MAGNETIC PROPERTIES OF SILVER NANOPARTICLES COMPARED WITH GOLD NANOPARTICLES.

E. Goikolea, M. Insausti, I. Gil de Muro, J.J. Saiz Garitaonandia and J. Cashion
Zientzia eta Teknologia Fakultatea, Euskal Herriko Unibertsitatea, P.O. Box 644, E-48080 Bilbao (Spain)
qipinpem@lg.ehu.es

Gold nanoparticles are one classic and the most stable metal nanoparticles, which have attracted great interest due to their potential applications in electronic, optical materials and in catalysis [1]. The use of thiols, polymers, surfactants and other ligands as capping agents in the preparation of these particles can not only control the particle size and shape and prevent agglomeration but also can introduce functional groups to the surface, favoring the application in biomedical materials. What's more, thiol surfactants seem to be able to induce permanent magnetism in gold nanoparticles [2]. In order to study the influence of the thiol agent in this behaviour, we have prepared other capped metals. Here we present the synthesis, caracterization and magnetic behaviour of silver nanoparticles, comparing these results with those obtained from gold nanoparticles. What's more we present ^{197}Au Mössbauer spectroscopy at 5 K for one sample of gold nanoparticles.

The preparation procedure of Ag-SR nanoparticles has been based on Brust method [3]. $AgNO_3$ was transferred from aqueous solution to toluene using cetyltrimethylammonium bromide (CTAB) as the phase-transfer reagent and reduced with aqueous sodium borohydride in the presence of dodecanethiol. Thermogravimetric measurements of the obtained powder reveal that the sample is formed by 22% of organic ligand and 88% of silver.

Representative transmission electron micrographs, along with the corresponding selected area diffraction pattern have been obtained. TEM photographs show particles of a mean size of 2 nm, with not as circular shape as shown by Au-SR nanoparticles. The characteristic rings in the polycrystalline diffraction pattern can be indexed to the allowed reflecting planes expected from fcc Ag.

Magnetization M vs H curves have been obtained for silver nanoparticles at 5 and 300K. Hysteresis is observed at both temperatures, indicating a ferromagnetic behaviour with a transition temperature above room temperature. Characteristic values appear in Table 1. It is to note the higher magnetic moment (M_s = 7.46 emu/g_{Ag}) obtained for silver nanoparticles than the obtained for gold ones.

Table 1. Magnetization data obtained at for Ag-SR and Au-SR nanoparticles

T(K)	M_s(Ag) (emu/g_{Ag})	M_r(Ag) (emu/g_{Ag})	H_c(Ag) (Oe)	M_s(Au) (emu/g_{Au})	M_r(Au) (emu/g_{Au})	H_c(Au) (Oe)
5	7.46	0.92	183	1.5	0.12	130
300	6.81	0.53	87	1.2	0.08	78

The Mössbauer spectrum of the gold phase shows two components. The first is the characteristic single line due to metallic gold for which the position is shifted by - 0.26 mm/s from the value expected for bulk gold. The second component is a broadened sextet, which constitutes 33% of the spectral area. If we assume that the moment is confined to the 33% of the sample, then the moment per magnetic gold atom is 0.24 μB.

References:

[1] J. Liu, Y. Lu, Anal. Chem. **76** (2004) 1627.
[2] P. Crespo et al, Phys. Rev. Lett. **93(8)** (2004) 87204.
[3] M. Brust et al, J. Chem. Soc., Chem. Commun. (1994) 801.