Mechanism of Reflection Band Broadening by Photopolymerization of Reactive Mesogen in Cholesteric Liquid Crystal Film

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Several researches have focused on making cholesteric liquid crystal (CLC) reflectors as regards switchable or tunable characteristics with thermal, electric- or photo-field. Therefore, the control of the reflection band in the CLC film has attracted attention. Since a remarkable approach was proposed for the bandwidth widening [1], several works have followed up to recently, including using thermally induced pitch gradients [2]. In this work, we investigate the broadening phenomenon of the reflection band of CLC film with reactive mesogen (RM) with introducing the phase separation model of the polymer and CLC. Broadband reflection was achieved by ultra violet (UV) irradiation with an intensity gradient across the film thickness. When a CLC film with RM monomers is irradiated by UV light (intensity ~ 0.2 mW/cm^2, wavelength ~ 365nm), the LC molecules absorb UV light and a gradient in UV intensity can be achieved over the cell thickness. The polymerization occurs at a fast ratio toward the UV light source resulting in a faster consumption of the most RM monomers. Thus, the local depletion of these monomers was faster, generating a concentration gradient. Consequently, CLC film explored the opposing concentration gradient of the pitch-tightening and the pitch-widening by local difference of polymer networks density during polymerization. The reflectance spectrum of a CLC film, nonirradiated and irradiated, are shown in Fig.1. Based on the spectral broadening characteristics, the broadening of the cured CLC film was about three times of uncured bandwidth (from 500 to 750 nm). Measured spectrum data was fitted and a good agreement with the theoretical model [3] based on the phase separation of the CLC and polymer, and selective reflection from variable pitch CLC film. In conclusion, the mechanism for the broadening spectrum of the CLC film was identified in this work. It was also expected that CLC film with the pitch gradient covering entire visible range could find several applications for optical devices.

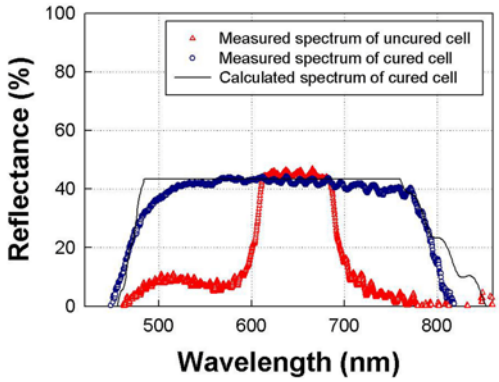

Fig. 1 Measured and calculated reflection spectra of our CLC film

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References:
[1] D. J. Broer, J. Lub, and G. N. Mol, *Wide-band reflective polarizers from cholesteric polymer network with a pitch gradient*, Nature **378**, 467 (1995).
[2] T. J. White, A. S. Freer, N. V. Tabiryan, and T. J. Bunning, *Photoinduced broadening of cholesteric liquid crystal reflectors*, Jpn. J. Appl. Phys. **107**, 073110 (2010).
[3] V. A. Belyakov, V. E. Dmitrienko, and V. P. Orlov, *Otics of cholesteric liquid crystals* **127**, 63 (1979).

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