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Electrostatic reconfiguration of photo-patterned periodic structures with half-integer twist disclination lines in ferroelectric nematic liquid crystals

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Ferroelectric nematic (N_F) liquid crystals (LCs) exhibit strong spontaneous polarization **P** along the local director **n**, breaking the **n** = **-n** inversion symmetry of the conventional nematic (N) LC phase. Consequently, half-integer topological defects, which are topologically allowed in the apolar N phase, become complex structures in the polar N_F phase, necessitating the formation a polarization reversal wall (PRW) or surface-pinned defects (Fig. 1b) [1, 2]. We investigate half-integer twist disclinations in the N and N_F phase using cells featuring a uniform alignment layer on the top surface and a 1D periodically rotating anchoring on the bottom surface (Fig. 1a) [3]. These specific anchoring conditions induce a twist conflict, generating a periodic array of half-integer twist disclination lines.

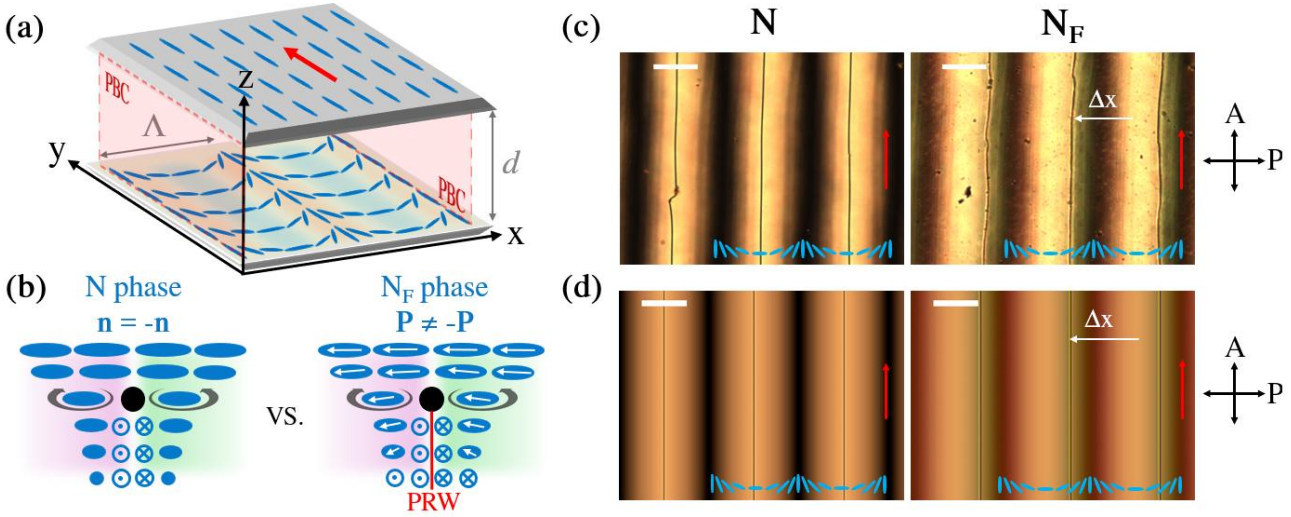

Figure 1: ***(a)*** *Cell geometry with periodically rotating anchoring on the bottom surface and uniform anchoring on the top surface.* ***(b)*** *Molecular configuration at the half-integer topological defect in N phase and N_F phase. Polarized optical microscopy images of N and N_F phase domain formation in a 5.8 µm thick cell* ***(c)*** *compared with optical simulations* ***(d)****, scale bar represents 50 µm.*

While the paraelectric N phase exhibits an optically symmetric texture with centrally localized defects, the transition to the N_F phase in RM734 drives a lateral displacement Δx of the disclination lines, creating a distinct asymmetric optical texture (Fig. 1c) observed with polarized optical microscopy. Through optical simulations (Fig. 1d), we demonstrate that the system adopts this asymmetric configuration to increase the amount of twist in the bulk, thereby decreasing the electrostatic self-energy. Experiments with RM734 doped with 0.5 wt% ionic liquid (BMIM-PF_6) confirm this electrostatic driving force, as mobile ions screen the bound charges and significantly suppress the reconfiguration. Finally, a comparison with alternative N_F materials reveals other stable topologies, including the observation of polar 2π-twist disclinations. These results offer important physical insights for engineering complex polar structures in ferroelectric nematic LCs.

References

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