



ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)



Journal of Magnetism and Magnetic Materials 310 (2007) 2868–2870



[www.elsevier.com/locate/jmmm](http://www.elsevier.com/locate/jmmm)

## Self-heating characteristics of cobalt ferrite nanoparticles for hyperthermia application

Sang Won Lee<sup>a</sup>, Seongtae Bae<sup>a,\*</sup>, Yasushi Takemura<sup>b</sup>, In-Bo Shim<sup>c</sup>, Tae Min Kim<sup>d</sup>,  
Jeongryul Kim<sup>d</sup>, Hong Jae Lee<sup>d</sup>, Shayne Zurn<sup>e</sup>, Chul Sung Kim<sup>c</sup>

<sup>a</sup>Department of Electrical and Computer Engineering, Biomagnetics Laboratory (BML), National University of Singapore, Singapore 117576, Singapore

<sup>b</sup>Department of Electrical and Computer Engineering, Yokohama National University, Japan

<sup>c</sup>Department of Physics, Kookmin University, Seoul 136-702, Korea

<sup>d</sup>R&D Center, LG Micron, Gyeonggi 431-767, Korea

<sup>e</sup>WaveRider Inc., Nevis, MN 55467, USA

Available online 27 November 2006

---

### Abstract

The self-heating temperature rising characteristics of  $\text{CoFe}_2\text{O}_4$  hard spinel ferrite nanoparticles were investigated and were compared to those of soft spinel ferrite in order to explore the effects of magnetic anisotropy and magnetic susceptibility on the behavior of self-heating temperature rising characteristics for hyperthermia application. The maximum self-heating temperature, elevated by using our specially designed RF-MRI modified LC circuit in a solid state, was  $4.6^\circ\text{C}$ . The corresponding frequency and magnetic field strength product for the  $4.6^\circ\text{C}$  temperature rising,  $H_0f$ , was  $13.4 \times 10^8 \text{ Am}^{-1} \text{ s}^{-1}$ . The extremely low elevated temperature and the small specific absorption rate (SAR) relevant to the gentle slope from the time vs. temperature rising curve were found to be primarily due to a stronger anisotropy (or a smaller magnetic susceptibility) of  $\text{CoFe}_2\text{O}_4$  hard spinel ferrite nanoparticles compared to the soft spinel ferrite nanoparticles.

© 2006 Elsevier B.V. All rights reserved.

PACS: 75.50.Gg; 75.50.Tt; 76.60.Es; 87.54.Br

Keywords:  $\text{CoFe}_2\text{O}_4$  ferrite; Nanoparticles; Self-heating temperature; Hyperthermia

---