Reflection spectra of distorted cholesteric liquid crystal structures in cells with interdigitated electrodes

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In cells with interdigitated electrodes (IDEs), the electric field is not uniform when a potential difference is applied between the two sets of electrodes. Because the response of a cholesteric liquid crystal (CLC) material to applied electric fields depends on the direction and strength of the field, the electro-optic response in this type of cell can be complex. We have used a microspectrophotometer to probe various locations in IDE cells and to elucidate the change in optical properties as a function of electric field. Our main focus has been the monitoring of the helix unwinding for CLCs with positive dielectric anisotropy in regions of the cells between the electrodes (gaps), where the electric field is in the plane of the substrate and perpendicular to the helical axis. In these conditions, the pitch is expected to increase and the helical structure to become deformed as the magnitude of the field is increased.1 We will discuss how the variations as a function of applied electric field in the transmission and reflection spectra in the gap regions are strongly dependent on the cell thickness and spacing between electrodes, as these determine the magnitude of the field gradient through the cell thickness.2,3 It is possible to obtain either a uniform unwinding of the helix and progressive red-shift of the selective reflection, or a gradient of pitches in the cell, which leads to broad reflection spectra and different reflection colors depending on which side of the cell is illuminated.

Irrespective of the interdigitated electrodes parameters, because of the deformation of their helical structure accompanying the pitch elongation, Bragg reflections of all orders can become active even for light at normal incidence. We will show that for various CLC mixtures with the main (first-order) reflection in the near-infrared range, second and third-order reflections can be observed easily in the visible range when an electric field of appropriate magnitude is applied. This effect could be exploited to obtain devices that are clear in the visible range in the off-state and that present a reflection band in the on-state, whose position can be tuned by the magnitude of the electric field (see Figure 1).

Figure 1: (a) Reflection spectra in the second-order range for a CLC mixture with main reflection at 950 nm in a cell with IDEs as a function of applied voltage. (b) Optical microscope reflection images (75 µm × 190 µm) of the CLC sample for the same voltages (leftmost image: 0 V, rightmost image: 245 V).

References:


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