Mössbauer Studies of Nano-Size Controlled Iron Oxide for Biomedical Applications

Sang Won Lee[1], Sam Jin Kim[1], In-Bo Shim[1], Seongtae Bae[2], *Member, IEEE*, and Chul Sung Kim[1], *Member, IEEE*

[1]Department of Physics, Kookmin University, Seoul 136-702, Korea
[2]Department of Electrical and Computer engineering, National University of Singapore, Singapore 117576, Singapore

We present the magnetic properties and the material characteristics of magnetite (Fe_3O_4), which was successfully prepared by using the reaction of iron(III) acetylacetonate [$Fe(acac)_3$] with surfactants at high temperature (so called by "high temperature decomposition method"). According to the results of high resolution transmission electron microscopy (HRTEM) analysis, the prepared iron oxide particles had the average particle sizes between 4 and 6 nm and very uniform size distributions. The crystal structure analyzed by using both XRD and Mössbauer spectra confirmed that the prepared iron oxide nanoparticles only have single magnetite (Fe_3O_4) crystal phase. The typical superparamagnetic behaviors were observed from the prepared iron-oxide nanoparticles. In addition, they showed the saturation magnetization, M_S of 59.5 emu/g for 4 nm, and of 59.7 emu/g for 6 nm, respectively at room temperature under the externally applied magnetic field of 10 kOe. The measured Mössbauer spectrum at 4.2 K was fitted using two magnetic components: (1) hyperfine fields $H_{\rm hf} = 514$ and 492 kOe, (2) isomer shifts $\delta = 0.35$ and 0.73 mm/s. The fitted data apparently verified that the prepared iron oxide samples only have pure magnetite ($[Fe^{3+}]_A\ [Fe^{2+}Fe^{3+}]_BO_4$).

Index Terms—**Bio-medical applications, magnetite, Mössbauer spectroscopy, nanoparticles, superparamagnetism.**