Effect of Aerogel Confinement on the Smectic A to Smectic C Transition

N.A. Clark and A.G. Rappaport
Department of Physics
University of Colorado
Boulder, CO 80309, U.S.A.

Liquid crystals (LCs), by virtue of their fluidity, soft elasticity, and experimental accessibility offer exceptional opportunities for the study of the structural and dynamical effects of quenched disorder, which can be readily introduced, for example, by confinement within appropriate random porous media. We present a study of the effects of confinement in SiO_2 aerogel on smectic layering: one-dimensional (1D) crystal ordering of fluid layers in three dimensions. The smectic structure, the material having the simplest positional ordering, described by the two-component order parameter $\Psi e^{i\phi}$, where ϕ describes the layer positions, is the most easily deformed periodic structure and is therefore significantly affected by disorder. In the smectic A phase rod-shaped molecules are on-average normal to the layers, and in the smectic C they adopt a collective tilt. A consequence of the molecular tilt is a large susceptibility for layer compression (but not for dilation) in the vicinity of a second order SmA to SmC transition, and a shrinkage of the layers in the SmC phase. X-ray diffraction from the layering of the materials 8S5 and W371 shows remarkable effects of this elastic asymmetry on layer structure near the SmA to SmC transition, including a localized condensation of the phase ϕ into layer spacings of high susceptibility. The work is supported by NSF Grant DMR 0072989, and 0213918.