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Circularly rubbed liquid crystal cells

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In 2002 Suh et al. devised a highly sensitive method for measuring extremely long pitches in chiral nematics using cells combining one linearly and one circularly rubbed surface [1]. In such circularly rubbed cells (CRC) all cross-rubbing angles [0 - 2π] are simultaneously present. When filled with a nematic liquid crystal two radial disclination lines are formed normal to the linear rubbing. In the case of a chiral nematic the defect lines are azimuthally shifted, and the shift is a measure of the helical pitch of the chiral nematic.
CRCs also constitute a useful tool for studying specific aspects of more complex, i.e. lower symmetry materials e.g. the impact from various amount of cross-rubbing on surface-stabilized ferroelectric smectic C* and antiferroelectric SmC_a* bookshelf structures, and for surface-induced TGB-like smectic structures [3].
Recently, CRCs have proven highly valuable also for studies of ferroelectric nematics, for example revealing the polar nature of the ferroelectric nematic (N_F) phase [4], the antipolar nature of the antiferroelectric smectic Z phase [5], and the in-plane polar surface anchoring of N_F on rubbed polymer surfaces. Furthermore, modified CRCs, where the linear alignment was imposed by obliquely evaporated SiO_2, (ECRC) revealed two-fold polar alignment of N_F on such surfaces [6].
The CRC geometry not only imposes a varying nematic director twist in the cell area but also creates splay and bend deformations in the bulk director field. From the positions of defect lines and domain walls one should, at least qualitatively, be able to estimate ratios between elastic constants of N_F materials. Our experimental and theoretical studies of CRCs/ECRCs filled with N_F materials show that the domain structure in N_F is affected by the alignment first adopted at the isotropic to nematic transition, the electrostatic avoidance of splay, surface pretilt, and polarization driven twist [7].

Here we summarize some of our work on using CRCs for studies of various liquid crystal systems, with special focus on ferroelectric nematics.

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