Reorientation Processes in Smectic-*A* Elastomers

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Smectic-*A* elastomers combine the positional long-range order of mesogenic molecules in one dimension with the rubber elasticity of a polymer network. By applying mechanical fields, the director can be oriented macroscopically, and with a second cross-linking step a permanently stable monodomain can be obtained (1, 2).

Nishikawa *et al.* observed a huge anisotropy of the mechanical properties in smectic-*A* elastomers. Upon deformation along the layer normal a linear stress-strain response was found with a modulus two orders of magnitude larger than in the direction of the layer planes. After a critical threshold strain, the material becomes softer and a reorientation of the layer structure sets in (3). The reorientation behaviour was described in elastic theories as a layer undulation (4) and a layer rotation, where layer normal and director are rigidly locked (5). However, in chiral smectic-*A* elastomers the director and the layer normal can be manipulated independently by an electrical field, which suggests that they are not necessarily locked (6). A generalised theory of smectic-*A* rubber elasticity predicts such relative rotations also for non-chiral networks, since rubber elastic energies are usually larger than those of electrical fields (7, 8).

A macroscopical orientation of smectic-*A* elastomers is often difficult, since a uniaxial mechanical field may not be sufficient to align the director and the layer normal simultaneously. Therefore we have synthesised new macroscopically ordered networks by systematically inducing a high-temperature nematic phase in which the orientation is obtained easily. We present high-resolution X-ray measurements under strain (taken at beamline BW4 of HASYLAB, DESY), revealing that the linear regime in the stress-strain experiment can be attributed to changes in the layer spacing and that a layer rotation sets in at the threshold strain.

Furthermore we performed X-ray measurements under shear strain applied in the layer plane, which clearly show the development of a macroscopic, smectic-*C* like tilt.

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