VARIOUS MAGNETIC NANOPARTICLES PREPARATION AND COMPARISON REGARDING BIOMEDICAL APPLICATION

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In few past years, magnetic nanoparticles (MNPs) have gained the great attention in medical and pharmaceutical applications due to their ability of drug delivery or various biomolecules separation [1, 2]. Iron oxide based-nanoparticles belong among most widely used materials in this field. Recently, more sophisticated Fe_2O_3 nanoparticles were synthesized by surrounding the magnetic core by amorphous silica shell, which could be further modified for better conjugation with various biological molecules [3]. SiO_2 protecting coating was found to be useful also in the case of paramagnetic gadolinium nanoparticles designed for multimodal contrast agent with optical and magnetic properties. However, the synthesis of such products is often time-consuming, so there is a demand to use rather a simple way of magnetic nanoparticles fabrication. This study is aimed to comparison of magnetic properties of silica coated samples with non-coated one prepared by simple precipitation method.

Next to previously reported techniques of Fe_2O_3/SiO_2 [4] and Gd/SiO_2 [5] preparation, we employ an easy co-precipitation method to fabricate Fe_2O_3 magnetic particles. $FeCl_2.4H_2O$ was mixed with K_2CO_3 under constant stirring up to pH 7, which results in the formation of black precipitate. After separation, the precipitate was dried for 15 min at 80 °C, then finely crushed in agate mortar and finally thermally treated for 4 hours at 200 °C in the oven. The obtained Fe_2O_3 powder was redish-brown in colour. These nanoparticles revealed the magnetic properties in water suspension when external magnetic field was applied. The resulting pH value of product was equal to 5.5.

SEM analysis showed that nanoparticles in all prepared samples tended to form the agglomerates with particle size less than 100 nm (Fig. 1). According to XRD measurement, haematite crystallographic form was observed as majority phase in the case of Fe_2O_3/SiO_2 annealed for 4 hours at 800 °C. We suppose, there are also very small maghemite or magnetite particles but they were not detected in XRD spectra probably due to "hiding" of their peaks in amorphous ones of SiO_2. Gd^{III}/SiO_2 nanoparticles were found to be completely amorphous. Fe_2O_3 powder consisted of 60% iron oxide and 30% of sylvite (KCl). Since X-ray powder diffraction cannot distinguish between maghemite and magnetite nanoparticles, Mössbauer spectroscopy analysis was performed in order to better determine Fe_2O_3 sample. The results showed the maghemite phase as dominant one (36%) with small portion of magnetite (6%) and some amorphous or very small iron oxide nanoparticles but for their more precise identification, a measurement in external magnetic field should be done. Moreover some superparamagnetic or paramagnetic component was detected in this sample. All three samples behaved as a very weak ferromagnetic material as can be seen from Fig. 2.

References:

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Figures:

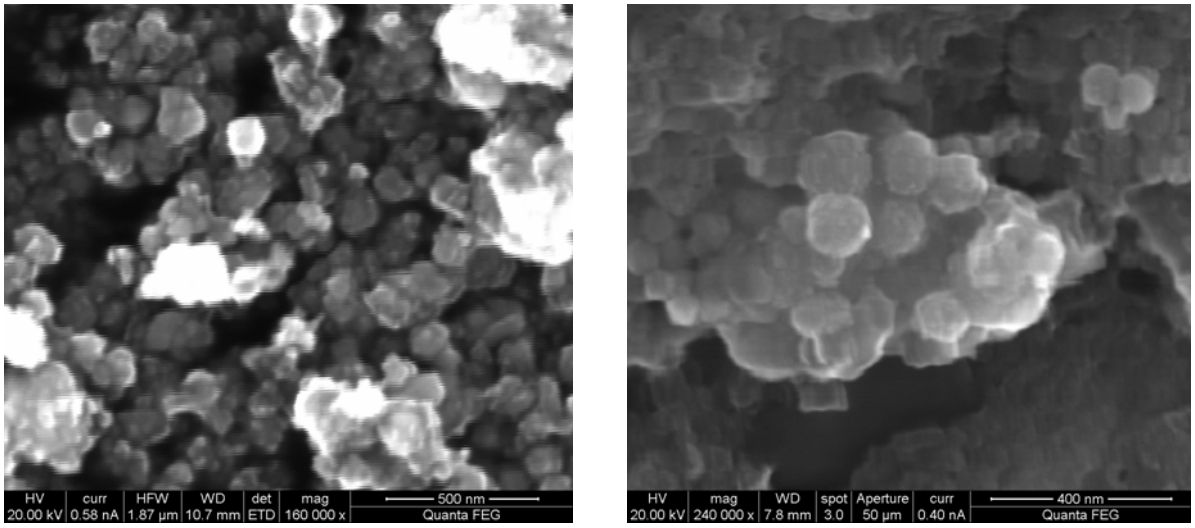

Fig. 1 *SEM image of Fe_2O_3 (left) and Gd^{III}/SiO_2 (right)*

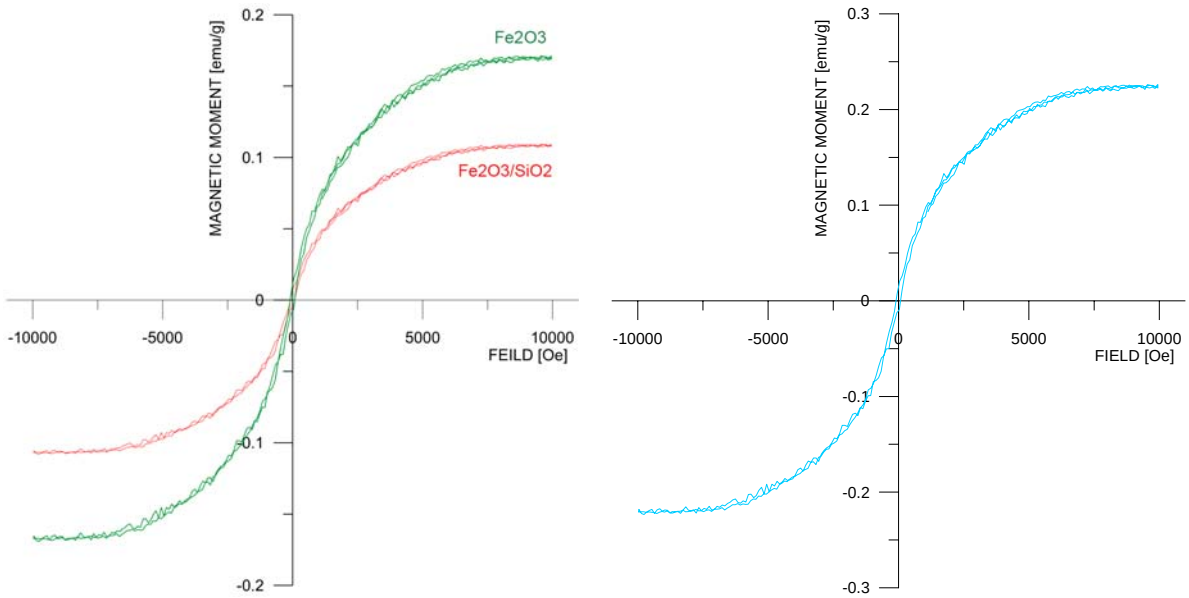

Fig. 2 *Magnetization curves of Fe_2O_3 and Fe_2O_3/SiO_2 (left) and Gd^{III}/SiO_2 (right)*