fumito AROAKA is supported by Japan Society for the Promotion of Science (JSPS).

Reference

[1] T. Niori, T. Sekine, J. Watanabe and H. Takezoe, J.Mater.Chem. 6, 1231 (1996)

[2] D.R. Link, G. Natale, R. Shao, J.E. Maclenann, N.A. Clark, E. Korblova and D.M. Walba, Science, 278, 1997 (2000)

[3] M. Zennyoji, Y. Takanishi, K. Ishikawa, J. Thysayukta, J. Watanabe and H. Takezoe, J.Mater.Chem. 9, 2775 (1999)

[4] S.H. Han and J.W. Wu, J. Opt. Soc. Am. B 17(7), 1205 (2000)

[5] J. Thisayukta et al., Jpn. J. Appl. Phys., to be submitted

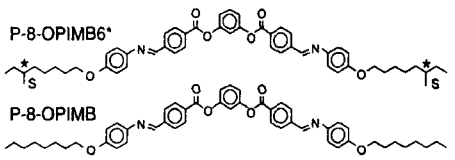

Fig.1. The chemical structure of bent-shaped molecule

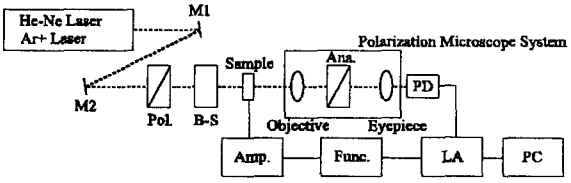

Fig.2. Experimental set-up for the linear electro-optic measurement. The components are denoted by: M1, M2: mirrors; Pol.: polarizer; Lens: objective lens(10x); B-S: Babinet-Soleil compen-sator; Ana.: analyser; PD: photodiode; Func.: function generator; Amp.: high-speed amplifier; LA: lock-in amplifier; PC: computer system.

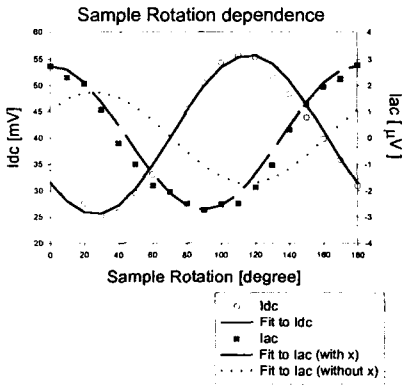

Fig3. Sample rotation angle(θ) dependence

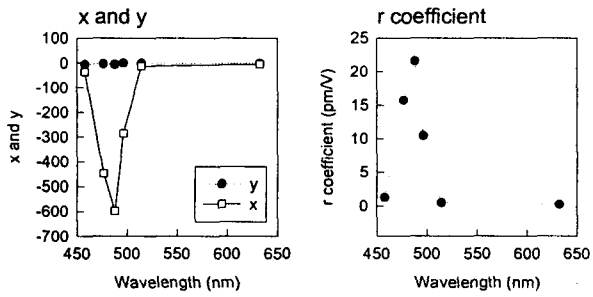

Fig.4 The dispersion of x, y and r_{eff} value