Design and synthesis of carbon encapsulated iron nanoparticle for drug delivery

M. Reza Sanaee, S. Chaitoglou, V.-M. Freire, N. Aguiló-Aguayo, E. Bertran
FEMAN Group, Institute of Nanoscience and Nanotechnology (IN2UB), Dep. Applied Physics and Optics, Universitat de Barcelona,
Martí Franquès, 1, E08028 Barcelona, Spain
sanaee@ub.edu

Magnetic nanoparticles are being of great interest because of their unique properties especially in drug delivery, magnetic resonance imaging and cell separation. In many clinical situations, medication doses are oversized as a result of impaired drug absorption or tissue unspecific delivery [1]. The ultimate goal of magnetically controlled drug delivery and drug therapy is to selectively delivering drug molecules to the diseased site without a concurrent increase in its level in healthy tissues. In this research study, carbon encapsulated iron nanoparticles (CEINPs) were designed and produced by arc discharge method in a way to make them as suitable nanocarriers. It has been reported that a particle size range of 50–300 nm is strictly demanded [2]. Barbe et al [3], proposed a novel drug delivery system. They studied drug release of silica nanoparticles with both sizes of 50 nm and 250 nm in different organs, and their 250 nm particles did not trapped by lung capillaries. Moreover, an optimum geometry for endocytotic uptake is 50 nm and spherical particles are more easily internalized compared to elongated particles [4 & 5]. One of the disadvantages of using magnetic nanoparticles is the risk of their magnetic interaction and hence their agglomeration and blockage of vein. To overcome this difficulty, the magnetic particles are covered by carbon shell. According to the TEM and SEM observations the carbon shell is spherical and their median size is 220 nm and the iron core is 3 nm, (Figure 1). Generally, due to the size distribution of iron nanoparticles there are some iron particles which are not superparamagnetic and therefore a large carbon shell is necessary to open enough space between iron particles. The magnetic properties are characterized by SQUID. Accordingly, their superparamagnetic behavior is investigated at body temperature (Figure 2). Moreover, the blocking temperature is very low (Figure 3). The crystallinity of carbon shell and surface properties are characterized by Raman spectroscopy and Fourier transform infrared spectroscopy (FTIR), respectively. Consequently, carbon shell shows less defect and high crystallinity and FTIR spectrum illustrates the suitability of surface for further functionalization and modification (Figure 4). Nanoparticles can control the basic functions of cells, and potentially kill cancer cells, by virtue of their size alone without the need for drugs [6]. As the conclusion, produced particles fulfill the requirements of drug delivery and therapeutic applications in terms of size, shape, magnetic and surface properties. In addition, carbon shells are biocompatible and thermally stable.

References

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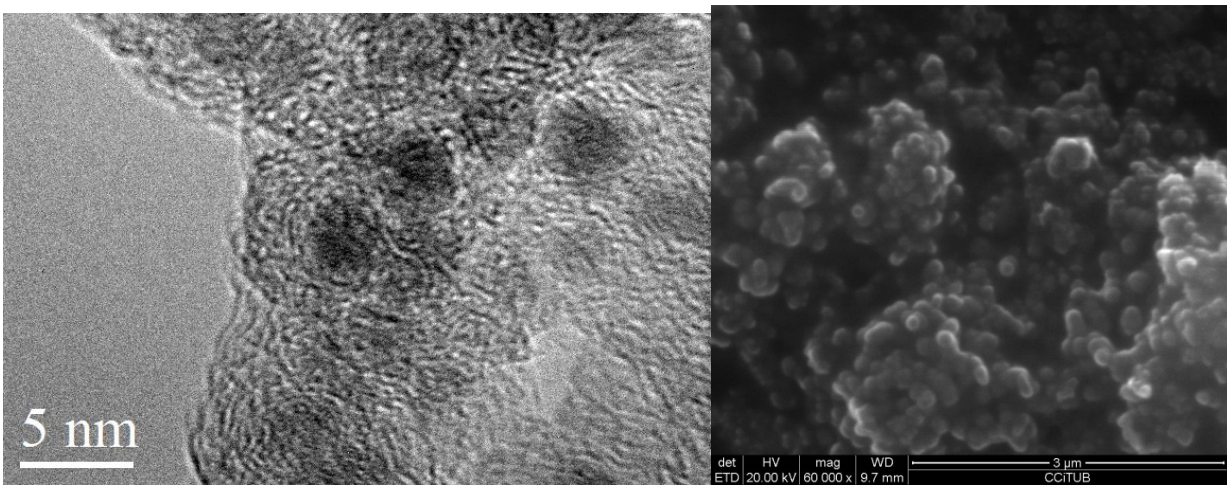

A **B**

Figure 1. A) TEM image of small iron particle, B) SEM image of spherical CEINPs

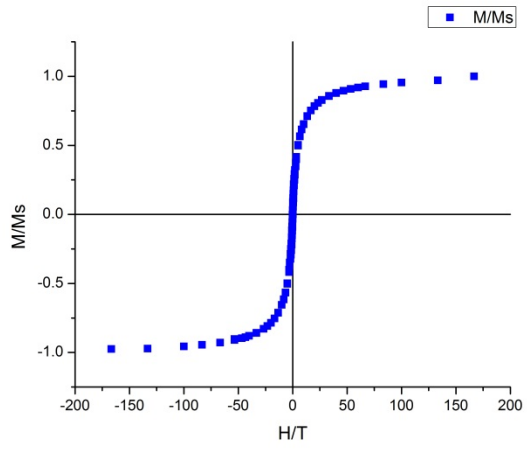

Figure 2. Hysteresis loop of CEINPs at body temperature

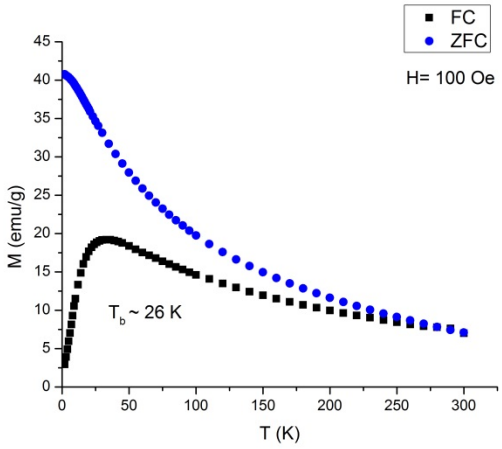

Figure 3. Zero-field-cooled and field-cooled magnetization curves

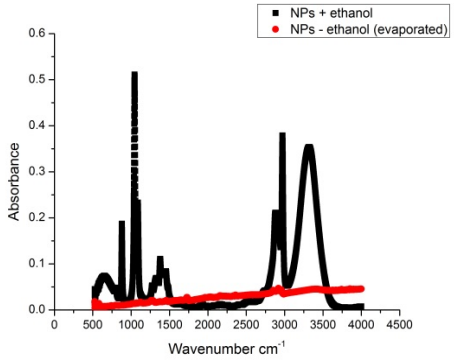

Figure 4. FTIR spectra of CEINPs