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Self-organized arrays of topological defects in thin smectic liquid crystal films

Abstract

Combining optical microscopy, synchrotron X-ray diffraction and ellipsometry, we studied the internal structure of linear defect domains (oily streaks) in films of smectic liquid crystals 8CB with thickness 100 - 300 nm confined between air and a rubbed PVA polymer substrate which impose hybrid anchoring conditions (normal and unidirectional planar, respectively). I will show how the presence or absence of dislocations control the structure of highly deformed thin smectic films. Each domain contains smectic layers curved in the shape of flattened hemicylinders to satisfy both anchoring conditions, together with grain boundaries whose size and shape are controlled by the presence of dislocation lines. A flat grain boundary normal to the interface connects neighboring hemicylinders, while a rotating grain boundary (RGB) is located near the axis of curvature of the cylinders. The RGB shape appears such that dislocation lines are concentrated at its summit close to the air interface. The smectic layers reach the polymer substrate via a transition region where the smectic layer orientation satisfies the planar anchoring condition over the entire polymer substrate leading to an additional 2D defect between an horizontal smectic layer and perpendicular ones, which may be melted, in order to avoid the creation of a transition region structure composed of a large number of dislocations.

As a result, linear defect domains can be considered as arrays of oriented defects, straight dislocations of various Burger vectors, whose location is now known and 2D nematic defects. I will also discuss the possibility of easy variation between the present structure with a

moderate amount of dislocations and a structure with a large number of dislocations and I will show how this array of defects can control the assembly of nanoparticles embedded in the distorted smectic film.