On the self-assembly of net-like nanostructures in ferrofluids

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Abstract

Understanding the physical forces that govern nanoparticles self-assembly is central to the ability to engineer super-nanostructures for advanced nanotechnology applications. Magnetic force represents one of such important forces that is responsible for structural transformations and condensation in ferrofluids (FF). In this work, we study internal structural transformations in FF in the absence of external magnetic field by introducing the first direct statistical model that takes into account formation of linear chains, Y-forks and net-like nanostructures. The results show that, in agreement with experiments, when the concentration of the magnetic nanoparticles and their magnetic interaction energy are small enough, majority of the particles are united in individual linear chains. But, when these parameters exceed some threshold magnitude, the main particles population switches to net-like nanostructures. These results highlight the importance of magnetic dipole interactions in the absence of external magnetic field, and their essential role in the bottom-up construction of hierarchical nano-architectures of viable fundamental and practical implications. (C) 2015 Elsevier B.V. All rights reserved.

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