MAGNETIC PROPERTIES OF METALLIC NANOPARTICLES

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Nanoparticles often exhibit different physical properties than bulk materials with the same composition, mainly because two reasons: (i) As the size of these system reaches the typical lengths of some phenomena, it is expected that the response of the system depends on the boundary conditions (which are no longer periodic, but determined by the particle size), and therefore, to be different from bulk material. (ii) Because of the large ratio of surface to volume atoms in nanoparticles, the surface energy becomes important when compared with volume energy and therefore the equilibrium situation can be different from that for bulk materials. Furthermore, surface atoms not only are different to volume atoms, but they can also be modified by interaction with other chemical species, that is, by capping the nanoparticles. This phenomenon opens the possibility to modify the physical properties of the nanoparticles by capping them with appropriate molecules. Actually, it should be possible that non ferromagnetic bulk materials exhibit ferromagnetic-like behaviour when prepared in NP. We have obtained magnetic nanoparticles from non magnetic bulk materials by different methods: Pd, Pt and the surprising case of Au (that is diamagnetic in bulk). In the case of Pt and Pd, the ferromagnetism arises from the structural changes associated with size effects. On the other size, gold nanoparticles become ferromagnetic when they are capped with appropriate molecules: the charge localised at the particle surface gives rise to ferromagnetic-like behaviour. The large spin-orbit coupling of those noble metals yields to a large anisotropy and therefore to high order temperatures.

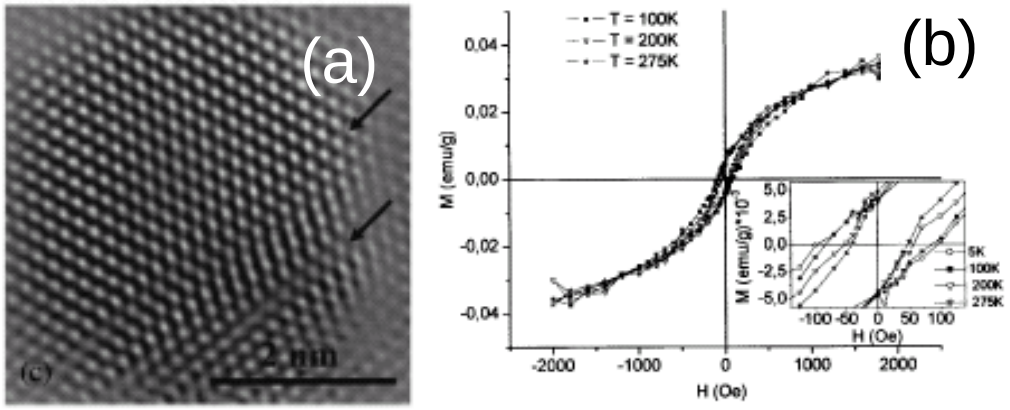

Figure 1. (a) Fourier filtered HRTEM image of a Pd nanocrystal (diameter 4.4 nm) showing two twin boundaries. (b) Hysteresis loops at different temperatures of Pd nanoparticles. Inset: a more detailed view of the thermal coercivity response of the same sample.

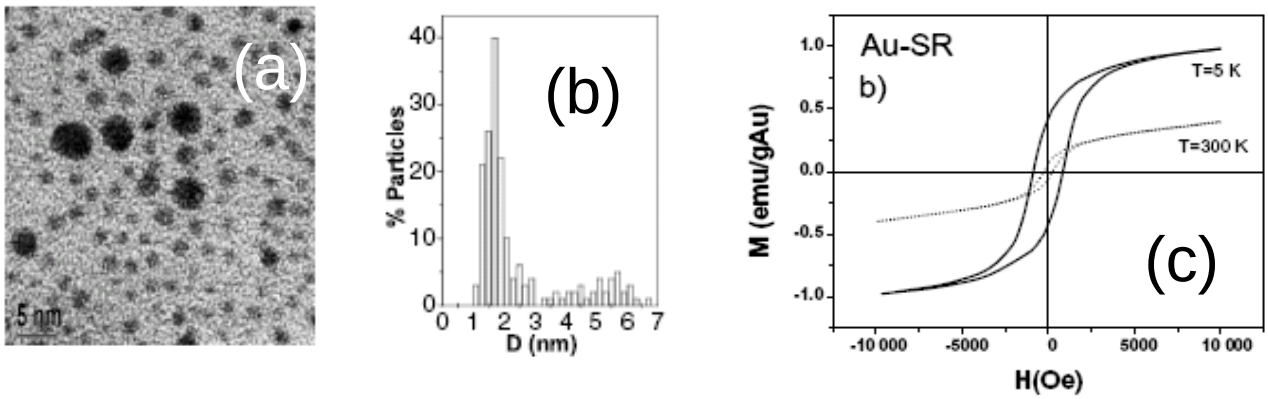

Figure 2. (a) Transmission electron micrographs, (b)the corresponding size histogram and (c) hysteresis loops from thiol-capped gold nanoparticles.

References

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