Ellipticity of the light transmitted by a smectic C* liquid crystal layer with short pitch helix

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A chiral ferroelectric smectic C* liquid crystal (FLC) was developed by doping a smectic C matrix with a chiral compound, providing the helix pitch $p_0 = 350\text{nm}$ in order to avoid any light scattering of visible light, when the helix is not unwound. Two cells with different FLC layer thickness (16- and 50μm) have been made, having helix axis parallel to the glass plates. The boundary conditions were asymmetric, since one plate was covered by ITO only and the other one by polyimide spin-coating over ITO layer. A step- and a stair voltage have been applied to the cell, with the aim of studying the ellipticity modulation of the transmitted light beam, when the incident one is linearly polarized. We confirmed within 5 % accuracy the Malus law for both step- and stair function, allowing us to define ellipticity simply as $e = \sqrt{\frac{I_{\min}}{I_{\max}}}$, and obtained the helix axis deviation in the region of helix inharmonic distortion for both plus – and minus voltage peak.

We observed a regular variation vs. voltage of the ellipticity at different angles α of the cell main optical axis with respect to the polarizer: this demonstrates the possibility of controlling the birefringence by means of an external electric field. The ellipticity has been evaluated, when α was 0° (90°) and 45°.

We can then conclude that the 0° (90°)-ellipticity investigation completely illustrates the optical quality of the spatially non-uniform birefringent structure. Furthermore, the consideration of such plots together with the detection of the ellipticity when the angle $\alpha = 45^\circ$ allows us to describe the electro-optic behavior of the cell vs. voltage as a retardation layer proportional to either λ/4 or λ/2 or λ.

These measurements permit the evaluation of the electrically controlled birefringence via the ellipticity: a definite protocol concerning this type of investigations has been established.

Acknowledgements

The work was partially supported by Russian Foundation of Basic Research, grants: 07-07-91582-АСП_а, 08-03-90009-Бел_а, 07-02-96610-р_ and by Fondazione Cassa di Risparmio di Torino (FCRT) in the frame of the bilateral project Piemonte-Russia “Nanotecnologie per le industrie elettromeccaniche, dell’informazione e del medicale (FCRTnano)”.