Preparation, Structure and Magnetic Properties of Bimetallic Nanoparticles

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A significant number of recently published papers are concerned with magnetic colloidal particles, whose attractiveness stems from their possible application to ultra-high-density magnetic data storage media. The properties of small particles depend on their composition, shape, and method of preparation. A decrease in the size of ferromagnetic nanoparticles means an increase in their reactivity and decrease of curie temperature. The combine 3d- (Fe, Co, Ni) with noble metals through formation of alloys improves a stability of colloids and leads in new properties of magnetic systems, often distinct from those of the corresponding monometallic particles. Covering ferromagnetic particles with a noble metal is one more way to increase their stability against oxidation.

A "reverse" core-shell particle system, where a noble dia- or paramagnetic noble metal-core is surrounded by a ferromagnetic Co-shell is an interesting system to study surface and interfacial magnetism such as for example, induced polarization effect [1] or a giant magnetoresistance effect [2]. In our article [3] we have already shown that Ag-core/Co-shell nanocrystals exhibit optical activity and magnetic behavior.

Here we will present a new route for the preparation of bimetallic magnetic nanocrystals (PtCo, PdCo) with core-shell structure. The stable colloids with a narrow particle size distribution were obtained in organic solvents (diethylether or dioctylether) using methods of wet chemistry. The samples were characterized by transmission electron microscopy, X-ray fluorescent analysis, UV-VIS and electron-energy loss spectroscopy, SQUID magnetometry and x-ray magnetic circular dichroism measurements.

At first the so-called modified “polyol” process has been used for preparation of pure Pt or Pd nanoparticles (Fig. 1a, c). Later, decomposition of cobalt carbonyl on the noble metals seeds, if carried out at relatively low temperature, aborts formation of any alloy yielding only Pt or Pd-core/Co-shell particles (Fig. 1b, d).

In the case of PtCo systems it was possible to grow a Co-shell with controllable thickness using a simple high-temperature thermolysis procedure. PtCo composite particles are superparamagnetic at room and ferromagnetic at low temperatures.

Magnetic properties of the particles as a function of particle size and composition will be discussed.

References:

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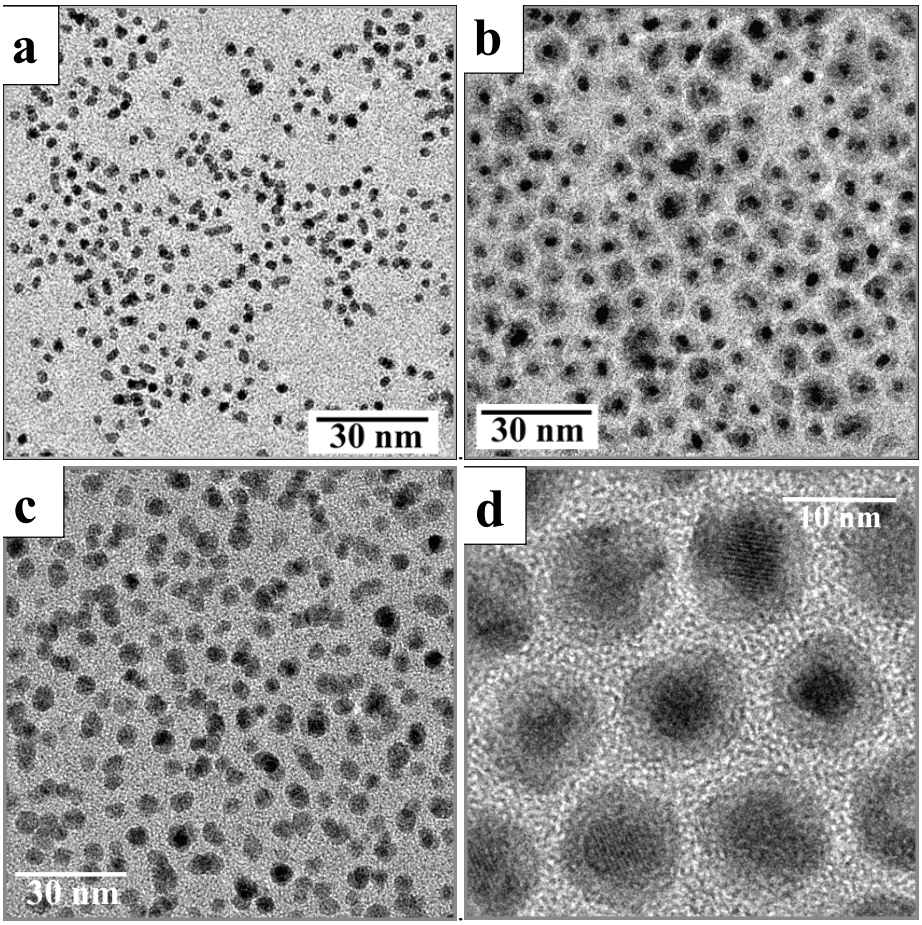

Fig. 1. TEM images of : a) individual platinum nanoparticles; b) Pt@Co nanoparticles; c) individual palladium nanoparticles; d) Pd@Co nanoparticles.