A multifunctional approach focused on hyperthermia response of commercial ferrofluids

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Magnetic ferrofluids have received special attention due to their various biomedical applications including cancer diagnosis and treatment. The aim of this study was to investigate the ability of commercial ferrofluids to work as multifunctional heat mediators. Samples under study are the MRI agents FeraSpin-XX series from nanoPET-Pharma (www.nanopet-pharma.com) where XX denotes XS, R, Re and XL with variable hydrodynamic diameters of iron-oxide magnetic nanoparticles. Magnetic nanoparticles being subjected to an AC magnetic field may show remarkable heating effects related to losses during the magnetization reversal process of the particles. Taking advantage of this behaviour of the nanoparticles it is possible to locally raise the temperature inside a tumor between 41°C and 45°C (a desirable hyperthermia limit) to promote cell death, a treatment known as magnetic particle hyperthermia (MPH). Calorimetric measurements were taken using two different AC magnetic field frequencies (210 and 765 kHz) corresponding to similar magnetic field amplitudes (15-25 kA/m) and varying solution concentration (0.5-2 mg_{Fe}/mL). The magnetic heating characteristics of the ferrofluids were investigated and determined by estimating the quantifiable index of heating efficiency, the Specific Loss Power (SLP), which is measured in watts per gram of magnetic material (Fig. 1). Iron oxide nanoparticles with optimum performance were used to an *in vitro* hyperthermia study that performed on human osteosarcoma cell line Saos-2 cells. Finally, our work revealed a size-dependent cytotoxicity profile, tunable SLP together with fast thermal response, features that are crucial for adequate thermal efficiency combined with minimum treatment duration. The heating efficiency along with their non-cytoxic behaviour of these commercial magnetic ferrofluids reveal their multifunctional role in modern theranostics. The wide range of accessible features of magnetic nanoparticles underscores their potential as the most promising platform material available for theranostics.

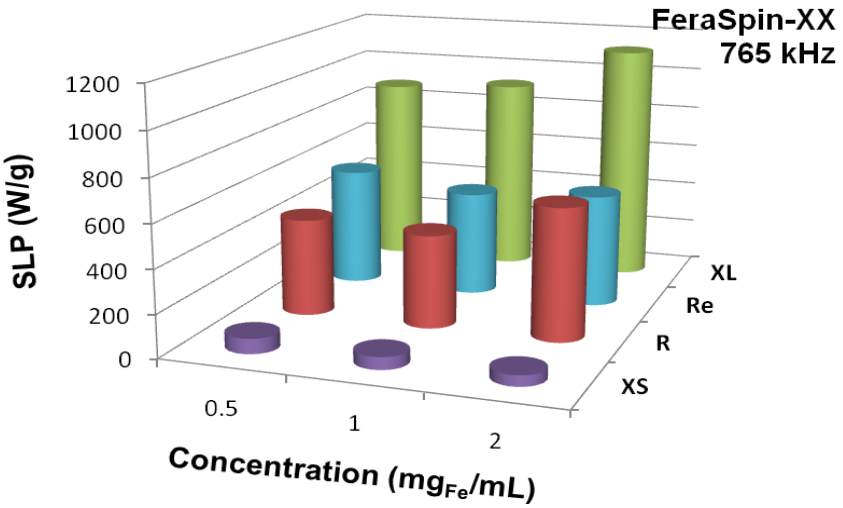

Figure 1: SLP at various concentrations of FeraSpin-XX (XS, R, Re and XL) under AC magnetic field frequency 765 kHz at 25 kA/m.

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