Planar Anchoring Strength and Pitch Measurements in Achiral and Chiral Chromonic Liquid Crystals Using 90-degree Twist Cells

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Chromonic liquid crystals are formed by molecules that spontaneously assemble into anisotropic structures in water. The ordering unit is therefore a molecular assembly instead of a molecule as in thermotropic liquid crystals. Although it has been known for a long time that certain dyes, drugs, and nucleic acids form chromonic liquid crystals, only recently has enough knowledge been gained on how to control their alignment so that studies of their fundamental liquid crystal properties can be performed. A simple method for producing planar alignment of the nematic phase in chromonic liquid crystals is described, and this in turn is used to create twisted nematic structures of both achiral and chiral chromonic liquid crystals. Cells in which the alignment directions on the bottom and top substrates are perpendicular cause domains of right- and left-handed twist to form as shown in the photomicrograph below.

Right- and left-handed twist domains in 15 wt% disodium cromoglycate

In each twist domain, the director twists through an angle $T$ and the directors at the surfaces are offset from the alignment direction by an angle $S$ ($T + 2S = 90$ degrees). The optics of these 90-degree twist cells is well known from the early work on twisted nematic LCDs. Thus an investigation of the transmission of polarized light produces measurements of the twist and offset angles, which when combined with elastic theory, allows the anchoring strength to be calculated in achiral systems. This is the first determination of the planar anchoring strength for a chromonic liquid crystal, and for this alignment technique it is quite weak, about $3 \times 10^{-7} \text{ J/m}^2$ for both disodium cromoglycate and Sunset Yellow FCF.

The addition of a chiral amino acid to the system causes the chiral nematic phase to form, and similar optical measurements in 90-degree twist cells produce a measurement of the intrinsic pitch of the chiral nematic phase. From these measurements, the helical twisting power for L-alanine is found to be $(0.011 \pm 0.004) \mu \text{m}^3\text{wt}%^{-1}$ for 15 wt% disodium cromoglycate. Fingerprint textures also allow the helical twisting power to be measured, yielding consistent results. These new helical twisting power determinations clear up an inconsistency in previous measurements using fingerprint textures.

References:

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