The polarization characteristics of the electro-controlled liquid crystal light modulator

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Abstract — The usage of the matrix method of the light propagation medium optics for the investigation of the polarization characteristics of the light modulators based on the nematic liquid crystal (NLC) is described. The results of the Muller matrix components measurements of the liquid crystal in the electric pulse process are presented. The character of the matrix transformation symmetry and light scattering matrix of the medium are determined. The general analyses of the temporal dependence of non-zero Mueller matrix components of the liquid crystal modulator were made.

Keywords - Mueller matrix, nematic liquid crystal.

INTRODUCTION

The matrix method of optics of light-scattering media owns high information properties. Therefore it successfully is used for the solution of urgent problems of hydrooptics, biology, medicine, astrophysics, technology of opto-electronic instrument-making etc. Accordingly, the theoretical and experimental operations in a direction of development of the specified method have urgent character. It is difficult to calculate the energy and polarization characteristics of a light field formed at a scattering of polarized radiation by systems of non-spherical particles of the various shape, size, index of refraction and degree orientation. Therefore role of examinations on objects with known geometrical optic parameters of optical inhomogeneities essentially grows. Such model experiment guesses embodying test – object with model at strictly fixed others. The examinations in given direction are accompanied by a lot of technological and technical problems. At model operation of objects with a various degree of orientation of systems optically anisotropic particles there are special problems.

EXPERIMENTAL RESULTS

The measurements is spent on a laboratory Stoke-goniometer. The sample is irradiated with monochromatic light of the laser diode with \( \lambda=670 \text{ nm} \), diameter of a bundle \( d=5 \text{ mm} \), aperture angles of illuminator and receiver do not exceed 12°. Explored NLC (\( \Delta \phi > 0 \)) places in a flat capillary with thickness 10 \( \mu \text{m} \), on which interiors the transparent current-conducting coats are put. Electrical impulses from the generator with duration \( \tau=0.75 \text{ sec} \), with a period \( T=2.5 \text{ sec} \), amplitude \( A=5 \text{ V} \) given to current-conducting coats. Thus, NLC medium is under action of a impulsing electric field. A flat capillary with NLC temperaturely stabilizes under the temperature \( T=291 \text{ K} \) with precision 0.03 K.

The time dependencies of Mueller matrixes components for NLC in various experimental situations have features. Let's consider a situation when a scattering angle \( \alpha=0° \). In this case we work with transformation matrix (MT). The symmetry of components \( f_{12}=f_{21}, f_{32}=f_{43}, f_{31}=f_{44} \) is clearly realized and is maintained as during activity of an electric intensity impulse \( (E=5 \text{ V}, \tau=0.75 \text{ sec}) \), and during its absence. The component \( f_{12} (f_{21}) \) at the initial moment has negative and close to simple value, that shows primary orientation of light-scattering heterogeneous of NLC medium in a horizontal plane [1]. In the beginning of activity of an impulse there is a sharp diminution of absolute value \( f_{12} (f_{21}) \), that can be connected with deorientation of structural elements of NLC. The basic time of activity of an impulse is accompanied by consecutive increasing of absolute value \( f_{12} (f_{21}) \), but the primary value of component is not reached. The relaxation phenomenon for \( f_{12} (f_{21}) \) represents the special interest. After removing an impulse of electric field, during 0.25 sec there is a diminution of quantity component \( f_{12} (f_{21}) \) to 0.34, that corresponds to value of orientation degree in system NLC about 0.37 [2]. After 0.5 sec this component reaches value, close to primary about 0.88, that corresponds to \( B=0.9 \) [3].

Thus, given estimation of a time dependence results of NLC MT nonzero components during activity of an energy impulse shows on the one hand complexity NLC structural elements interaction mechanisms with an electric field, on another hand – have an effective possibility of realizing the model medium with some geometrical optic parameters.

CONCLUSION

Analyzing the received time dependencies \( f_{ik} \) components of Mueller matrixes of electrocontrollable NLC , it is necessary to note such features: The structure of Mueller matrix NLC in these conditions corresponds to optically anisotropic medium, which contains system of symmetric oriented particles under the temperature \( T=291 \text{ K} \) and impulse amplitude \( A=5 \text{ V} \). The symmetry of components \( f_{12}=f_{21}, f_{32}=f_{43}, f_{31}=f_{44} \) is clearly realized and is maintained as during activity of an electric intensity impulse \( (E=5 \text{ V}, \tau=0.75 \text{ sec}) \), and during its absence.

REFERENCES