Synthesis of superparamagnetic nanoparticles for magnetic hyperthermia application

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Abstract

Magnetic nanoparticles (MNPs) have attracted increasing interest during the last decades due to their unique properties and potential applications in biomedicine, such as magnetic separation, drug delivery, magnetic resonance imaging (MRI) or magnetic hyperthermia.[1] Among them, magnetic hyperthermia is a promising approach for the treatment of isolated tumours on which magnetic nanoparticles are subjected to an alternating magnetic field in order to generate a specific amount of heat. This heating allows raising the temperature of the tumour and activates mechanisms of cellular damage.[2]
However, due to the rapid advances in the use of magnetic nanoparticles for biomedicine, it is especially important to develop synthetic routes that allow a rigorous control of the microstructure of the magnetic core, as well as their size, monodispersity and magnetic properties.[3] Besides, for all these *in vivo* applications, where the target concentration is very small, or the encapsulation efficiency is quite low, it is important to achieve the temperature enhancement with as low as possible amount of MNP. Therefore, the specific loss power (SLP) of the magnetic nanomaterial must be as high as possible.
Superparamagnetic iron oxide nanoparticles, also known as SPIONs, are the most used materials for this kind of applications due, principally, to their low toxicity and good biocompatibility.[4] Other superparamagnetic nanoparticles based on metals or metallic alloys, have remarkable high SLP and magnetic susceptibility. However, they are highly toxic, so different approaches should be addressed to avoid their side effects.
In this study, either SPIONs, or metallic suparamagnetic nanoparticles have been synthesized in order to optimize their magnetic properties as well as for improve the hyperthermia effect that they can induce for their use in cancer treatments. The influence of the parameters of the synthesis on the structure and properties of the nanoparticles has been studied. The effect of different functionalization of the MNPs has also been addressed.
The crystalline structure of the nanoparticles as well as, size, shape, stability and, more importantly, magnetic hyperthermia behaviour have been determined. This exhaustive characterization has allowed the optimization of each synthesis procedure in order to obtain monodisperse and homogeneous nanoparticles with high specific absorption rates which is a very important improvement, compared with the same kind of nanoparticles available in the literature. Moreover, these magnetic nanoparticles with tailored magnetic hyperthermia will be integrated in further stages of the research into drug delivery systems with specific cell recognition for their implementation for cancer hyperthermia treatments.

References

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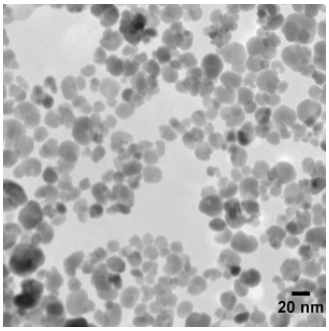
Figures



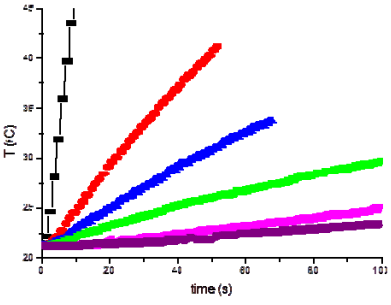


Figure 1. TEM image of SPION magnetic nanoparticles. Figure 2. Magnetic hyperthermia heating curves of different MNPs.