Evaluation of the induction heating of magnetic nanoparticles synthesized by different chemical methods.

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Magnetic nanoparticles have already been proved successfully in different biomedical applications (MRI, separation cells, drug delivery…). This work has focused on the development of this kind of particles considering its potential application for hyperthermia.

Several magnetite nanoparticles Fe_3O_4 (**S6,S8, S10**) have been synthesized by two methods of synthesis: the co-precipitation method for the S6 sample and the poliol method for the S8 and S10 samples. Between these last samples, the precursor concentration (iron chloride) was varied.

After the synthesis, these samples were coated with citric acid as dispersant agent (named: **S6-AC**, **S8-AC** and **S10-AC**), for comparing the heating of the particles with and without coating.

It was carried out the evaluation of the size (by transmission electron microscopy), magnetic properties (measured in an electromagnet) and composition (by X-Ray Diffraction) of these magnetic nanoparticles. To study the induction heating of these materials, preliminary tests were done in an industrial equipment. Considering a higher heating capacity of the samples coated with citric acid dispersant, these samples were selected for an accurate study in a specific equipment for hyperthermia.

The particle size was found to be approximately the same for all the samples, between 8 -12 nm. Also, the saturation magnetization values were similar (57-67 emu/g), obtaining values slightly higher for the samples with the citric acid dispersant agent.

The X-Ray diffractograms of the S6-AC and S8-AC samples show identical compositions (magnetite) for both samples. However the S6-AC shows a double heating rate than the corresponding to the S8-AC. Figure 1.

On the other hand, using the same synthesis method but changing the conditions, the particles obtained can be different. This difference is clearly observed in the heating capacity. In the X-Ray diffractogram of the S10-AC sample, in addition to the peaks related to the magnetite, it appears several peaks corresponding to iron metallic nanoparticles. S10-AC particles heat up to 10 times quicker than the S8. Figure 2.

All our particle dispersions have shown capacity to get 70ºC in less than 3 minutes, when heated by exposition to an AC magnetic field with the frequency of 441 kHz.

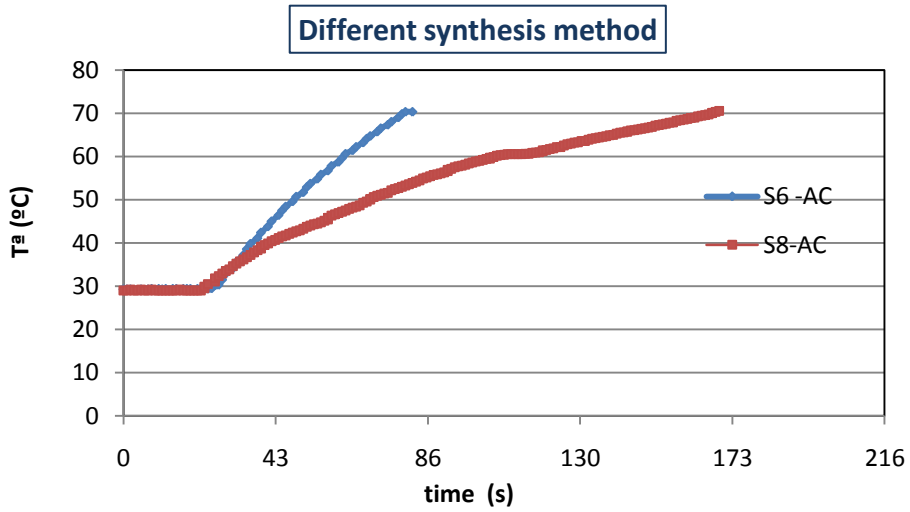

Figure 1. Induction heating for the S6-AC and S8-AC samples.

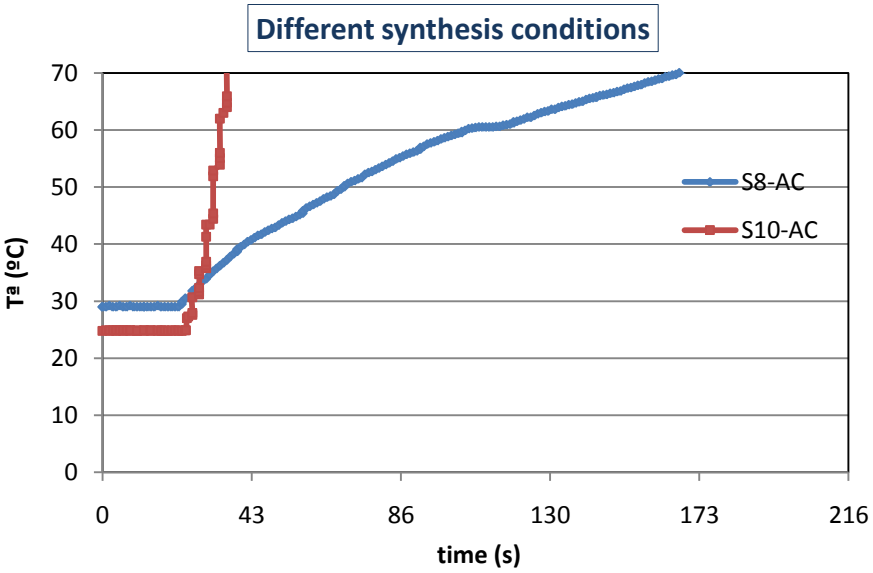

Figure 2. Induction heating for the S8-AC and S10-AC samples.