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Three-dimensional vector holograms formed in Twisted-nematic azo dye-doped polymer liquid crystal composite

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Polarization-sensitive materials, in which linear and/or circular birefringence is induced by the incident polarized light, are necessary in order to record the polarization gratings. And azobenzen is one of the representatives of these materials because of axis-selective trans-cis photoisomerization reaction, which lead to holographic optical recording. In the previous paper, Sasaki *et al*[1] presented three-dimensional (3D) vector holograms formed in anisotropic photoreactive polymer dissolved liquid-crystal (LC) composites. Here, the azo-dye doped liquid crystalline material was a uniaxial anisotropic medium with homogeneous (HOMO) alignment. As the result, the polarization state of the light is modulated along to the thickness direction of the recording medium.

In this study, we further investigated the 3D vector holograms in twisted-nematic (TN) azo dye-doped polymer liquid crystal composite, as photoreactive anisotropic medium, and its recorded optical characteristics. To obtain an alignment cell, the composite was sandwiched between two rubbed poly (vinyl alcohol) (PVA)-coated glass substrates with 10μm thick polyester film spacers. We considered the twisted angle, which is defined as the angle between the rubbing directions of two PVA-coated glass substrates, in cases HOMO alignment (0°), and compare it with TN alignment (30°, 45° and 90°). 90° TN cell is illustrated in Fig.1.

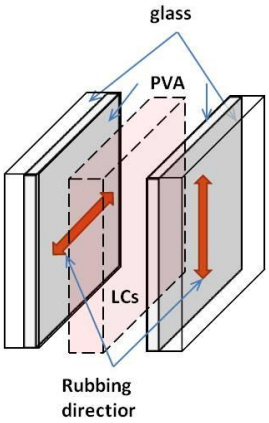

Fig.1 – Illustration of 90° TN cell

3D vector holograms were written by two orthogonal linearly polarized, mutually coherent Nd:YAG laser beams with an intensity of 900mW/cm^2 respectively and probed by using a linearly polarized He-Ne laser. Polar plots of polarization states for incident and diffraction beams are shown in Table.1. This result suggests that the polarization directions are rotated when the laser beam is diffracted in the medium, and the rotation angle can be controlled by the twisted angle of the sample cells. By considering these resulting diffraction properties of the recorded gratings and the photoalignment of azo-dye molecules, we confirmed the 3D distributions of the director corresponding to the polarization modulation caused not only by the propagation of light interference in LCs, but also by the initial orientation of the LCs.

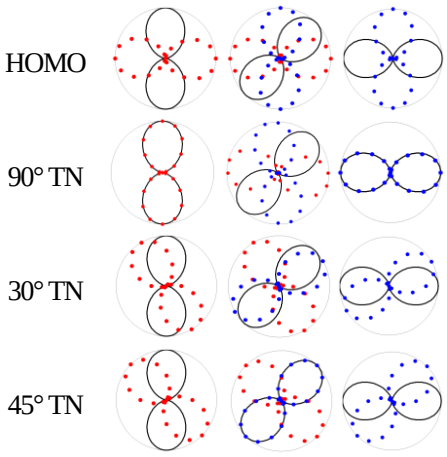

Table.1 - Polar plots of polarization states for incident and diffraction beams The incident beam is indicated as solid lines. Red and blue plots represent measured data for positive and negative first-order diffraction beams.

[1] Tomoyuki Sasaki, Hiroshi Ono, Nobuhiro Kawatsuki, Applied Optics, Vol. 47, No.13, 2008