ELECTRO-OPTICAL PROPERTIES OF IMPERFECTLY ORDERED PLANAR CHOLESTERIC LAYERS

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ABSTRACT
The electro-optical behaviour of imperfectly ordered planar layers of a mixture of 20% cholesteryl chloride and 80% cholesteryl oleyl carbonate (natural pitch $p_0 = 0.37 \mu m$) is discussed. Microscopic observations reveal that these layers consist of a number of uniform planar regions with different pitch ($p \neq p_0$), separated by disclinations. With increasing layer thickness these regions become smaller while the differences in pitch decrease. The electric-field-induced blue shift of the selective reflections is suggested as resulting from a successive distortion of the planar regions. The observed decrease in blue shift with increasing layer thickness, as well as the absence of this shift in regions with uniform pitch, demonstrate the correlation between the blue shift and the field-induced periodic distortion.

I INTRODUCTION
Cholesteric layers with the helix axes perpendicular to the boundaries (planar texture) show a characteristic selective reflection of incident light. The wavelength of maximum light reflection is given by $\lambda_{\text{max}} = n.p$, while the width of the reflection band is of the order $p\Delta n [1,2]$. In these relations $p$, $n$ and $\Delta n$ denote the pitch of the helix, the mean refractive index, the difference between the extraordinary and ordinary refractive index, respectively. Harper
observed a shift of the reflection peak to shorter wavelengths when an electric field was applied parallel to the helical axes. This blue shift in $\lambda_{\text{max}}$, which has been ascribed to a field-induced pitch contraction was studied experimentally in more detail by several investigators [4-7]. This situation of a field parallel to the helices has been analyzed theoretically by Meyer [8] and Leslie [9]. For a cholesteric liquid crystal with a positive anisotropy of the dielectric constant ($\varepsilon_\parallel - \varepsilon_\perp > 0$), Meyer predicts that above a threshold field a conical deformation of the planar texture will occur. This uniform conical deformation is accompanied by a contraction of the pitch resulting in a shift of $\lambda_{\text{max}}$ to shorter wavelengths. The deformation is produced only when $k_{33}/k_{22} < 1$, where $k_{33}$ and $k_{22}$ are the Frank elastic constants for bend and twist, respectively. Leslie's more exact treatment leads to practically the same results, provided that there are many turns of the helix in the layer, i.e. $N = d/p \gg 1$, d being the thickness of the layer.

We have previous [5] measured the blue shift of a mixture of cholesteric esters as a function of the applied electric field. The observed shift was found to be an order of magnitude smaller than predicted by Meyer's theory. Furthermore, the blue shift was preceded by the formation of a periodic grid-like pattern, which indicates that the deformation is not uniform as required by the model. These observations suggest that the observed blue shift is not due to a conical deformation of the texture. Recently [10] we proposed a new explanation in which the shift is not caused by a pitch contraction but results from the field-induced periodic deformation of the planar texture.

In section II a more detailed discussion of the correlation between the periodic distortion and the blue shift is presented, leading to further predictions concerning the blue shift. The material and sample preparation, the measurement of the voltage thresholds for periodic perturbation and the testing of the predictions are discussed in sections III, IV and V, respectively.

**II PERIODIC PERTURBATION AND BLUE SHIFT**

By now it is well known that an electric field can induce periodic perturbations in the planar cholesteric texture [5,11,12]. These instabilities, predicted by Helfrich [13], occur above a threshold voltage $V_c$. For