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Article

Saturation of Specific Absorption Rate for Soft and Hard Spinel Ferrite Nanoparticles Synthesized by Polyol Process

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Abstract: Spinel ferrite nanoparticles represent a class of magnetic nanoparticles (MNPs) with enormous potential in magnetic hyperthermia. In this study, we investigated the magnetic and heating properties of spinel soft $NiFe_2O_4$, $MnFe_2O_4$, and hard $CoFe_2O_4$ MNPs of comparable sizes (12–14 nm) synthesized by the polyol method. Similar to the hard ferrite, which predominantly is ferromagnetic at room temperature, the soft ferrite MNPs display a non-negligible coercivity (9–11 kA/m) arising from the strong interparticle interactions. The heating capabilities of ferrite MNPs were evaluated in aqueous media at concentrations between 4 and 1 mg/mL under alternating magnetic fields (AMF) amplitude from 5 to 65 kA/m at a constant frequency of 355 kHz. The hyperthermia data revealed that the SAR values deviate from the quadratic dependence on the AMF amplitude in all three cases in disagreement with the Linear Response Theory. Instead, the SAR values display a sigmoidal dependence on the AMF amplitude, with a maximum heating performance measured for the cobalt ferrites (1780 W/g_{Fe+Co}), followed by the manganese ferrites (835 W/g_{Fe+Mn}), while the nickel ferrites (540 W/g_{Fe+Ni}) present the lowest values of SAR. The heating performances of the ferrites are in agreement with their values of coercivity and saturation magnetization.

Keywords: ferrite nanoparticles; polyethylene glycol; polyol method; magnetic hyperthermia; specific absorption rate; Linear Response Theory; saturation of SAR

1. Introduction

In recent decades, the potential applications of magnetic nanoparticles (MNPs) in various fields, have increased exponentially due to their specific characteristics [1–4]. While MNPs possess common features with other nanoparticulate systems owing to their size, such as a high surface to volume ratio, nevertheless they have specific unparalleled advantages, like the possibility of remotely controlling their movement, temperature, and organization by using external magnetic fields. These characteristics