The influence of colloidal parameters on the specific power absorption of magnetite nanoparticles with core-shell structure.

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Magnetic nanoparticles with appropriate coatings are increasingly being used in many biomedical applications, such us magnetic resonance imaging, drug delivery, cell and tissue targeting or hyperthermia [1-3]. For hyperthermia therapy, nanotechnology offers a powerful tool to the design of nanometer heat-generating sources, which can be activated remotely by the application of an external alternating magnetic field.

Adequately coated iron oxide-based nanoparticles have been the most extensively studied material in hyperthermia experiments because they are thought to be biocompatible and nontoxic, making them suitable for in vivo applications [4-5]. The effective use of magnetic nanoparticles for these applications depends on several factors related to the size, shape, solvent and magnetic properties of the biocompatible nanoparticles. Although the size dependence of the heating power has been already investigated and indicates the existence of an optimal particle size in which the heating power is maximum [6], there is no systematic data on the influence of particle concentration, coating or solvent properties. In order to study the influence of these effects on the heating properties of the system, several dispersions containing single-domain magnetite nanoparticles with particle size between 4 and 12 nm coated with poly-acrylic acid (PAA) have been chemically synthesized through the coprecipitation method. The PAA-coated magnetite nanoparticles showed both crystallinity and magnetic properties similar to the bulk material. The specific power absorption (SPA) of the magnetic dispersions has been evaluated separately by changing both their magnetite nanoparticle concentration and their coating agent in water solution. In this sense, several functionalizing polymers/molecules have been used to coat the magnetic nanoparticle surface (i.e. PAA, oleic acid). Two different silica shell thicknesses coating the PAA-coated magnetite nanoparticles have been also studied. The effect of heat diffusion through the nonmagnetic silica shell coating on the heating power generated by the magnetic nanoparticles is discussed.

In order to evaluate separately the Brownian contribution to the general hyperthermia mechanism, the heating properties of magnetic dispersions at a fixed particle concentration have been evaluated as a function of the solvent viscosity, η. It is important to remark that the magnetite concentration was kept constant and the final dispersions showed a very good stability.

In conclusion, our approach in this work includes the synthesis of biocompatible core-shell magnetite based nanoparticle dispersions and has been focused on the SPA dependence of several factors related to the particle concentration, coating agents and solvent properties, mainly in those dispersions containing PAA-coated magnetite nanoparticles. The results obtained will be shown and discussed.

References

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