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Superparamagnetic cobalt substituted iron oxide nanoparticles as heat source in magnetic hyperthermia: influence cobalt concentration on Specific Loss Power

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When magnetic nanoparticles (MNPs) are placed in an alternating (ac) magnetic field, they absorb the energy of the field and convert it into heat, which causes a temperature change in the system. Consequently, it makes them suitable for cancer treatment with magnetic hyperthermia (MH). The efficiency of heat generation by MNPs is expressed through Specific Loss Power (*SLP*). *SLP* dependence on the heat capacity of nanoparticles and the temperature change in the system with time ($\Delta T/\Delta t$), and most often it was estimated from calorimetric heating measurements. For the treatment of malignant diseases by MH, it is necessary to accumulate a sufficient amount of MNPs in the tumor tissue and they should have enough high *SLP*. Nanoparticles $Co_{0.047}Fe_{2.953}O_4$ (S1) and $Co_{0.086}Fe_{2.914}O_4$ (S2) were synthesized by co-precipitation method at 80 °C for 2 hours to be tested for potential application in MH. X-ray diffraction data show that the nanoparticles crystallize in a spinel-type structure (space group Fd3m) and are single-phase. The calculated crystallite size by Scherrer's equation using FWHM of reflection (311) was 9.9 and 11.5 nm, respectively. TEM analysis shows that the particles are quasi-spherical in shape and ~15 nm in size. By measuring the magnetization in different magnetic fields, it was found that the samples are superparamagnetic at room temperature with a value of saturation magnetization of 69.5 emu/g (S1) and 73.4 emu/g (S2), which indicates an incremental influence of incorporating cobalt into the crystal lattice of the host compound (Fe_3O_4) on the magnetism of nanoparticles. Calorimetric curves of S1 and S2 heat generators were measured using a commercial DM100 device (nB Nanoscale Biomagnetics, Zaragoza, Spain) in different external fields and frequencies. The heating curves of studied nanoparticles showed that sample S1 could be potentially used as a heating agent in magnetic hyperthermia applications. The *SLP* values were around 50 W/g (H_{AC} = 15.91 kA/m and f = 252 kHz) for S1, while S2 was significantly lower at ~25 W/g. To be used as heating agent in magnetic hyperthermia, sample S1 was coated with citric acid ($CA@Co_{0.047}Fe_{2.953}O_4$) and poly(acrylic) acid ($PAA@Co_{0.047}Fe_{2.953}O_4$). Further hyperthermia studies, FT-IR, DLS, ζ-potential measurements and TGA analysis are yet to be performed.