SYNTHESIS, CHARACTERIZATION AND MAGNETIC PROPERTIES OF Fe-Ag NANOPARTICLES PREPARED BY MICROEMULSION TECHNIQUE.

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Nanosized magnetic particles have attracted much interest in recent years due to their promising technological applications such as high-density magnetic storage media, microelectronics, ferrofluids or drug delivery sistems. These applications require a nanometer-scale control of the material, in terms of size, shape, composition and crystal structure, as well as an organization into 2D or 3D superlattices [1]. Recently, many investigations have yield successfully synthesized fine particles exploiting the restricted environments offered by surfactant systems [2].

In this sense, silver coated iron nanoparticles have been prepared using a sequential synthesis offered by reverse micelles. This method allows the synthesis of iron nanoparticles that can avoid oxidation and maintain their magnetic properties. The microemulsion was prepared using cetyltrimethylammonium bromide (CTAB) as the surfactant and *n*-butanol as co-surfactant, octane as the oil phase and aqueous reactants as the water phase. The reverse micelles act as nano-reactors limiting the growth of both the spherical iron core and the silver shell. The particles were produced by exchange of matter through diffusion between the droplets containing Fe^{3+} and Ag^{+} and those containing sodium borohydride ($NaBH_4$). The characterization of the samples was performed by means of X-ray diffraction (XRD), transmission electron microscopy (TEM) and thermogravimetric analysis (TGA). Magnetic properties have been investigated using Mössbauer spectroscopy and SQUID magnetometer.

XRD was used to confirm the presence of silver, as this metal obscures the pattern of *bcc* iron. Transmission microscopy has shown particle sizes well below the predicted maximum size of 15 nm for superparamagnetic behavior (Fig. 1), as well as a narrow size distribution. TG-DTA curves of the samples recorded in air atmosphere have proved that silver coated nanoparticles are not air-sensitive.

Magnetic measurements in the studied samples present susceptibility plots which exhibit a cusp in the ZFC curve in the temperature range 40 – 65 K, which correspond to the blocking temperature, T_B, which slightly decreases with decreasing the size of the nanoparticles. Above T_B, in the superparamagnetic regime no hysteresis loop is observed. Mössbauer spectra of the samples recorded above 77 K exhibit only a central doublet which reveals the collapse of magnetic ordering due to superparamagnetic relaxation (Fig. 2).

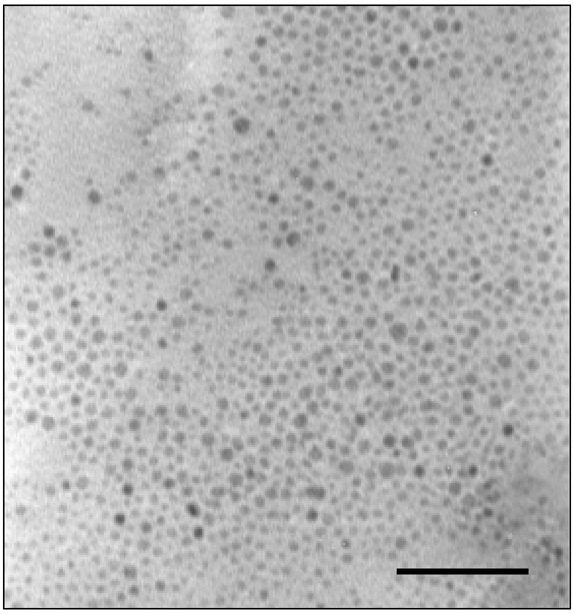

Fig. 1. TEM micrograph of a Fe-Ag sample. The scale bar represents 50 nm.

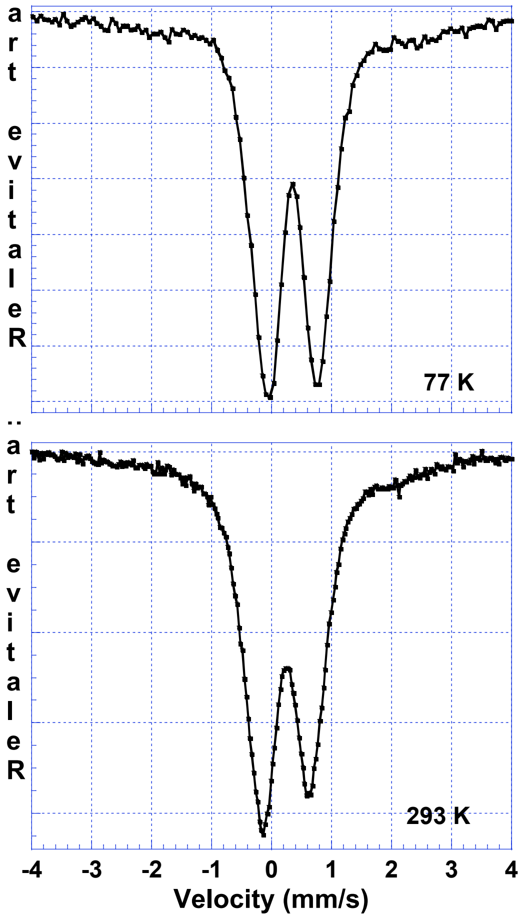

Fig. 2. Mössbauer spectra of a Fe-Ag sample at room temperature and 77 K.

References:
[1] M. Pileni, Appl. Surf. Sci. 1, 171 (2001).
[2] B. Ravel *et al.*, J. Appl. Phys. 91, 8195 (2002).