Silica coating of FeCo magnetic nanoparticles in non-alcoholic media

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During the last years magnetic nanoparticles (MNPs) have offered promises in local hyperthermia and in application in magnetic targeted drug delivery. Local hyperthermia depends on specific loss power (SLP) of the MNP which scales with the saturation magnetization (Ms) of the magnetic material[1]. Magnetic hyperthermia uses vectorised MNPs to heat cancerous regions in an alternative magnetic field. Metallic MNPs have larger magnetic moments than oxides, allowing similar heating while using lower concentrations. However these particles are highly sensitive to oxidation (caused by oxygen and water), and thus, magnetic properties are easily lost. Some attempts to protect MNPs such as coating Fe ones with SiO_2 have been made, however drastic reaction conditions such as using H_2 at 800ºC or H_2 and acetylene at 400ºC were required[2].

One suitable coating to render FeCo nanoparticles biocompatible and easy to functionalize would be a silica shell which could prevent the formation of oxides. Up to date, some methods have been developed for coating ferrite[3] or cobalt ferrite[4,5] nanoparticles with a controlled thickness shell of silica by using slight modifications of the Stöber sol-gel method in alcoholic media[6], but coating of metallic FeCo MNPs has not been described yet.

Our group has been working during the last~~s~~ years in the synthesis of FeCo MNPs[7] and in the synthesis of SiO_2 nanoparticles in non-alcoholic media[8]. Here we will present the application of these synthetic methods to the coating of FeCo nanoparticles with silica in non-alcoholic media (figure 1). Resulting FeCo/SiO_2 MNPs keep original magnetic properties (Ms and coercitivity) depending on the synthetic conditions.

We will also show the influence of parameters (such as solvent, temperature, reagents ratio, stabilizing agents, dispersion of FeCo and thermal treatment after synthesis) on the size of the FeCo/SiO_2 agglomerates (figure 2) and/or on the magnetic properties of the resulting solid.

Finally, we will show some examples of MNPs and MNPs/SiO_2 exposed to air and the stability (or not) of their magnetic properties depending on the synthetic method.

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Figure 1. Synthesis of FeCo MNPs (1) and coating with SiO_2 (2).

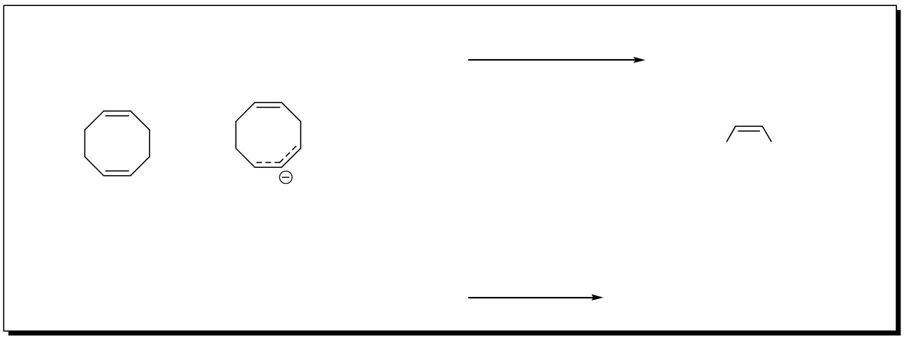
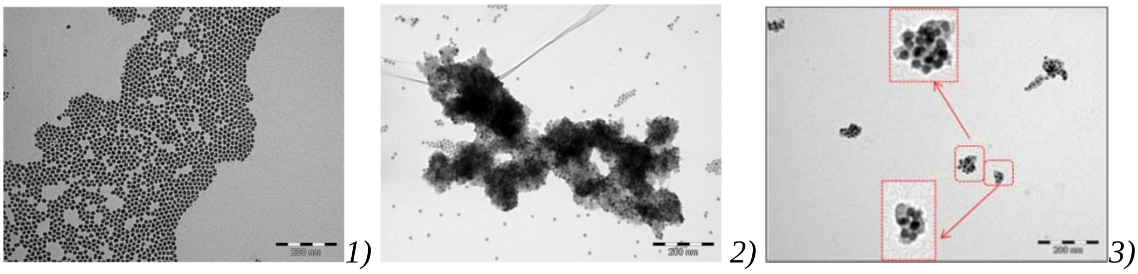


Figure 2. Selected TEM images of FeCo (1), and FeCo@SiO_2 before optimization of the coating method (2) and after (3)



Co(COD)(COT) +

COD: CO