염료가 혼합된 이진 액정 구조 내에서의 편광 격자 소자의 동적 조절 효과

Dynamic Polarization Grating Effects in a Dye-Doped Binary Liquid Crystal Configuration

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Polarization gratings[1] can control a polarization state of an incident light as well as a propagation direction of it. Recently, several researches for developing dynamic polarization gratings by incorporating a liquid crystal (LC) have been proposed. The diffraction efficiency of the LC polarization gratings could be easily controlled by applying a voltage. However, in the conventional LC polarization gratings, the selected polarization state of the diffracted light was inevitably varied in the presence of an applied voltage. Thus, the polarization properties could not be precisely controlled.

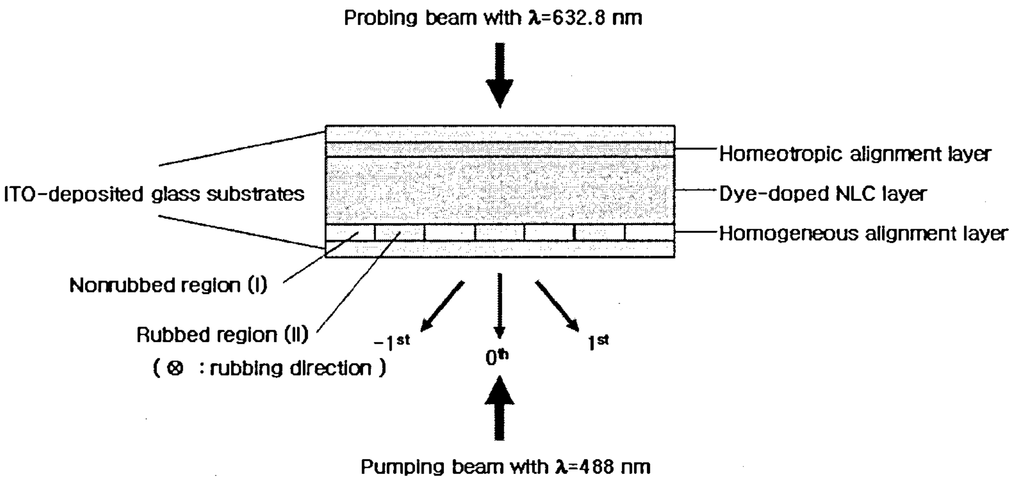

Figure 1 : The cell structure of the dye-doped LC and the experimental setup for fabricating and measuring a dynamic polarization grating.

In this paper, we demonstrate a novel type of a dynamic polarization grating by using a light-induced anisotropic anchoring phenomena in a dye-doped LC (DDLC) cell aligned on a selectively rubbed polymer surface as shown in Fig. 1. Upon irradiation of a linearly polarized pump beam, the dye molecules in the LC host diffuse and adsorb to the irradiated surface with generating a light-induced easy axis of the LC molecules through the trans-cis photo-isomerization[2]. Due to the difference of the azimuthal anchoring energy between the nonrubbed region (I) and the rubbed region (II), the light-induced LC reorientations take place in a different manner so that the LC molecules in the region (I) are more freely moved toward a direction perpendicular to an incident pump polarization than those in the region (II). The generated optic axes in both domains are independent with an applied voltage. Thus, the polarization properties of the proposed structure can be optically controlled by varying the polarization state of the single pump beam.

Experimental results show that the selected polarization properties were not changed when we control the diffraction efficiency by applying voltages as shown in Fig. 2. Moreover, the diffraction efficiency of the proposed structure is insensitive to the polarization state of an incident beam. These results are a unique so that it is expected to be exploited to several polarization selecting applications such as polarimeters, polarization controllers, dynamic polarization beam splitters, and etc.

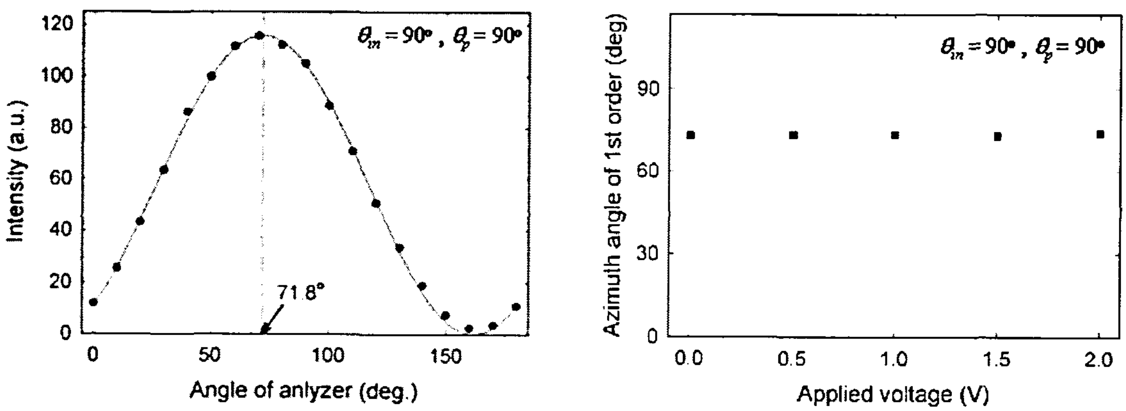

Figure 2 : The polarization grating effects : (a) the transmitted intensity of first order diffracted probe beam as a function of a analyzer orientation angle and (b) the diffracted polarization state as a function of an applied voltage. θ_p and θ_{in} are the polarization states of the pump beam and the incident probe beam, respectively.

1. M. Le Doucen et. al., "Polarization properties and diffraction efficiencies of binary anisotropic gratings: general study and experiments on ferroelectric liquid crystals", Opt. Comm. **151**, 321-330 (1998).

2. C.-R. Lee et. al., "Surface-assisted photoalignment in dye-doped liquid-crystal films", Phys. Rev. Lett. **69**, 031704-031709 (2004).

and the incident probe beam, respectively.