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Layering and Tilting of Long Molecules in a Random Environment: 8S5 in an Aerosil Dispersion

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Beamline(s): X20A

Introduction: The nematic to smectic A (layering and smectic A to smectic C (tilting) transitions in 8S5 were studied in a porous random environment. 8S5 is a key liquid crystal system because, in the smectic A phase there is a very large difference between the correlation length perpendicular to the layers and parallel to them. This results in a highly asymmetric X-ray powder diffraction line-shape. Additionally 8S5 is interesting because it is a non-polar liquid crystal and because the tilting transition has been studied in this environment.

Methods and Materials: The porous random environment is created by a dispersion of aerosols, 70Å diameter silica spheres, which exert a pinning field on the liquid crystal. The spheres are coated with hydroxyl groups and hence hydrogen bond together to form a network of filaments. 8S5 was studied using a small-angle X-ray diffraction with seven different densities of aerosols in the temperature range 80ºC to 40ºC.

Results: Our results show that the smectic A ordering (layering) of a non-polar material is less perturbed by the aerosils than other polar materials. This is presumably due to weaker anchoring to the silica. The line-shape in the smectic A phase shows the anticipated asymmetry. The results of our studies on the smectic C (tilted) phase were unexpected. The transition temperature was much more strongly reduced by the random environment than that of the layering transition; the mean-field temperature dependence and saturation value of the order parameter were unperturbed while the asymmetry of the line-shape changed systematically as a function of aerosil density. These results provide important pointers to the effect of a porous random environment on liquid crystal properties.