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Sonosynthesis of Iron Carbide@Iron Oxide Nanoparticles

P. Zavala-Rivera[1], A. I. Argüelles-Pesqueira[1], J. A. Lucero-Acuña[1], P. Guerrero-Germán[1] and A. Rosas-Durazo[2]

[1.] Posgrado en Ciencias de la Ingeniería, Departamento de Ingeniería Química y Metalurgia, Universidad de Sonora, México.
[2.] Núcleo de Investigación Científica y Desarrollo Tecnológico, Rubio Pharma, México.

Nowadays, iron oxide nanoparticles have been widely used as contrast agents for magnetic resonance, administration and controlled release of drugs, cell therapy, vaccine carriers, nanoscale biosensors, nano-coatings on surfaces and nanofotothermolysis, among others. [1]. In the present work the sonosynthesis of core-shell nanoparticles of iron carbide @ iron oxide (ICONs) was carried out in order to provide a wide field of applications, specially as theranostic agents due to its magnetic properties and metallic composition. The ICIONs were characterized to evaluate the size and the presence of the core/shell type nanoparticle; which HRTEM characterization showed a contrast among the nanoparticles with a core made from iron carbide (Fe_3C) and a shell of maghemite (γ-Fe_2O_3).

We described an organometallic sonosynthesis of Iron Carbide@Iron Oxide core-shell nanoparticles (ICION's) stabilized with oleic acid. ICION's size average and distribution was obtaining using Transmission Electron Microscopy (TEM) by image characterization with ImageJ 1.51m9 software from Wayne Rasband, National Institute of Health, and the interplanar distance was processed using Fast Fourier Transform by the same software[1]. Hydrodynamic diameter and organic/aqueous stability was measured with a Malvern Instrument Zetasizer Nano ZS.

The synthesis route is based in the sonochemistry reaction of organometallic precursor like $Fe(CO)_5$ in 1-octanol (99%) using low intensity ultrasonic water-bath with a fabric frequency of 40 kHz. Once the process of chemical sonosynthesis of the ICIONs was completed, it was purified by centrifugation. After purification, the precipitate is resuspended in toluene for storage and subsequent applications.

The TEM results shows a spherical morphology in which a contrast between the nucleus and the shell of the can be visualized, also, is important to notice that the iron carbide core change with the size and the iron oxide coating length is constant, around 2.56 nm ± 0.4 (n=157) (Figure 1a). The particle diameters have been estimated from the TEM was around 3.99 nm ± 1 (n = 501) with a dispersion plot in the inner Figure 1b. The HRTEM made on both, the area of core and the shell were analyzed showing interplanar distance of 2.10 and 2.41 Å (Figure 1c), which represent cementite and maghemite phases respectively [2], [3].

It was showed a novel method to synthesize core shell nanoparticle made of iron carbide and iron oxide using sonosynthesis instead of more traditional techniques like hydrothermal. The diameter of the particles was found by TEM to be around 4 nm with a visible core-shell architecture, with a shell size constant to 2.56 nm; HRTEM showed differences within the interplanar distances between the core and the shell corresponding to iron carbide (Fe_3C) and iron oxide (γ-Fe_2O_3).

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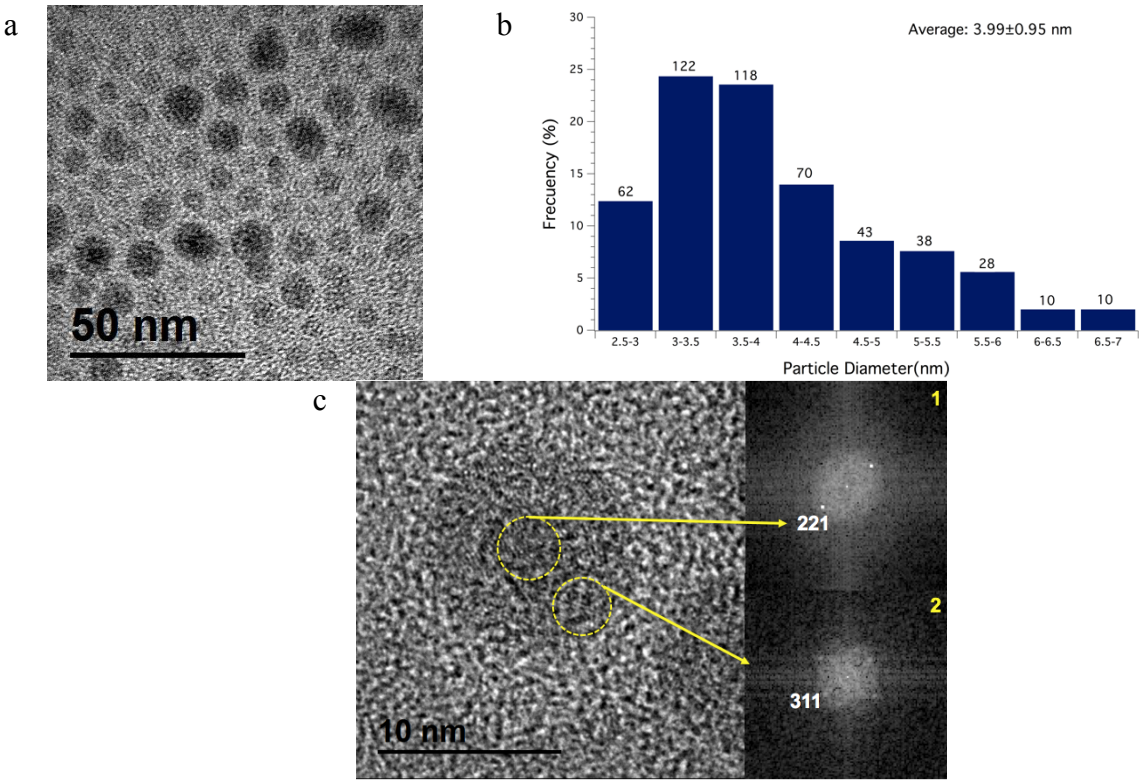

Figure 1. Transmission electron microscopy (TEM). Iron carbide@Iron Oxide Nanoparticles can be observed where core-shell and spherical structure can be visualized (a). Nanoparticles size distribution (b). High resolution transmission electron microscopy (HRTEM). Two interplanar distances where found wich 2.10 Å corresponds to Fe_3C (211) and 2.41 Å to γ-Fe_2O_3 (311) (c).

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