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The Contrast of Cholesteric-Nematic Transition in Indused Cholesterics

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The contrast characteristics of cholesteric-nematic transition (CNT) in nematic-cholesteric mixtures with a low (up to 2 wieght %) optical active dopant content were analysed. The correlation between induced cholesterics physical parameters, liquid crystal layer contructional parameters and the contrast value is fixed. The mathematical model of light scattering process using light scattering object with a variable dimentions is

evaluated. The correlation between light scaterring element dimentions and supermolecular spiral structure parameters is fixed.

1. Introduction

Liquid crystals today widely used for light scattering elements creation, such as optical switches, modulators, stabilizers etc. One of the most perspective electrooptical effects in Liquid crystals is the cholesteric-nematic transition (CNT) in indused cholesterics, that is connected with a possibility of making the devices without polarizers on its base.

2. Problem statement

The maximum transparency of the cell value in the CNT process under the action of electric field corresponds to a light passing through the liquid crystal in transparent homeotropic nematic state. The scattering of light by the nematic texture occurs at owing to dielectric penetrability tensor fluctuations [1]. The main parameters, that define the value of scattering in this case , are dielectric anysotropy and Frank elasticity constants. But the value of scattering intensity by nematic is small, and the pellucidity in the transparent state of elements, that functions on the base of CNT effect, defines in general by absorption and reflection at conductive layers [2]. That is why, from the point of view of a maximum contrast value achievement it is important to study the light scaterring process by focal-conic cholesteric texture by CNT process.

Previous theoretical and experimental studies of light scattering by induced cholesteric allows to pick out the two main gear of scattering: the scaterring at nonhomogeneouses of the medium (domains) at the condition $\lambda << P_0$ (where λ-radiation wavelength, P_0-cholesteric spiral pitch), and the selective Bragg scattering at the cholesteric lattice [1]. This work is dedicated to this gears analysis into induced cholesterics with a different spiral

structures and to fixing the correlations between the liquid crystal physical parameters and scattering intensity of cholesteric focal-conic texture value. It would be allow to define the conditions of a maximum contrast achievement for the devices on the base of CNT effect.

3. Results and discussion

As the objects for our studies the induced cholesterics on the base of nematic matrices (the mixtures of cianobipheniles, oxycianobipheniles, and asoxycompounds) with a small content (up to 2 weight %) of chiral dopants (cholesterine esters) were selected. Such an objects selection gave us to possibility of creation of a wide class of induced cholesterics with a different spiral structures, dielectric anysotropy and Frank elasticity values.

Our studies were carried out in a standard cell of "sandwich"-type with a liquid crystal layer thickness by 25 mm. The induced cholesterics volt-contrast characteristics were obtained by means of experimental apparaturs, that was consisted of light source (He-Ne laser, $\lambda = 0.63$ μm, P=2mW), cuvette with the liquid crystal cell, photo receiver (photo multiplier) and two-coordinate recorder. At the cell the tiangle-shaped filled control signal was applied with a growing (decreasing) rate of 1.3 V/s.

The data of minimum intensity relative value measuring for the light, that passed through the cell by CNT process, allow to analyze the dependence of laser radiation scattered by liquid crystal cell intensity on ratio (d-liquid crystal layer). This dependence is described by the function of such a type:

$$I_{min} = I_{max} \exp\{- Ad/P_0\}, \qquad (1)$$

where I_{min}, I_{max} - minimum and maximum intensities of light, that passed through the cell, d- cell thickness, P_0- cholesteric spiral pitch, A- fucking index.
As we can see, this expression corresponds to a well-known exponential law of energy weakening by the light passing through the "mist" layer with a thickness of x ("scattering in a mist" model) [3];

$$I=I_0\exp\{-2\pi N\rho^2 xk'\}, \qquad (2)$$

where ρ- radius of scattering particles; N- number of particles in 1 cm^3 of "mist"; k'- function, that depends on particle radius and wavelength.

The pitches of our mixtures lies at the range from 5 to 200 μm. That is why the Bragg scattering efficiency for the visible light will be a small ($\lambda<<P_0$) and scattering intensity value decreases with a P_0 growth [1].

4. Conclussion

So, the main scattering gear for the visible light in this case will be the scattering at the focal-conic domains of induced cholesterics. If the liquid crystal layer thickness is the same, spiral pitch value P_0 defines the light scattering particles dimensions and concentration. Index A in (1) accounts the dispersion of dimensions and orientation directions of focal-conic domains.

So, the intensity of light scattering increases with a growth of domains value density, that corresponds to a high d/P_0 value case. The P_0 growth causes the number of domains in the layer decreasing and a transparency growth. In the case $d/P_0<<1$, the

focal-conic cholesteric texture would not create, that leads to a transparency critical growing and contrast decreasing.

The results of our studies give a possibility to create the liquid crystal materials for light scattering elements on the base of CNT effect with a given contrast value.

References

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