Polarization-Responsive Behavior in Nonlinear Optical Effect of Polymer-Stabilized Dye-Doped Liquid Crystals

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Liquid crystals (LCs) exhibit functional optical properties for hologram and light modulator based on their molecular orientation. The orientation can change by application of external stimuli such as electric field and light to the LCs. In particular, dye-doped LCs undergo their molecular reorientation by irradiation with linearly polarized light [1]. Such molecular reorientation occurs in accordance with an incident light intensity, which is recognized as a typical nonlinear optical effect. Recently, we found that the nonlinear optical response of oligothiophene dye-doped LCs could be successfully sensitized by adding low-concentration polymers [2-4]. In a series of experiments, we revealed that an elliptical diffraction beam appeared on the screen despite the irradiation of the polymer-containing LCs with a circular beam. In this study, we investigated the formation behavior of the diffraction rings in response to the polarization direction of the incident light to explore the mechanism of the deformed diffraction.

A host LC (5CB), acrylate monomer (A4CB), guest dye (TR5), and photopolymerization initiator (Irgacure 651) was mixed and injected into a 100-μm-thick glass cell treated with octadecyl trimethoxy silane to obtain homeotropic alignment of LCs. The glass cell was irradiated with ultraviolet (UV) light at a wavelength of 365 nm to perform photopolymerization. Polarized optical microscopy and polarized UV-visible absorption spectroscopy revealed that the LC and dye molecule in the cell were homeotropically aligned. We investigated the photoinduced molecular reorientation behavior of the LC by irradiation with a circular-shaped DPSS laser beam at a wavelength with 488 nm. As a result, an elliptical diffraction beam was observed by irradiation of the sample with the laser beam. Moreover, the elliptical pattern of diffraction rings reflected the polarization direction of the incident beam.

1) I. C. Khoo, J. H. Park, J. Liou, *Appl. Phys. Lett.*, **2007**, *90*, 151107.
2) Y. Aihara, M. Kinoshita, J. Wang, J. Mamiya, A. Priimagi, and A. Shishido, *Adv. Opt. Mater.*, **2013**, *1*, 787.
3) J. Wang, Y. Aihara, M. Kinoshita, J. Mamiya, A. Priimagi, and A. Shishido, *Sci. Rep.*, **2015**, *5*, 9890.
4) K. Usui, E. Katayama, J. Wang, K. Hisano, N. Akamatsu, and A. Shishido, *Polym. J.*, **2017**, *49*, 209.