Computer simulation of a model nematic in a porous system

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Nematic liquid crystals embedded in porous systems exhibit a number of anomalous properties. They are often modelled in terms of random local ordering fields, by analogy with random anisotropy magnets in which also the real local order is spatial. These models, and hence the systems themselves, have much in common with glasses. They are thus expected to show significant history-dependent effects. Two model systems in this genre which have attracted significant recent interest are the RAN and SSS (sprinkled silica spin) lattice models. The RAN model is a Lebwohl-Lasher lattice model with locally coupled nematic spins, together with uncorrelated random anisotropy fields at each site, while the SSS model has a finite concentration of impurity spins frozen in random directions. Here Brownian simulation is used to study the effect of different sample histories in the low temperature regime in a three-dimensional (d = 3) model intermediate between SSS and RAN, in which a finite concentration $p < p_c$ (p_c the percolation threshold) of frozen spins interacts with neighboring nematic spins with coupling W. We compare the phase behavior of systems quenched in zero ordering field and high ordering fields to that of systems which have been annealed. Depending on the method of cooling, there are three possibilities for zero-field phases. These are phases with: (a) long-range order (LRO), (b) algebraic order (quasi-long-range order QLRO) , or (c) short-range order (SRO). In the last case, however, the range of the order is much larger than the impurity separation, and the correlation length depends on the ordering fields according to the well-known Imry-Ma relation. We also present hysteresis curves which show history-dependence.