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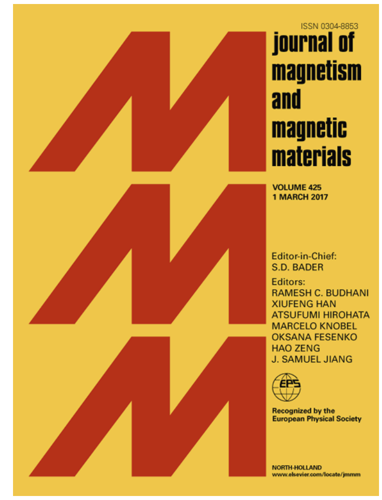

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Experimental determination of the frequency and field dependence of Specific Loss Power in Magnetic Fluid Hyperthermia

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Abstract

Magnetic nanoparticles are promising systems for biomedical applications and in particular for Magnetic Fluid Hyperthermia, a promising therapy that utilizes the heat released by such systems to damage tumor cells. We present an experimental study of the physical properties that influences the capability of heat release, i.e. the Specific Loss Power, *SLP*, of three biocompatible ferrofluid samples having a magnetic core of maghemite with different core diameter d = 10.2, 14.6 and 19.7 nm. The *SLP* was measured as a function of frequency f and intensity of the applied alternating magnetic field H, and it turned out to depend on the core diameter, as expected. The results allowed us to highlight experimentally that the physical mechanism responsible for the heating is size-dependent and to establish, at applied constant frequency, the phenomenological functional relationship $SLP=c\cdot H^x$, with $2\leq x<3$ for all samples. The x-value depends on sample size and field-frequency intensity, here chosen in the typical range of operating magnetic hyperthermia devices. For the smallest sample, the effective relaxation time $\tau_{eff} \approx 19.5$ ns obtained from *SLP* data is in agreement with the value estimated from magnetization data, thus confirming the validity of the Linear Response Theory model for this system at properly chosen field intensity and frequency.

Keywords

Magnetic Fluid Hyperthermia, Magnetic Nanoparticles, Superparamagnetism, Specific Loss Power.

1. INTRODUCTION

Magnetic nanoparticles are promising tools in biomedical applications against cancer, and suitable systems for diagnostics by e.g. Magnetic Resonance Imaging and innovative therapies, like drug delivery and Magnetic Fluid Hyperthermia (MFH) [1-11]. The MFH is a recently developed anti-cancer locally acting technique which aims to reduce the side effects of the traditional techniques as chemo- or radio- therapies [12]. This technique makes use of the capability of magnetic nanoparticles (MNPs) to release heat when exposed to an alternating magnetic field (AMF), as a therapeutic treatment to selectively destroy tumor cells within the human body. In MFH treatments, the AMF application is strictly limited to a safety range of frequency f and intensity H due to medical and technical restrictions, as established by the Brezovich criterion which requires $H\cdot f < 4.85\cdot 10^8$ $Am^{-1}s^{-1}$ [13]. The amount of magnetic field energy converted into heat (and