Heliconical nematic and smectic phases formed by achiral molecules

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Spontaneous mirror symmetry breaking attracts a lot of attention among researchers working in soft matter science. Recently, such a phenomenon was found in fluidic phases, either isotropic liquid or liquid crystalline nematic phase showing only orientational order of molecules. It was shown, that although built of achiral molecules, the nematic phase can exhibit structural chirality – average molecular direction follows a short-pitch helix.

Here, we present a series of achiral asymmetric dimers with an odd number of atoms in the spacer, which form twisted structures not only in nematic phase but also in a phases with limited, one-dimensional positional order – smectic C and hexatic smectic I phases [1]. The formation of a variety of helical structures is accompanied by a gradual freezing of molecular rotation. The tight pitch structure of heliconical nematic (N_{TB}) phase and heliconical tilted smectic C (SmC_{TB}) phase is proved by resonant soft X-ray diffraction studies, performed with X-ray radiation energy tuned to carbon absorption edge.

In the lowest temperature smectic phase, HexI, the tendency to twist deformation is expressed through the formation of hierarchical chiral structures: nano-scale helices and mesoscopic helical filaments.

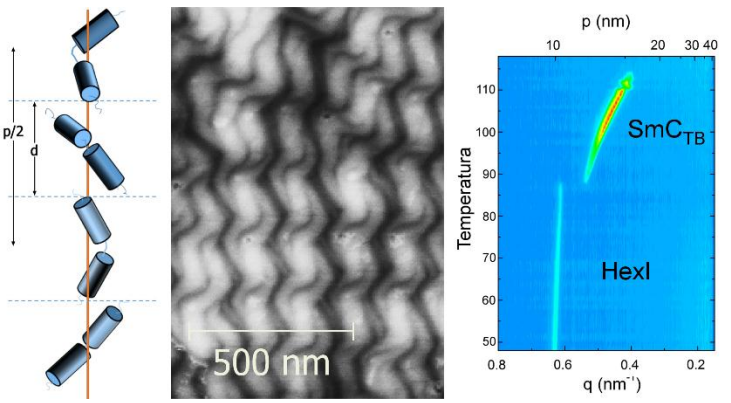

Fig. 1 *left*: model of SmC_{TB} phase; *middle*: AFM image of HexI phase registered at room temperature, showing twisted filament morphology; *right*: temperature evolution of resonant X-ray diffraction pattern in the SmC_{TB} and HexI phases of homologue n = 7.

[1] J. P. Abberley, R. Killah, R. Walker, J. Storey, and C. T. Imrie, Nat. Commun. 228 (2018).

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