Polarization characteristics of light passed through a cholesteric layer with tangential-conical boundary conditions

V.S. Sutormin[1,2], M.N. Krakhalev[1,2], I.V. Timofeev[1,2], R.G. Bikbaev[1,2], O.O. Prishchepa[1,2], V.Ya. Zyryanov[1]
[1]Kirensky Institute of Physics, Federal Research Center KSC SB RAS, Krasnoyarsk, Russia,
[2]Siberian Federal University, Krasnoyarsk, Russia

1. Introduction

Liquid crystals (LCs) are the unique functional materials owing to their high sensitivity to the external factors. In practical applications, the LC is in contact with the confining surface, which interaction with LC molecules specifies the director orientation at the interface and, consequently, the director orientation in the bulk. Nowadays, the rigid surface anchoring is widely used. In this case, the director orientation is not changed at the interface during the reorientation process of LC in the bulk induced by the external factors. We consider the LC cells with one of the substrates specifying the conical surface anchoring. The conical surface anchoring is characterized by the tilted orientation of director to the substrate and azimuthal degeneration [1], i.e., the azimuthal anchoring strength of LC with the substrate is near to zero. The present work is devoted to the investigation of the polarization characteristics of light passed through the cholesteric layer with tangential-conical boundary conditions.

2. Materials and Methods

The experiment was carried out with sandwich-like cells consisting of two glass substrates coated with polymer films and the cholesteric layer between them. Bottom substrate was covered by the polyvinyl alcohol (PVA) and the top one was covered by the poly(isobutyl methacrylate) (PiBMA). The PVA film was unidirectionally rubbed while the PiBMA film was not treated after the deposition process. The nematic mixture LN-396 (Belarusian State Technological University) doped with the left-handed chiral additive cholesterylacetate was used as a cholesteric liquid crystal (CLC). For the nematic mixture LN-396 the PiBMA film specifies the conical boundary conditions with the tilt angle 50° and PVA film specifies the tangential surface anchoring. The polarization of light passed through the CLC cell was studied by measuring the azimuth of polarization ψ and ellipticity angle χ. The azimuth of polarization is an angle between the major semiaxis of the polarization ellipse and the *x*-axis. The *x*-axis coincided with rubbing direction of PVA film. The ellipticity angle is an arctangent of the ratio between minor and major semiaxes of the polarization ellipse. The measurement of ellipsometric parameters was conducted using the electrooptic setup in which the He-Ne laser beam passed in sequence through the polarizer, CLC cell, quarter-wave plate, analyzer and was detected by a photodetector.

3. Results and Discussion

The orientation structure with simultaneous tilt and twist of the director was formed in the CLC cells with tangential-conical boundary conditions [2]. The dependences of ellipsometric parameters ψ and χ on the voltage applied to the CLC cell was investigated for the samples with different ratios between CLC layer thickness *d* and cholesteric pitch *p*. Figure 1 shows the parameters ψ and χ of light passed through the CLC cell with ratio $d/p = 0.28$. The incident light was linearly polarized with ellipsometric parameters $\psi_0 = 90°$ и $\chi_0 = 0°$. In the absence of an electric field, the linearly polarized light passed through CLC cell became elliptically polarized with $\psi = 16.5°$ and $\chi = -17°$. The ellipsometric parameters remained almost invariable until U = 0.3 V. In the range of control voltages from 0.3 to 3 V the nonmonotonic changes of ψ and χ were observed.

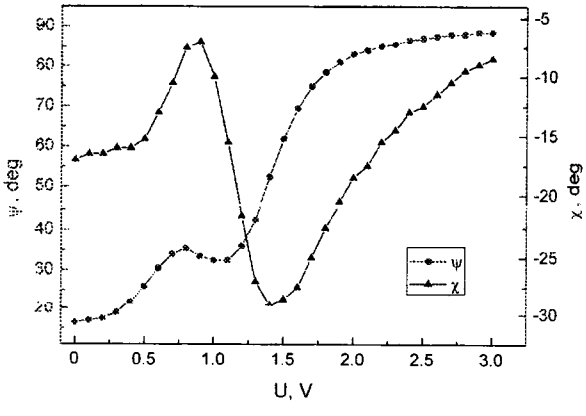

Figure 1: The dependences of ellipsometric parameters y and c on the control voltage *U*. LC layer thickness is *d* = 5.9 mm. The ratio *d/p* is 0.28

4. Acknowledgements

This work was supported by the Russian Science Foundation (No. 18-72-10036).

5. References

[1] B. Jerome "Surface effects and anchoring in liquid crystals" Rep. Prog. Phys., Vol. **54**. pp. 391-451, 1991.

[2] M.N. Krakhalev, R.G. Bikbaev, V.S. Sutormin, I.V. Timofeev, V.Ya. Zyryanov "Nematic and cholesteric liquid crystal structures in cells with tangential-conical boundary conditions", Crystals, Vol. **9**. pp. 249, 2019.