X-Ray Diffraction Reveals the Consequences of Strong Deformation in Thin Liquid Crystal Smectic Films

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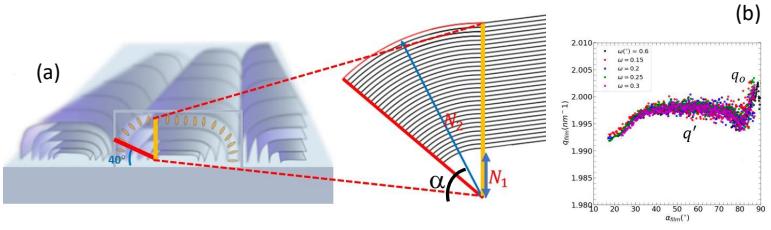
ABSTRACT

From a theoretical perspective, the smectic phase provides an arena to systematically study the effects of nonlinear elasticity via fluctuations [1] topological defects (where the distortions can be large) [2], and, as we will demonstrate here, even in complexions arising from antagonistic boundary conditions. By studying regions of high layer curvature via Grazing Incidence Small Angle X-ray Scattering (GISAXS) we have measured, with spatial resolution, the layer spacing and find that it is accurately described by the nonlinear response of bent layers under antagonistic anchoring [3].



We form smectic layers bend into arrays of flattened hemicylinders (Figure (a)). The high-resolution X-ray measurements for a film thickness 180 nm allow to determine the wave-vector value q = 2π/d - d being the intralayer spacings - as a function of α the layer normal orientation (Figure (b)). q' for curved layers with α < 85° is smaller than q_o for central layers with α = 89° -in yellow in Figure (a)).

We minimized the non-linear elastic energy of one given hemicylinder to show that a dilation is induced in the curved layers to relieve the large bending energy. Calculated and measured average dilations perfectly agree [3]. This dilation is a direct consequence of the smectic non-linear elasticity. It may occur in all lamellar systems of small curvature radius.

REFERENCES

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