Supplemental Information
Freely-Suspended Nematic Films and Free-Standing Smectic Filaments in the Ferroelectric Nematic Realm

Keith G. Hedlund, Vikina Martinez, Xi Chen, Cheol S. Park,
Joseph E. Maclennan, Matthew A. Glaser, and Noel A. Clark

Department of Physics, University of Colorado, Boulder, Colorado, 80309, USA

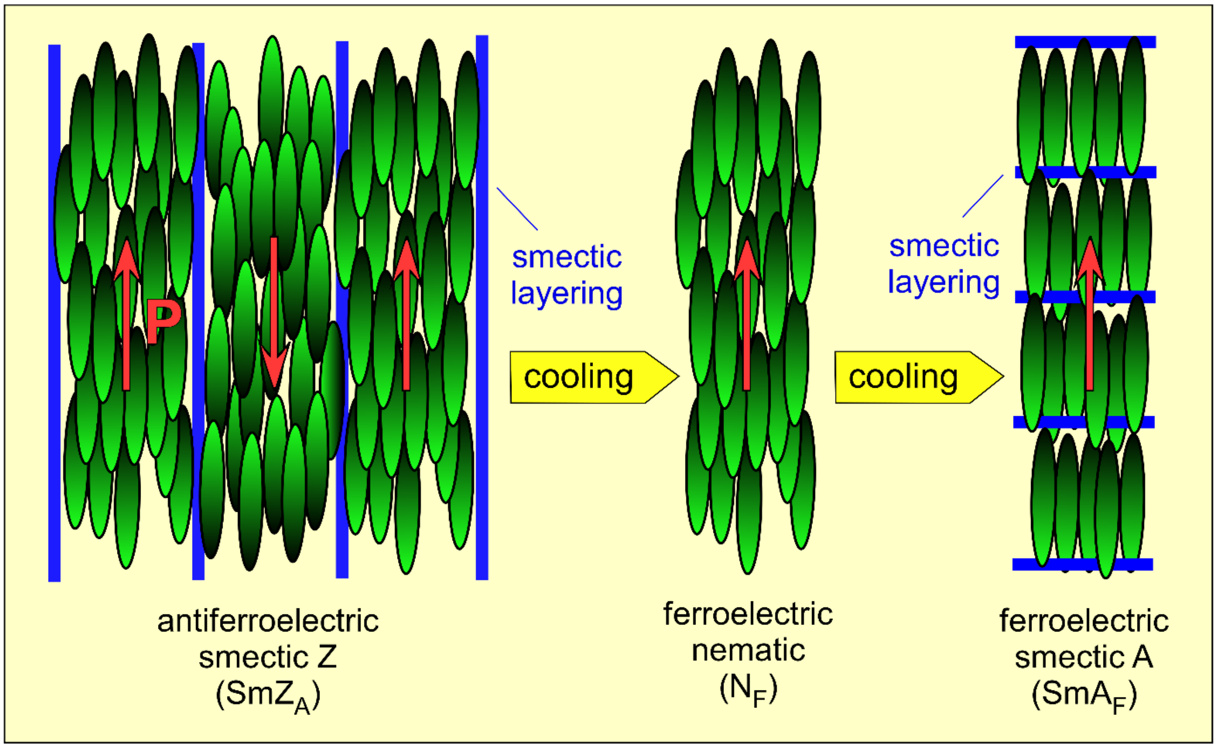

Figure S1. Three polar phases of the ferroelectric nematic realm. The SmZ$_A$ is an antiferroelectric, lamellar phase with the polarization **P** parallel to the layers and alternating in direction from layer to layer. The N$_F$ is the ferroelectric nematic phase, with the polarization uniform along the director. The SmA$_F$ is a ferroelectric, lamellar phase with the polarization also along the director.

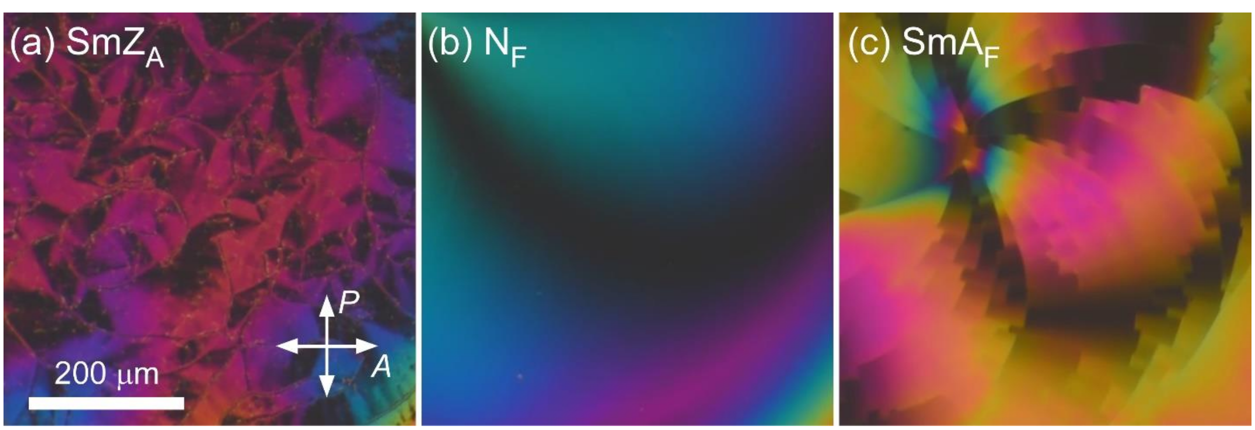

Figure S2. Typical textures of a freely suspended film of a 50:50 wt% mixture of AUUQU2N (2N) and DIO in the (a) SmZ$_A$ (85°C), (b) N$_F$ (68°C), and (c) SmA$_F$ (45°C) phases, viewed in transmission through crossed polarizers.

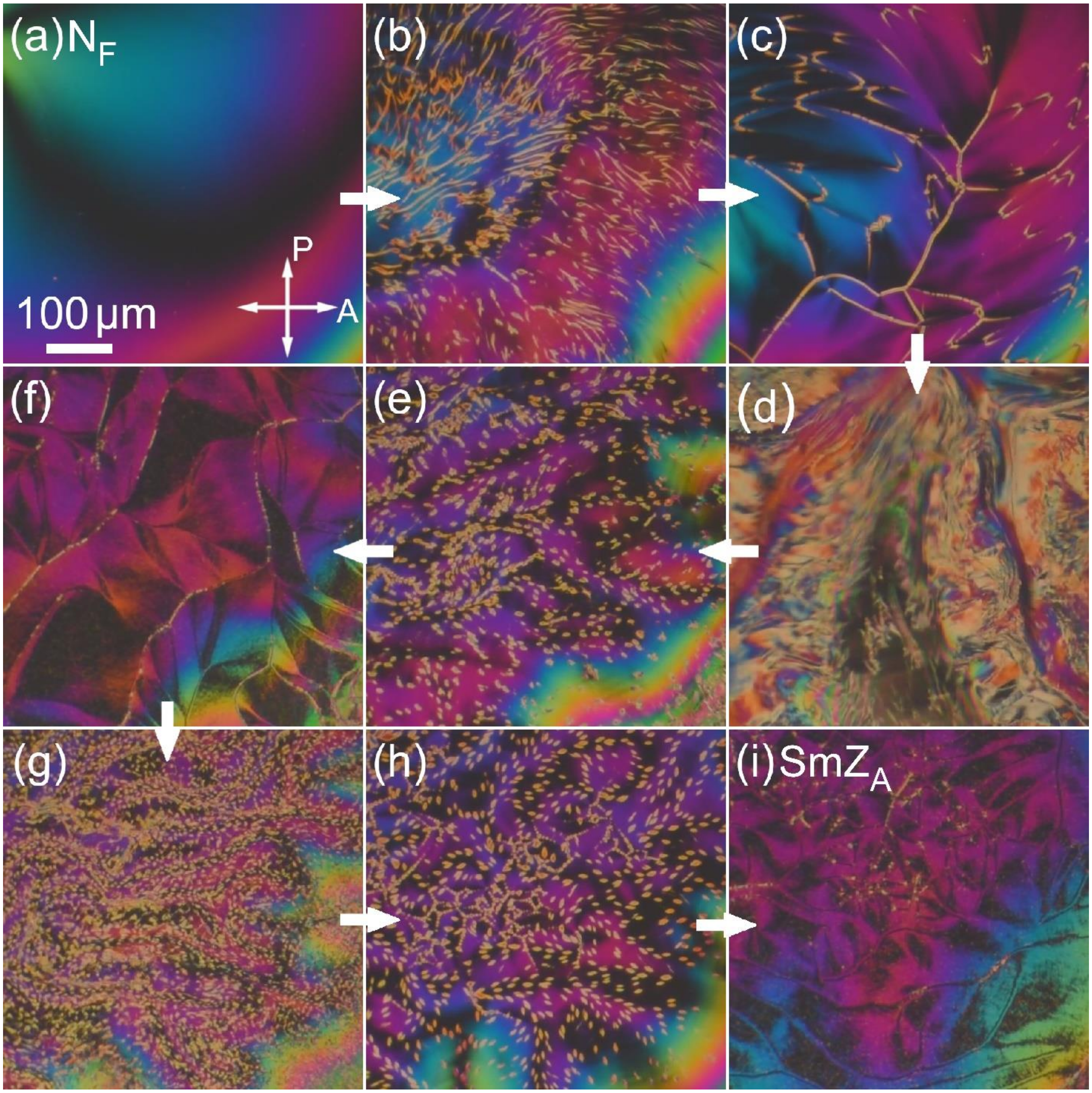

Figure S3. Transient texture observed in a slowly heated freely suspended film of a 50:50 wt% mixture of AUUQU2N (2N) and DIO at the transition from the N_F to the SmZ_A phase, at around 87°C. Small fluctuations in the film temperature in the vicinity of the transition result in the rapid, repeated formation and disappearance of the small, orange "rice grain" features that are characteristic of this first-order transition. Similar behavior can be seen both on heating, as in this sequence, and on cooling.

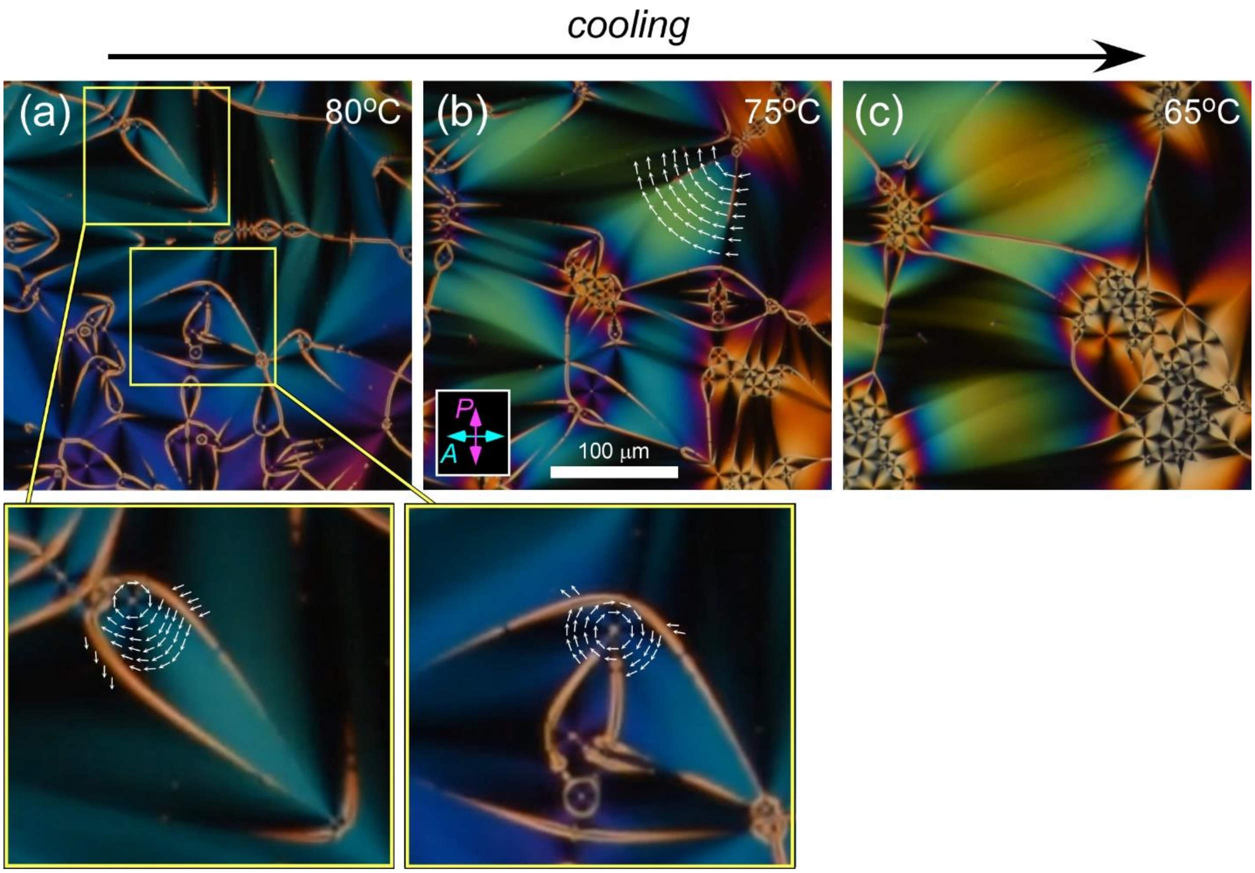

Figure S4. Point and line defects on a freely suspended smectic film of a 50:50 wt% mixture of AUUQU2N (2N) and DIO cooled at -10°C per minute in the N_F phase. The polarization fields for two of the parabolic defects in (a) are sketched below the main figure. On cooling, the point defects assemble into clusters and the film in their vicinity becomes significantly thinner.

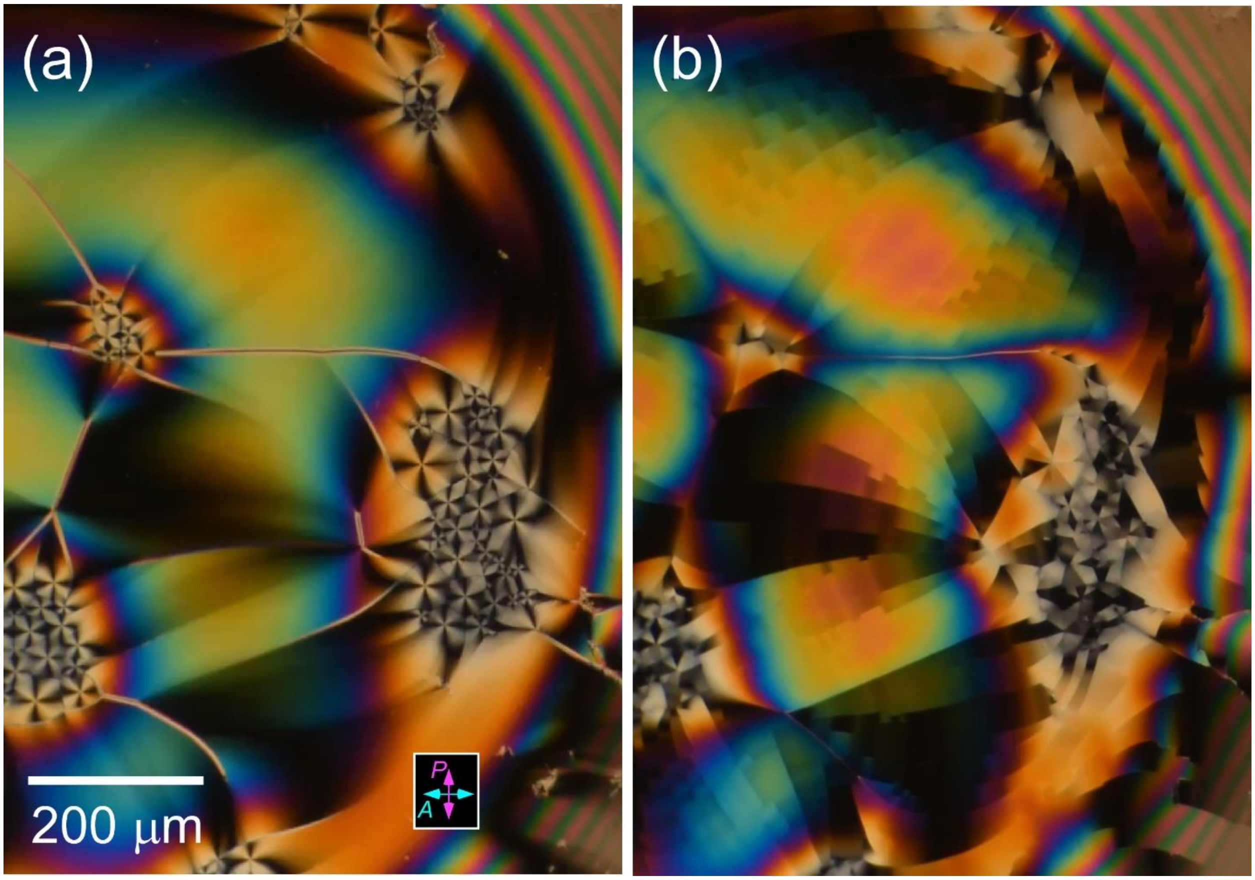

Figure S5. Formation of grain boundaries and evolution of a cluster of point defects in adjacent regions of a freely suspended smectic film of a 50:50 wt% mixture of AUUQU2N (2N) and DIO cooled at -10°C per minute from (a) the N_F phase (65°C) to (b) the SmA_F phase (45°C).

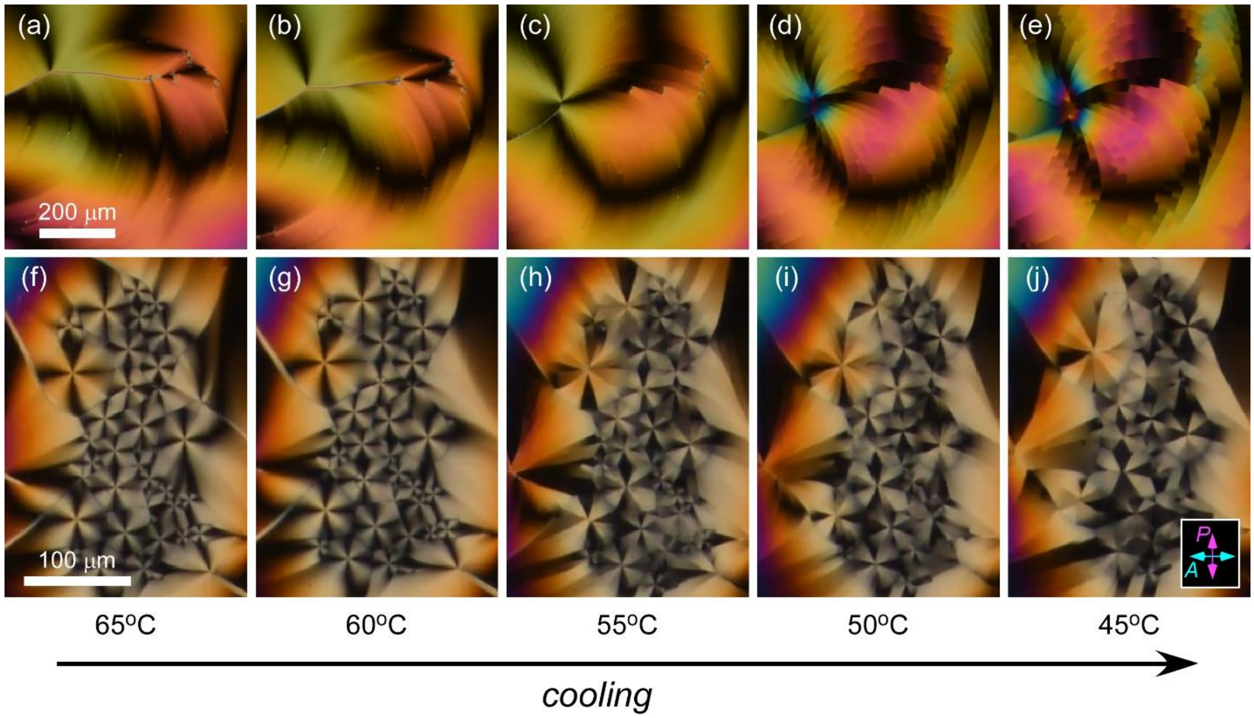

Figure S6. Detailed view of the formation of grain boundaries (a–e) and evolution of a cluster of point defects (f–j) in adjacent regions of the freely suspended smectic film shown in Fig. S3, cooled at -10°C per minute from the N_F phase (a,f) to the SmA_F phase (e,j).

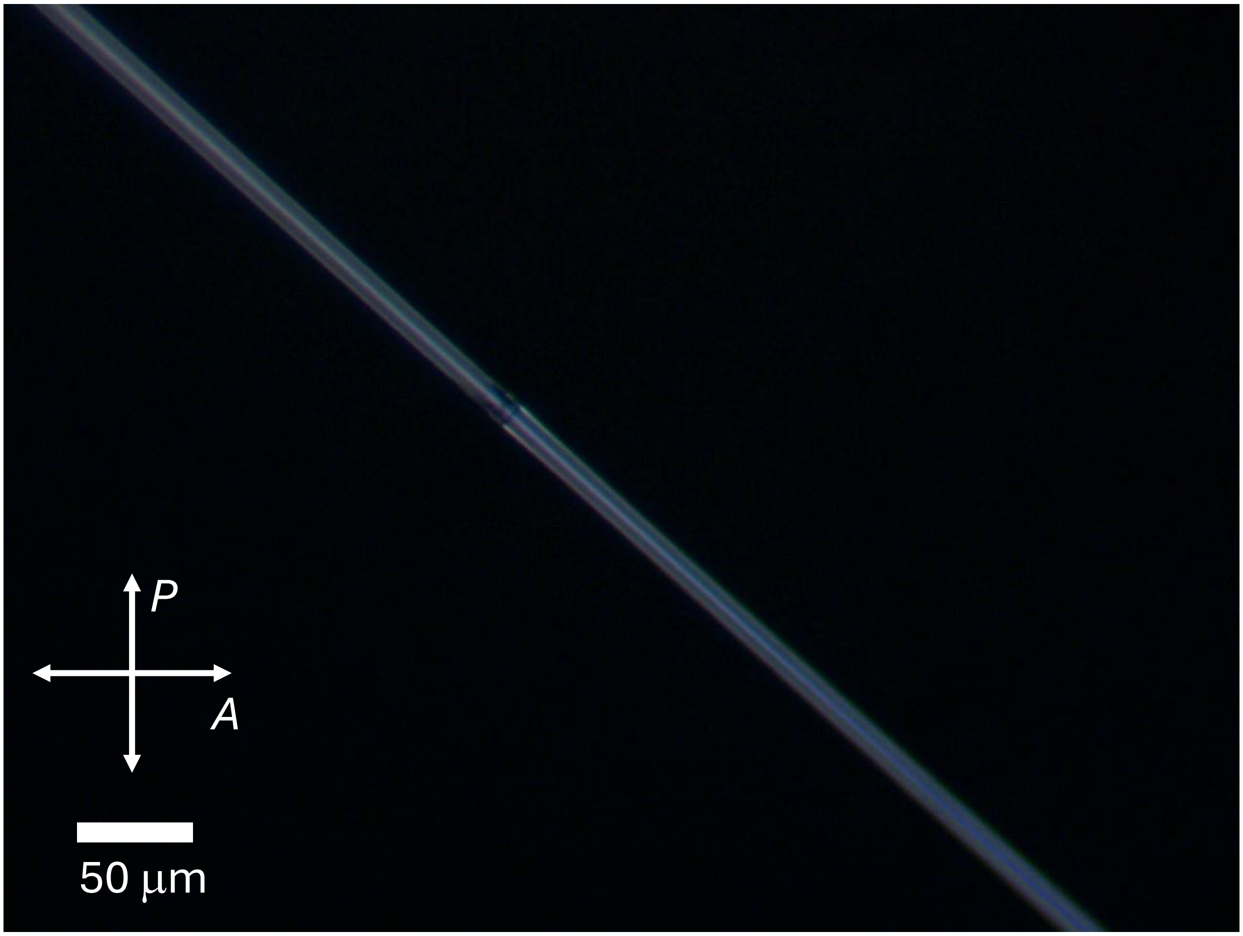

Figure S7. Typical section of a long, thin SmA_F filament of a 50:50 wt% mixture of AUUQU2N (2N) and DIO at 35°C, viewed in reflected light at 20x magnification. This filament is approximately 4 mm in length and about 10 microns in diameter. The bright centerline is a reflection from the top surface of the filament. The narrow, dark band near the middle of the image corresponds to a conical region mediating a small change in filament diameter.

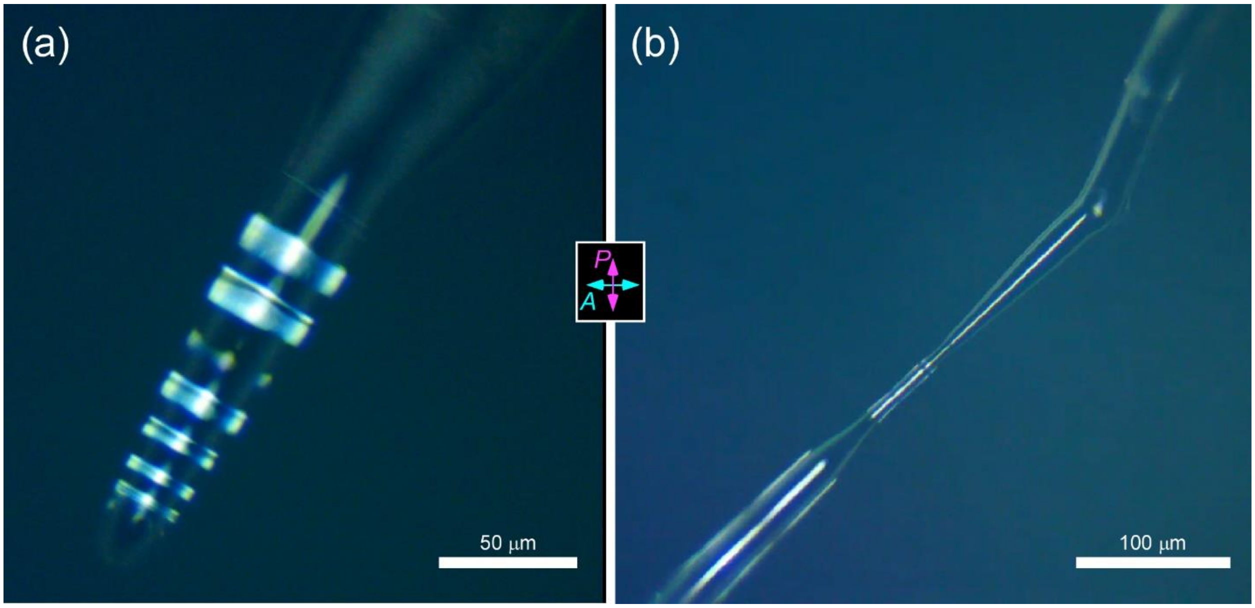

Figure S8. SmA$_F$ filaments of a 50:50 wt% mixture of AUUQU7N (2N) and DIO at 35°C, viewed in polarized reflected light at 20x magnification. The filaments show the typical banded textures and variations in reflectivity associated with changes in diameter and filament orientation. The upper part of the filament in (b) appears dark because it is bent downward, out of the image plane.

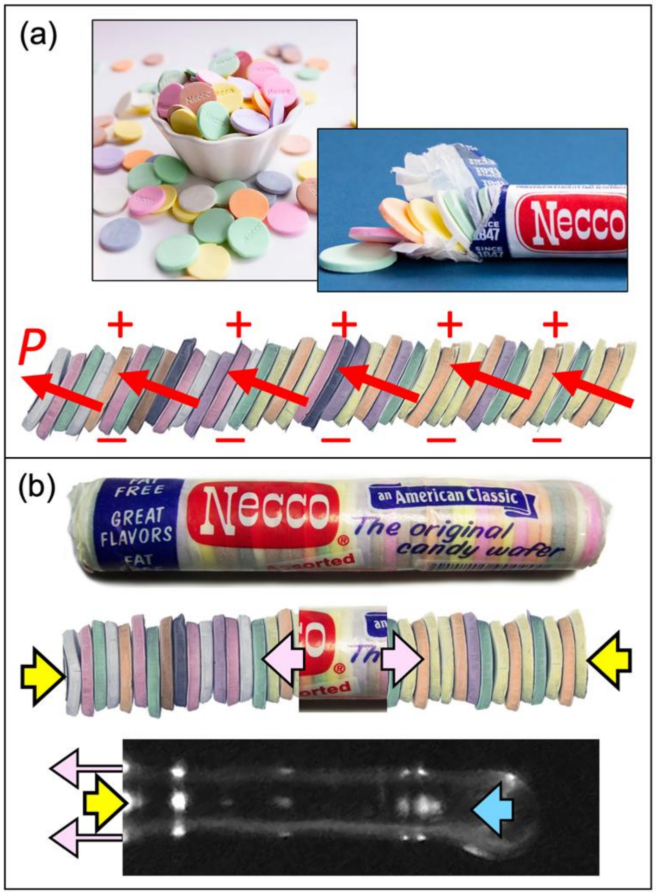

Figure S9. New England Confectionery Company candy wafers. (a) These disc-like, edible wafers are non-adhesive when dry but are frictional like chalk, making them also useful as building toys or as stacked tokens for games. (b) The wafers are arranged in single, columnar stacks in a gossamer-like paper tube, as shown. This packaging is robust, in spite of the lightweight nature of the tube. During production, the wafers are slipped into the tube and then compressed slightly on the ends (yellow forces). The tube is then crimped shut on the ends, in the process of which it is stretched by a small amount. This results in a dilative force (pink force, equal in magnitude to the yellow force) transmitted along the tube from end to end, which in turn puts the stack permanently under weak axial compression. This force suppresses the tilt of the wafers seen in (a), effectively minimizing the length of the stack (comparing the images in (a) and (b)). The actinic (axial) pink force stretches the cylindrical tube parallel to its axis, tending to keep its paper wall taut eveywhere and parallel to the axis, generating stresses that suppress relative displacement of the wafers in directions normal to the axis and keep them lined up next to each another. In an LC filament, shown in the final graphic, the equivalent of the dilative force is provided by surface tension (pink arrows), which also keeps the cross-section of the filament circular. The blue arrow represents Laplace pressure due to the surface tension around the bulbous free end of the filament.