Nanoscale physics

High-frequency magnetic properties of $La_{0.75}Sr_{0.25}MnO_3$ nanoparticles for hyperthermia applications

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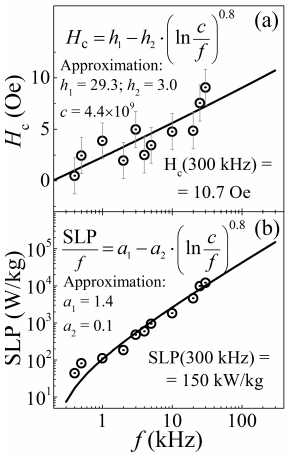
Hyperthermia, which is one of the most promising methods for cancer treatment, takes advantage of higher sensitivity of tumor tissue to heat and typically involves heating of the affected organ to 42÷45 C. Magnetic hyperthermia (MHT) is based on the injection of magnetic nanoparticles (MNPs) into a tumor and subsequent heating it by means of AC magnetic field (AMF).



An important step towards the clinical application of MHT consists in achieving a reliable control of the heating [1]. The MNPs of substituted manganites $La_{1-x}Sr_xMnO_3$ ($x \approx 0.25$) are promising materials for self-controlled MHT applications due to high heating efficiency and easy-tunable Curie point ($T_C \approx$ 40÷60 C).

The most efficient regime of MHT is achieved at frequencies of ~300 kHz. However, the experiments aimed at characterizing the MNPs at such frequencies are often complicated due to very high heating rate (~10 K/min) [1]. Instead, AMF frequencies of ~0.1÷ 10 kHz can be used with subsequent approximation of the key

parameters to higher frequencies, based on expressions for coercivity (H_c) and specific heating efficiency (SLP) from two-level model [2].

Our experiments confirm the validity of such approach (Fig. a,b).

1. *Belous A.G., Solopan S.O., Yelenich O.V., Tovstolytkin A.I., Kolodiazhnyi T.V., Osinsky S.P., Bubnovskaya L.N.* Nanoparticles of spinel and perovskite ferromagnets and prospects for their application in medicine // AIP Conference Preceedings.-2014.-**1627**, N 13.-P. 13-18.

2. *Carrey J., Mehdaoui B., Respaud M.* Simple models for hysteresis loop calculations of magnetic nanoparticles // J Appl Phys.-2011.**-109.-**P. 083921.