Pd Nanoparticles Functionalized with alkylamines: Structural and Magnetic Characterization

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Palladium nanoparticles are candidate materials for controllable magnetism because of the density of states at Fermi energy for Pd is close to fulfilling the Stoner criterion of magnetism [1]. The change in the electronic structure due to size effects or to a surface environment could enhance the density of states at the Fermi level and modify the magnetic behavior of palladium [2]. Therefore, Pd magnetic nanoparticles could play an important role not only in the understanding magnetism at nanoscale but also in the applications to magnetic devices or in biomedical fields [3]. In this sense, Pd nanoparticles stabilized with two alkylamines have been synthesized and characterized by x-ray diffraction, thermogravimetry and transmission electron microscopy (TEM). The magnetic behaviour has been studied by magnetization measurements (SQUID) and Electron Magnetic Resonance (EMR).

Pd nanoparticles have been obtained by liquid-liquid phase reduction, based on Brust method [4]. In these method the transfer of Pd^{+2} ions from an aqueous solution of Na_2PdCl_4 (aq) to toluene occurs using tetraoctylammonium bromide (TOAB) as the phase-transfer reagent in the presence of butylamine. If this alkylamine is not present, TOAB can also acts as stabilizer preventing the nanoparticles from aggregating. As a result, two kind of Pd nanoparticles have been obtained, Pd-NR (NR = butylamine) and Pd-TOAB, respectively. Changes in the preparation conditions yield samples with different magnetic behaviour.

Colloidal solutions of the nanoparticles were analyzed by means of TEM microscopy and homogeneous distributions of NPs with mean sizes around 4 nm were observed. In solid samples, Pd (fcc) structure was corroborated by the maxima observed by X ray diffraction. In order to know the content of organic matter thermogravimetric measurements were performed in Ar atmosphere and different contents (from 20% to 60%), depending on the sample preparation and the type of surfactant, have been obtained.

Magnetic measurements, at 5 and 300 K, have revealed a ferromagnetic nature in only some of samples in which magnetic hysteresis loops with low coercitive fields can be observed. The maximum value for saturation is achieved at 0.16 emu/g at 300 K for some of the preparations of the Pd-TOAB system. This magnetic behaviour has also been corroborated by EMR measurements where an intense resonance signal with a peak to peak linewidth (ΔH_{pp}) greater than 1000G appears. Further experiments are being performed in order to know the relation between the appearance of magnetic behaviour and characteristics of the nanoparticles.

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