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Magnetic Nanoparticles for magnetic hyperthermia and cytotoxic action: from the synthesis to their in vitro and in vivo characterization

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Chemotherapy and surgery are the main modalities to treat tumors in clinics. There are several FDA approved chemotherapeutic agents, such as doxorubicin, cisplatin, paclitaxel etc., however together with beneficial actions against tumor cells they also have various side effects due to their non-specific action against healthy cells.

On the other hand, the use of heat to reduce tumor mass is very ancient. Nowadays, many techniques allow to precisely focalizing the heat in very specific body regions resulting in treatments that are more efficient and minimize side effects. Magnetic nanoparticles can act as heat mediators under oscillating magnetic fields in the so-called “magnetic hyperthermia”. This field has received a renewed interest thanks to the development of nanoparticles preparation by non-hydrolytic methods. These approaches deliver magnetic nanoparticles with a better control in terms of size, size distribution and crystallinity. All these parameters affect structural and magnetic properties of nanomaterials and thus their heat performance. Here, I will first focus on our recent progress on the combination of cubic shaped iron oxide magnetic nanoparticles with thermo-responsive coatings to combine magnetic hyperthermia with heat-mediated drug delivery. I will cover all topics from the synthesis, to the functionalization and characterization, to the drug loading and in vitro characterization, to the in vivo efficacy study on xenograft tumor murine model. In addition, our bio-distribution studies have indicated the absence of toxicity of such materials and their in vivo clearance over three months.

I will also provide a comparative study of magnetic hyperthermia based on polyethylene glycole stabilized iron oxide nanocubes to another type of nanocubes made of spinel cobalt ferrites (Co0.6Fe2.3O4 NCs) providing also in this case the in vitro and in vivo study. In a murine model, the slow release of cytotoxic cobalt ions together with the heating effects of the Co0.6Fe2.3O4 NCs under the oscillating magnetic field of clinical use, has brought to a complete tumor regression in case of locoregional treatment of small tumors (less than 0.5 cm in diameter).