# Magnetic nanoparticles as *theranostic* agents in hyperthermia and MRI applications

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## Abstract

Magnetic nanoparticles (MNPs) have become key elements in the design of functional nanostructures able to play an active role in different biomedical applications, e. g. as heat generating sources in magnetic hyperthermia, as enhanced contrast agent in magnetic resonance imaging (MRI), drug delivery, cell separation and biosensing. In particular, superparamagnetic iron oxide nanoparticles (SPIONs) are the commonest used MNPs in biomedical research, since they are found to be biocompatible and non-toxic, show relatively high saturation magnetization with zero coercivity and remanence and have a large surface area available to be further functionalized.

In this talk, a general overview on several applications of SPIONs in the biomedical field will be presented, mainly focused on magnetic hyperthermia and magnetic resonance imaging. Contrast agents are widely used to enhance the natural contrast of magnetic resonance clinical images, and SPIONs have received great interest as a safer alternative to the traditional Gd chelates used in clinics nowadays. In order to study the ability of several SPIONs as negative contrast agents (T2-type) for neural stem cell tracking by MRI, the effect of different physico-chemical parameters on their relaxometric properties was investigated, e. g. synthesis procedure, chemical composition, coating agent. *In vitro* assays, in which SPIONs were incubated with rat mesenchymal stem cells (rMSCs), revealed that particle aggregation in the cell culture medium greatly influences cellular uptake.

On the other hand, the interaction of their magnetic moment with an externally supplied AC magnetic field provide SPIONs with the ability to transform the electromagnetic energy into heat. In other words, SPIONs behave as heat generating nanosources under an oscillating magnetic field. The main direct implication of this feature shows up in cancer therapy. MNPs can be guided towards the tumor region and locally induce a temperature increase to selectively kill the more thermal sensitive cancer cells while keeping alive the healthy ones. Particularly interesting is their incorporation into biocompatible natural and synthetic scaffolds for bone tissue engineering applications [1, 2]. The main objective for designing biocompatible and bioresorbable magnetic scaffolds is the possibility to obtain structures with additional multifunctionality and reinforced mechanical properties that can be manipulated in situ by applying external magnetic fields. Out of the biomedical field, we also explored magnetic hyperthermia as a chemical-free disinfection method against food spoilage microorganisms able to form biofilms on different substrates [3]. Results revealed that magnetic hyperthermia shows better bactericidal performance compared to a conventional direct heating.

## References

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