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Orientational instability of the director in a planar flexoelectric nematic cell with easy axis gliding

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The orientational instability of the director in a planar cell of a flexoelectric nematic liquid crystal (NLC) in a constant electric field oriented perpendicular to the cell plane is theoretically studied [1]. On the surface of one of the polymer substrates, the direction of the axis of easy orientation of the director can change. This change is due to the effect of its original orientation, the liquid crystal and the electric field on the axis of easy orientation of the director. The effect of the electric field is manifested in the reorientation of the elastic parts of the polymer molecules of the substrate due to the interaction of the intrinsic or induced dipole moments with the electric field. The corresponding contribution to the free energy of the NLC cell is considered to be linear or quadratic with respect to the electric field strength, respectively.

It was established that the orientational instability of the director has a threshold in the case of quadratic coupling of the electric field with the axis of easy director orientation and is threshold less in the case of a linear coupling. The temporal behavior of the director's field in the volume of the NLC after switching the electric field on with the subsequent transition of the system to a stationary state (Fig. 1) and a return to the initial homogeneous state after the voltage is turned off was considered. The influence of the values of the system parameters, in particular, the values of the flexoelectric coefficients of the NLC, was studied. It was established that an increase in the values of the flexoelectric coefficients and the coupling parameter of the electric field with the gliding easy axis leads to an increase in the deformations of the director's field and to a decrease in the threshold voltage.

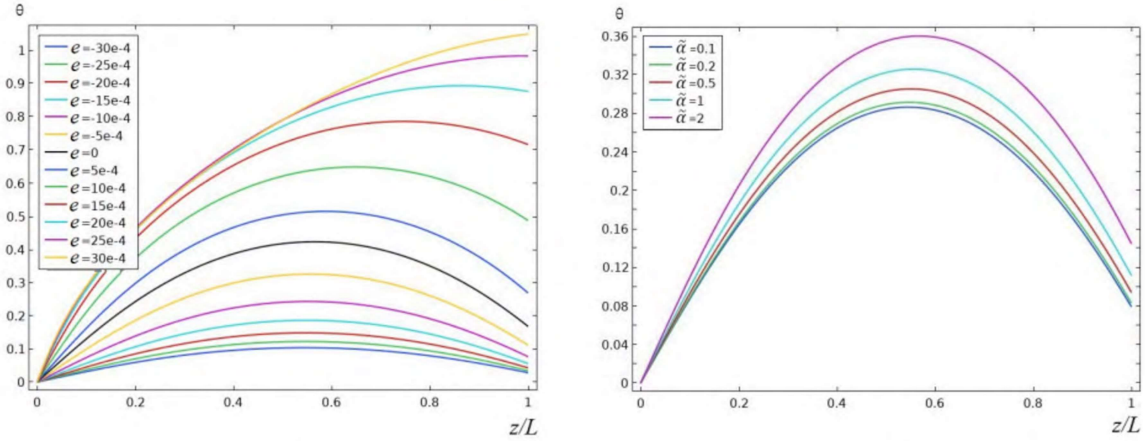

Figure 1. Stationary dependences of the director deviation angle θ on the cell thickness.
(a) $\tilde{\alpha} = \alpha/\sqrt{(\varepsilon_0 \varepsilon_a K_1)} = 1$ - the coupling parameter between the electric field and the easy axis,
(b) $e = e_{11}+e_{33} = -5\times10^{-4}$ dyn$^{1/2}$ - the sum of the flexoelectric coefficients.

The time for the system to reach a stationary state and the characteristic times of switching on and off were calculated, and their dependence on the system parameters was investigated. An increase in the value of the applied voltage leads to an increase in the value of the turn-on time in the case of positive values of the sum of the flexoelectric coefficients of the NLC and to a decrease in the turn-on time for negative values. The conducted theoretical research expands the concept of electrically induced reorientation of NLC cell on the substrate of which the conditions for the director are changed by an electric field.

References:

[1] I.I. Yakovkin, A.I. Lesiuk, M.F. Ledney, V.Yu. Reshetnyak, Journal of Molecular Liquids 363 (2022) 119888.