Superparamagnetic behaviour of water soluble Fe_3O_4@Au nanoparticles

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The preparation of monodisperse magnetic nanoparticles has attracted much attention due to their potential applications in fields such as magnetic storage, drug targeting and delivery, cancer therapy and medical imaging [1]. For these last purposes well defined and water soluble magnetic nanocrystals are desired. By contrast, most of the approaches to obtain highly crystalline and monodisperse nanoparticles take place in organic media, providing particles with a hydrophobic surface. Thus, their transfer into aqueous media with a proper coating is a key issue for their application in areas such as biomedicine. In this contribution, we present the preparation, surface modification and characterization of gold coated Fe_3O_4 nanoparticles.

Gold coated magnetite nanoparticles were synthesized by a two step procedure based on the polyol method [2]. The reduction of $Au(OOCCH_3)_3$ in the presence of the previously synthesized iron oxide seeds [3], yield gold coated nanoparticles of 5–7 nm, surrounded by organic ligands. The surface modification of the hydrophobic nanocrystals was performed by means of the amphiphilic poly(maleic anhydride-alt-1-octadecene) surfactant [4]. The hydrophobic regions of the polymer intercalates with the alkyl chains of oleic acid surrounding the nanoparticle, rendering the particles water soluble.

The presence of Fe_3O_4 and gold was confirmed by high resolution microscopy. TG-DTA curves measured in argon atmosphere show that depending on the synthetic conditions the organic content varies between 6 and 13 % for unmodified gold coated magnetite nanoparticles.

The expected superparamagnetic behaviour for nanoparticles below the critical size has not been observed in all the unmodified samples. Indeed, at room temperature, coercive fields values in the 30 -130 Oe range and characteristic of ferromagnetic behavior have been obtained from hysteresis cycles. Electron paramagnetic resonance spectroscopy measurements also show strong and broad signals with effective g values ranging from 2.0 to 2.38, depending on the sample.

EPR spectra of water soluble gold coated magnetite nanoparticles, in contrast, show a signal centered at a g value of 2.0, confirming the expected superparamagnetic behaviour for nanoparticles in the observed size range.

References:

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