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Spectral dependences of transmittance and polarizing ability of stretched PDLC films with homogeneous and inhomogeneous interface anchoring

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Polymer dispersed liquid crystal (PDLC) films, consisting of non-absorbing uniaxially-elongated liquid crystal (LC) droplets within polymer matrix effectively polarize light in the entire transparency region (visible and near IR) of the components used, while the dichroic polarizers can do that only in the dichroic band of own or impurity absorption. Besides, PDLC films allow modulating the intensity, polarization and phase of light by applying the electric or magnetic field. They are particularly promising in the collimated laser devices and projection systems.

Recently, a new approach has been realized to control the optical response of polymer dispersed liquid crystal (PDLC) film in the light-scattering mode [1]. It is based on the surface anchoring transitions caused by ionic surfactant and gives an opportunity to achieve simultaneously the limit polarization characteristics for unpolarized incident light.

In this presentation an optical-mechanical model has been developed to describe the transmittance, polarization and small-angle distribution of light scattered by an uniaxially-stretched polymer films containing the elongated ellipsoidal droplets of nematic liquid crystal doped with ionic surfactant [2]. The model is based on the Foldy-Twersky, anomalous diffraction, and single scattering approximations. We have studied the spectral dependences of the coefficients of coherent (directed) transmission and the polarization degree of forward-transmitted light, the angular distribution and polarization of light scattered in small angles by the stretched PDLC films with homogeneous (without surfactants) and inhomogeneous (with surfactants) surface anchoring. It has been considered the films consisting of ellipsoidal LC droplets with: the bipolar intrinsic structure formed under homogeneous tangential anchoring, the radial structure formed under homogeneous homeotropic (normal) anchoring, and the monodomain structure raised due to inhomogeneous surface anchoring.

The spectral dependence of transmittance and polarizing ability of the polymer dispersed liquid crystal films have been analyzed as well as the small-angle intensity distribution and the polarization degree of scattered light depending on the film thicknesses, refractive indices of LC and polymer, sizes of droplets, their anisometry parameters, concentration, polydispersity, and optical axes small-angle intensity distribution and the polarization degree of scattered light depending on the film thicknesses, refractive indices of LC and polymer, sizes of droplets, their anisometry parameters, concentration, polydispersity, and optical axes orientation and the field of view angle of the optical system. The optical characteristics of films with homogeneous and inhomogeneous interfacial anchoring at the surface of liquid crystal droplets are considered.

A high polarization degree (more than 0.97) can be achieved for the forward-transmitted light in the wide wavelength range (from 0.45 to 0.7 μm) both for PDLC films with monodomain and bipolar LC droplet structures and for films with inhomogeneous surface anchoring of "tangential-normal" type. A coherent transmittance of the films with bipolar droplet configuration and inhomogeneous "tangential-normal" anchoring is smaller than that of the films with monodomain internal structure. The films with homogeneous surface anchoring and radial LC droplet structure do not allow polarizing effectively the forward-transmitted light.

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References

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