Tunning the composition of multidoped magnetite nanoparticles starting from bimetallic FeMn, FeCo and FeZn oleates

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The preparation of nanostructures with specific sets of features (composition, size and morphology) requires a fine control over the synthetic protocol[1]. Specifically, iron oxide nanoparticles (IONPs) have become versatile building blocks for a wide range of biomedical applications including magnetic hyperthermia, magnetic resonance imaging and drug delivery among others. In this sense, the thermal decomposition of organometallic precursors allows synthesizing novel iron oxide-based magnetic NPs (MNPs) with a well-defined size and morphology[2]. The introduction of a low quantity of divalent transition-metal ions ($M_xFe_{3-x}O_4$, M = Mn, Co and Zn) within the spinel structure of MNPs has proven to be a good strategy to obtain mixed ferrites with tuned magnetic performance. Herein, we present an improved chemical route to synthesize Mn/Co/Zn-doped magnetite NPs based on the thermolysis of bimetallic oleates ($Fe_{3-n}M_nOl_{9-n}$). Following a similar approach, two types of M-doped magnetite NPs have been synthesized: *i)* Single-doped magnetite NPs ($M_xFe_{3-x}O_4$) and *ii)* Multi-doped magnetite NPs ($Ma_xMb_yFe_{3-x-y}O_4$) with a metal content of $0.02 < x,y < 0.2$. This synthetic protocol has led to a set of highly homogenous cuboctahedral NPs with average sizes ranging from 16 to 32 nm, with large saturation magnetization values (≥ 86 Am^2/kg at RT). These samples have been chemically, structurally, morphologically and magnetically analyzed making use of Inductively Coupled Plasma Mass Spectrometry (ICP-MS), X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM) and DC Magnetometry. Finally, the biomedical potential of the whole set of samples in the magnetic hyperthermia therapeutic modality has been analyzed in detailed by measuring the dynamical hysteresis loops at different frequencies (up to a field intensity of 90 mT). Some of the samples have shown a great magnetothermal efficiency (> 600 W/g) under clinical safety limits (36 kA/m and 125 kHz), with makes these nanoparticles promising candidates for future magnetically-mediated medical devices.

References

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[2] Hufschmid, R.; Arami, H.; Ferguson, R. M.; Gonzales, M.; et.al. Nanoscale 2015, 7, 11142−11154.

Figures

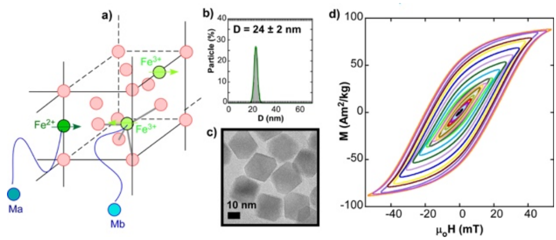

Figure 1. **a)** Assymetric unit of Fe_3O_4 lattice, **b ,c)** TEM image, corresponding size distribution and **d)** AC hysteresis loops of a $M_xFe_{3-x}O_4$ NPs sample.