Properties of a liquid crystal (8CB) confined into unidirectionnal nanopores

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The advancement of nanotechnologies in an increasing number of fields - including microfluidics, biotechnology, nanoelectronics - supports the growing interest of the scientific community in the understanding of the peculiar properties of systems of nanometer scale dimensions. A subject of current matter concerns the effects of confinement of molecular phases in mesoporous materials. The question of the phase behavior of fluids in restricted geometries is especially rich, leading to the occurrence of new phases or modifying the nature of the transition (order or critical scaling). Liquid crystals have been commonly used as model systems in statistical mechanics and soft matter physics [1]. Experiments on phase transitions in liquid crystals have provided many of the most detailed tests of the modern theories of critical phenomena.

In this contribution, we have introduced porous silicon (p-Si) as a way to control some conditions of confinement that provide an unique opportunity to check the effect of quenched disorder in strongly anisotropic geometry on both structural and dynamic aspects. p-Si displays a well-defined geometry with a preferential alignment (1D) of nanochannels (diameter: 300 Å, length: 30 μm).

The confinement of a liquid crystal (8CB) in p-Si shows interesting novel features related to a striking behavior of the Nematic-Smectic A transition. Various experimental techniques

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(neutron scattering, spectroscopic ellipsometry), demonstrated a preferential alignment of the molecules into the channels and the destruction of the quasi-long range order of the Smectic A phase. The transition is replaced by a progressive short range ordering which is well interpreted in the theoretical context of random fields, according to the disordered nature of the inner pore surface of p-Si [2].

By incoherent quasielastic neutron scattering, we have monitored the temperature variation of the molecular dynamics of the confined fluid. A strongly reduced mobility is observed at the highest temperatures in the liquid phase, which suggests that the interfacial molecular dynamics is strongly hindered [3]. A continuously increasing slowdown appears on cooling together with a progressive growth of the smectic static correlation length.

References

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