The Physics of Soft and Biological Matter

Phase diagrams for magnetic nanofilaments

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Artificial magnetic filaments can be obtained by mutually linking magnetic colloids to form a chain. These magnetic chains represent the equivalent of magnetic polymers but at supra-molecular scale. In difference to one-dimensional chemical magnetic polymers which only manifest their magnetic properties at $T < 100K$, magnetic nanofilaments can retain their magnetism at room temperature and zero field.

The emerging interest in this relatively novel field is due to the fact that magnetic nanofilaments are very appealing from the technological point of view. They can be thought as improved substitutes of current ferrofluids, or as elements for magnetic memories, chemical and pressure nanosensors, nano-propellers, elements of nanopumps, non-permanent photonic crystals, or as generators of unique patterns able to provide watermarks to authenticate cards or other documents, to just mention a few possible applications.

In this contribution we will present the results of our ongoing numerical and theoretical studies[1–3] of flexible and semiflexible magnetic filaments for different physical environments. As an example of it, we will provide insight into the determination of the phase diagrams at zero field for magnetic filaments in which monomers exhibit short-range LJ attractive interactions (Stockmayer polymers, i.e. filaments in poor solvent conditions) in the limit of strong dilution, as well as filaments in good solvent conditions. The cases of magnetic chains in bulk (see figure 1) and near attractive surfaces will be thoroughly explored. Phase diagrams for those systems have been observed to exhibit a rich variety of new phases when compared with the phases for non-magnetic chains in similar environments.

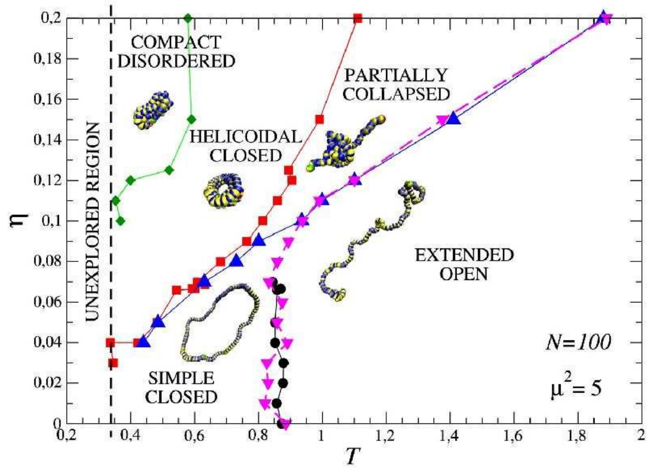

FIG. 1. A tentative phase diagram for magnetic filaments of length N=100, and a dipole moment per monomer of fixed strength $\mu^2 = 5$.

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