Organization of Iron Oxide Nanocrystals in Thermotropic Mesogens

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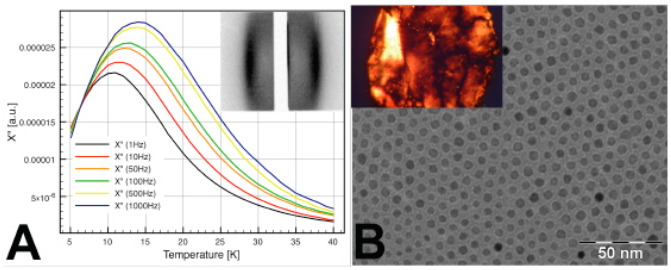
Abstract :

The self-organization of magnetic nanocrystals should lead to new long-range ordered structures and opens the possibility of inducing specific collective properties. The elaboration of structures ordered from nanocrystals, used as building blocks, has been intensively investigated. For instance, the 2D and 3D superlattices can usually be obtained either by controlled evaporation [1] or by Langmuir-Blodgett deposition technique [2].

In this study, we propose a new approach to obtain the assembly of nanocrystals (NCs) by using liquid crystal (LC) molecules as template ligands. The aim is to use the mesogen properties of these LC molecules in order to organize magnetic NCs in a mesophase structure. Recently, self-organized gold NCs have been observed in a thermotropic cubic phase [3] and a study on α-Fe_2O_3 nanoparticles in a thermotropic LC has been realized [4].



Figures – (A) χ' of Fe_3O_4@LC (SQUID AC). (Inset) SAXS Diffractogram.
(B) Image TEM of Fe_3O_4. (Inset) POM Image Fe_3O_4@CL.

For the design of our LC-functionalized nanocrystals, 3 nm diameters NCs were considered and the type of mesogens were selected to favor the induction of mesophases and to specifically coordinate the crystal surface (carboxylate and phosphonate functions). Monodisperse iron oxide nanocrystals were obtained from a thermal decomposition of iron-oleate complex. $Fe_{(3-\delta)}O_4$ nanoparticles of 3-4 nm (fig.B) in diameters were obtained by tuning the parameters controlling the kinetics of the formation such as temperature rate and organic solvents. These iron oxide NCs have a narrow size dispersity and are superparamagnetic ($T_{blocking}$ = 20K) at room temperature. Differents strategies have been attempted to exchange the oleic acid by the mesogenic ligand on the crystal surface. The first results obtained by DSC and wide- and small-angle XRD show that these crystals coated by LC molecules present a nematic phase (inset fig.A&B). The investigation on the magnetic behaviors by SQUID (DC/AC) revealed a modification of dipolar magnetic interactions and surface anisotropies according to the LC molecules on the NC surface (fig.A).

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