Fe_3O_4 Nanoparticles for Biomedical Applications.

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Fe_3O_4 nanoparticles with sizes from 5 to 110 nm were prepared by a direct method based on the precipitation of an iron (II) salt ($FeSO_4$) in the presence of NaOH and a mild oxidant (KNO_3) at 90º C in a mixture of solvents water/ethanol.[1] Particle size was controlled by changing the concentration of the iron salt leading to magnetite nanoparticles with narrow size distributions. Several samples were further coated with silica to obtain a core/shell structure.

The efficiency of the nanoparticles as heating agents was assessed through specific power absorption (SPA) measurements as a function of particle size and shape. The results show a strong dependence of the SPA with the particle size, with a maximum around 30 nm, as expected for a Néel relaxation mechanism in single-domain particles. The SiO_2 shell thickness was found to play an important role in the SPA mechanism by hindering the heat outflow, thus decreasing the heating efficiency. Both good heating efficiency and surface functionality for biomedical purposes were attained for the thinnest SiO_2 coatings of about 1 nm.

In order to test the efficiency of the synthesized nanoparticles as MRI contrast agents NMR relaxation measurements were performed in a top-bench equipment, operating a 1.5 Tesla and 37 °C. T_1 and T_2 relaxation times were determined for several magnetite concentrations in water-stable suspensions. Both spin-lattice and spin-spin relaxation show a monoexponential decay. For some of the samples the obtained values of the r_2 relaxivity are close to those of commercial MRI contrast agents.

References:

[1] Verges M.A., Costo R., Roca A.G., Marco J.F., Goya G.F., Serna C.J. and Morales M.P *J. Phys. D: Appl. Phys.* **41** . (2008) 134003.

Figures:

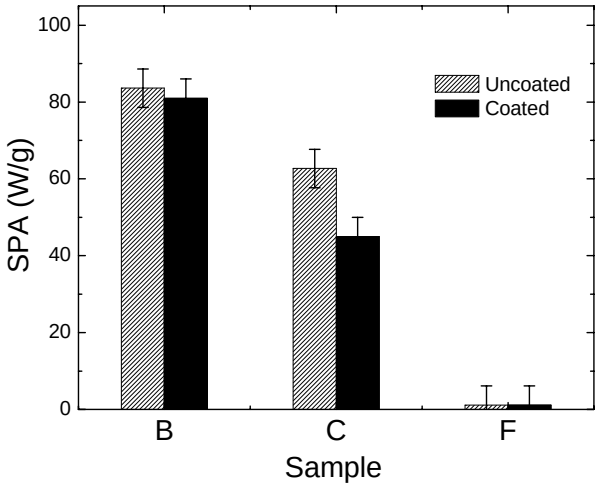

Figure 1:*SPA of single domain (BSi and CSi) and multidomain (FSi) silica coated nanoparticles. SPA for pure magnetite was 95 W/g.*

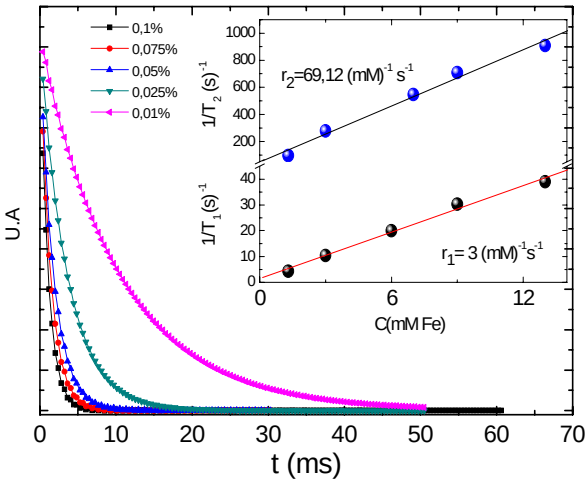

Figure 2*: T1 Relaxation time for a sample with d = 5 nm* ***Inset*** *relaxivity values*