TUNING OF THE SUPERPARAMAGNETIC BLOCKING TEMPERATURE OF γ-Fe_2O_3 NANOPARTICLES IN BI-MAGNETIC CORE-SHELL STRUCTURES.

J. Nogués[1*], G. Salazar-Alvarez[2], J. Sort[1], A. Uheida[3], M. Muhammed[3], S. Suriñach[2], M.D. Baró[2]

[1]Institució Catalana de Recerca i Estudis Avançats (ICREA) and Dept. de Física, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain
[2]Dept. de Física, Universitat Autònoma de Barcelona, E-08193 Bellaterra (Barcelona), Spain
[3]Materials Chemistry Division, Royal Institute of Technology, SE-100 44 Stockholm, Sweden

Magnetic nanoparticles, and in particular iron oxides, are used in widespread technological applications. Some of them require the nanoparticles to be in the superparamagnetic state, for example, to avoid interparticle aggregation. However, for applications like recording media the nanoparticles must remain ferromagnetic. Moreover, the use of magnetic nanoparticles in sensors calls for the particles to be magnetically soft without being superparamagnetic [1]. In this context, the influence of different types of magnetic shells (ferrimagnetic or antiferromagnetic) on the magnetic properties of maghemite (γ-Fe_2O_3) core nanoparticles has been investigated. The core-shell structures have been fabricated by two different post-synthesis methods using previously prepared cores: i) Co(II) ions were adsorbed on the cores to form a shell with a composition near $CoFe_2O_4$ and ii) a MnO layer was formed by using the cores as seeds for the heterogeneous growth. It is shown that both ferrimagnetic and antiferromagnetic shells allow to controllably increase the blocking temperature, T_B, of the system with respect to that of untreated particles. The presence of the shells also brings about a remarkable increase of the coercivity (about an 8-fold increase). Moreover, in the case of antiferromagnetic shells a shift of the hysteresis loop along the field axis, i.e., exchange bias [2], is also observed after field cooling from above the Néel temperature. These results open the door to the possibility to synthesize a single, generic, type of particle, which can later be modified to adapt to the needs of a specific application.

[1] M.A. Willard et al., Int. Mater. Rev. 49, 125 (2004).
[2] J. Nogués et al., Phys. Rep. 422, 65 (2005).