Assembly of Anisotropic Magnetized Particles

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Abstract

The assembly of permanently magnetized particles has recently gained attention for applications such as drug delivery, cancer treatment, fabrication of materials with tunable properties, nanorobots, etc. The point dipole model has been used to quantify the interactions between magnetized particles, but different studies suggest that this model is not valid for anisotropic shapes. Our approach implements the dipolar interaction between ellipsoids on Monte Carlo simulations to analyze the behavior of a dilute system of monodisperse and binary systems composed of spheres and ellipsoids, varying the field strengths and dipolar interaction strengths, under equilibrium conditions. We validated the simulation results of a dilute suspension without dipolar interactions with the Langevin model. We quantified the effect of the dipolar interactions on the monodisperse and binary suspension magnetization, and the local arrangement between particle neighbors. The self-assembly process at high dipolar interactions shows close-loop and ring-like structures in the spherical system, dendritic structures for ellipsoids, and sandwich-like chain structures in the binary mixture. On the other hand, in the directed assembly at high dipolar interactions, spheres form linear chains, ellipsoids form barbed-wire chains, and binary mixtures form branched chains with the individual components. Furthermore, results show that a binary system promotes fragmented chains compared to the monodisperse systems. Overall, results show the role of shape anisotropy on the self and directed assembly of magnetized particles composed of a binary system compared to monodisperse systems of spheres or ellipsoids.

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