Contribution ID: **128** Type: **Poster**

A ferroelectric liquid crystal confined in cylindrical nanopores: Reversible smectic layer buckling, enhanced light rotation and extremely fast electro-optically active Goldstone excitations

Tuesday, 15 May 2018 17:45 (15 minutes)

The orientational and translational order of a thermotropic ferroelectric liquid crystal (2MBOCBC) imbibed in self-organized, parallel, cylindrical pores with radii of 10, 15, or 20 nm in anodic aluminium oxide monoliths (AAO) are explored by high-resolution linear and circular optical birefringence as well as neutron diffraction texture analysis. The results are compared to experiments on the bulk system. The native oxidic pore walls do not provide a stable smectogen wall anchoring. By contrast, a polymeric wall grafting enforcing planar molecular anchoring results in a thermal-history independent formation of smectic C*helices and a reversible chevron-like layer buckling. An enhancement of the optical rotatory power by up to one order of magnitude of the confined compared to the bulk liquid crystal is traced to the pretransitional formation of helical structures at the smectic-A*-to-smectic-C* transformation. A linear electro-optical birefringence effect evidences collective fluctuations in the molecular tilt vector direction along the confined helical superstructures, i.e. the Goldstone phason excitations typical of the para-to-ferroelectric transition. Their relaxation frequencies increase with the square of the inverse pore radii as characteristic of plane-wave excitations and are two orders of magnitude larger than in the bulk, evidencing an exceptionally fast electro-optical functionality of the liquid-crystalline-AAO nanohybrids.

References

M. Busch et al., Nanoscale (in press) 2017 DOI: 10.1039/C7NR07273B

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Session Classification: Poster 2

Track Classification: MS 1.12: Fluids in Nanoporous Media