MAGNETIC PROPERTIES OF SELF-ASSEMBLED COBALT NANOPARTICLES CRYSTAL SUPERLATTICES

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Colloidal dispersed nanoparticles (NP) could self assemble into complex structures when segregated from the solvent either by evaporation or precipitation in adequate conditions. Thus, different micro and macroscopic structures like opals, fractals, anisotropic structures and others formed by nanoparticles can be obtained as a result of the balance between electrostatic forces, surface tension, entropy, substrate topography and affinity, among others, and evidently, the size, shape and concentration of the particles. In addition, in ferromagnetic materials, the dipolar magnetic interactions, add a new term in the interactions balance.

High anisotropic structures obtained by self-assembly of ferromagnetic NPs reveal the strong dipolar interaction even with soft magnetic materials like cobalt. Additionally, superlattices self-assembled without applied magnetic field are of fundamental interest to understand the magnetic interaction, because a partial orientation of easy axes of the NP is not induced. On the another hand, these mesoscopic structures that bridge the gap between the microscopic atomic level and the macroscopic state can contribute to understanding magnetism in both regimes.

In this work we report on the important role of dipolar magnetic interactions on the formation of self-assembled structures of magnetic NPs in the absence of applied magnetic field. We used a 6 nm spherical Co NPs synthesized by thermal decomposition in a mixture of organic solvent (dichlorobenzene) and two surfactants (oleic acid and trioctyl phosphine oxide). The self-assembly process is realized onto high ordered pyrolytic graphite (HOPG). The rice-grain like structures was observed when the colloid, deposited by drop casting technique, is evaporated at room temperature.

Self-assembled structures on graphite have been characterized by optical microscopy and SEM (see Fig. 1). Atomic force microscopy images of the nanoobjects are shown in Fig.2 (left), together with magnetic force microscopy images (see Fig.2 right), making evident the magnetic character of these self-assembled structures. Basic magnetic characterization of the self-assembled samples is shown in Fig. 3

FIGURES

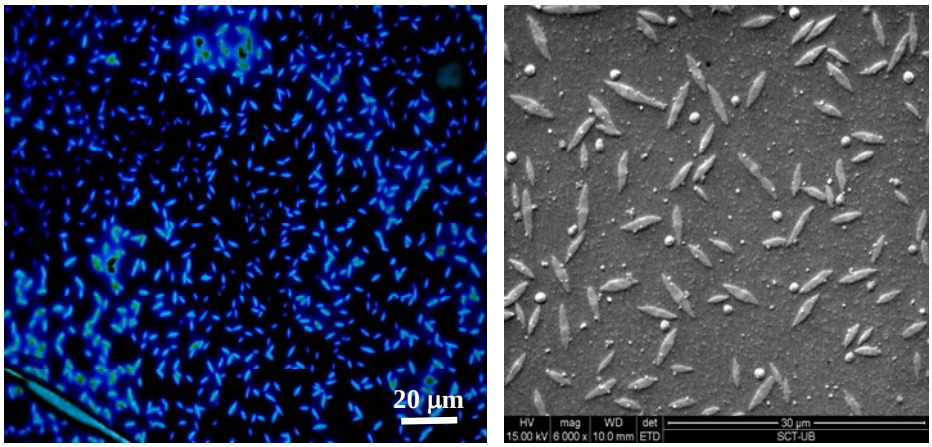

Figure 1. Left: Optical Image of self-assembly structures (5-9µm) of cobalt nanoparticles after its deposition onto HOPG substrate. **Right:** SEM Image of self-assembly structures (5-9µm) of cobalt nanoparticles after its deposition onto HOPG substrate.

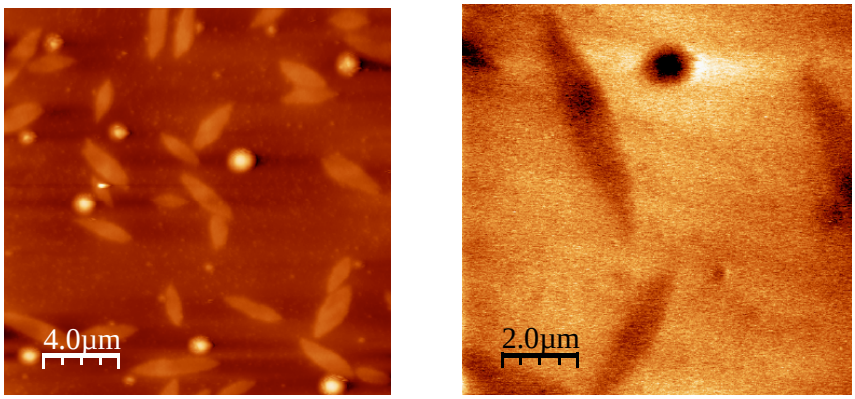

Figure 2. Left) Atomic force microscopy image of self-assemble structures integrated by cobalt nanoparticles. Right) MFM image of some of these structures showing the magnetic character at room temperature.

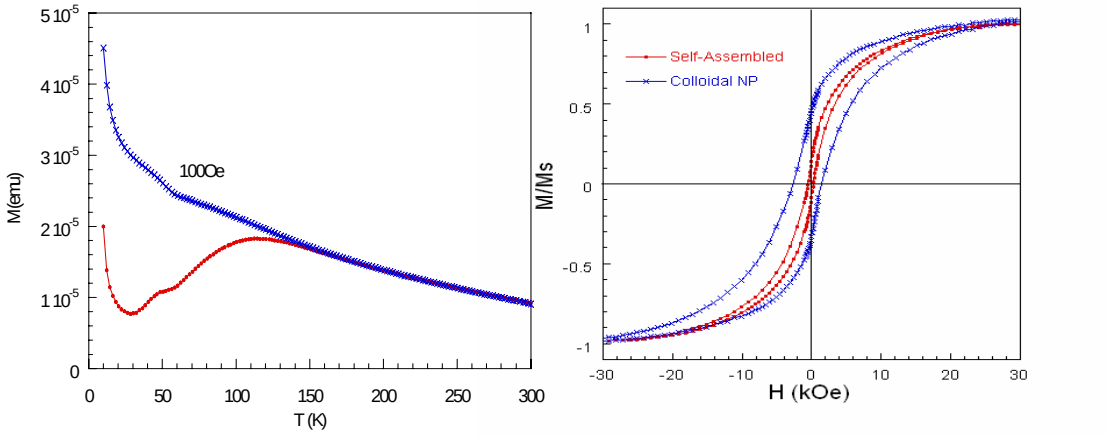

Figure 3. ZFC (red) and FC (blue) magnetization curve of self-assembled NPs onto HOPG (Left). Low temperature (T=10 K) hysteresis loop for colloidal and self-assembled Co NPs (Right).