Diffraction in Holographic Polymer Dispersed Liquid Crystal with in-Plane Electrodes

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Polymer-dispersed liquid crystal (PDLC) is a material promising for application in optical communications, diffractive optics and optical data storage. Holographic polymer-dispersed liquid crystals (HPDLC) have been demonstrated as candidates for a number of applications including diffractive optical elements, optically pumped lasers, reflective displays, switchable lenses and mirrors, light shutters, filters and telecommunications devices. Optical properties of HPDLC can be controlled with electric field of electrodes of various configurations including in-plane electrodes geometry [1].

In this work we study the electric field control of diffraction efficiency of HPDLC film with in-plane electrodes [1]. We suppose that HPDLC film contains ellipsoidal bipolar liquid crystal (LC) droplets. Initial distribution of droplets orientation in the absence of electric field is considered to be uniform. LC droplets are treated as ones with homogeneous director orientation [2, 3]. We obtain the effective values of dielectric tensor of the droplet by averaging over its volume. We also assume that electric field induces reorientation of the droplet optical axis without changing effective values of its dielectric tensor. To find electric field inside the HPDLC film we apply the method of conformal mapping. We present the HPDLC as a rectangular volume grating averaging the dielectric tensor of LC-rich layer and taking into account statistical distribution of droplets symmetry axes in the presence of electric field [3]. The average LC-rich layer thickness is determined taking into consideration random deviations of layer thickness [4]. Diffraction of the light wave in the film is described using anisotropic coupled-wave theory [5].

Basing on the sated approach we calculate diffraction efficiency upon applied voltage for different angles between the grating vector and applied electric field. Results for both s- and p- light polarizations are obtained.

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