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Impact Of Particle Size And Substrate Affinity On Cobalt Nanoparticles Self-Assembly

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Abstract

Colloidal dispersed nanoparticles (NPs) self assemble into complex structures when segregated from the solvent either by evaporation or precipitation. Thus, different micro and macroscopic structures like opals, fractals, anisotropic structures and others formed by NPs are observed as a result of the balance between electrostatic forces, surface tension, entropy, topography, substrate affinity, among others, and evidently, the size, shape and concentration of the particles. In the case of magnetic NPs, the magnetic properties arise from the competition between short and long-range interactions. These competing interactions favour parallel alignment of distant spins, forming magnetic domains in 'bulk' magnets. In addition, the dipolar magnetic interactions, add a new term in the interactions balance.

The self-assembly (SA) process and mechanisms that control it are not well understood accurately. Its technological interest is evident but until the moment the most remarkable results have achieved in amorphous carbon membranes and only in some case on technological substrates which its repercussion is called to being of great relevance in an immediate future. In this complex context, the study of the self-assembly processes of cobalt NPs onto different substrates gives the opportunity to study down to the minutest detail the balance between NP-NP and NP-substrate interactions.

We observed different spontaneous SA of the particles depending of the size of the particles, in fact depending on their superparamagnetic behavior. Besides, large monolayer areas of cobalt NPs and different micro and macroscopic structures, resulted from the evaporation of a solution of cobalt NPs, were observed on different substrates. These structures give a conceptual framework to study the magnetic properties of both the material at the nanometric level and at the macroscopic level on the obtained structures. This is relevant, not only to built up super-structures for specific applications, like compact monolayers for magnetic recording media, but also to elucidate the behavior of NPs in liquid media, often out of equilibrium, aiming to disperse them in biological media.