



# ISAMMA2007

The 1<sup>st</sup> International Symposium on Advanced Magnetic Materials  
May 28-June 1, 2007, Jeju, Korea



## Organized by

Research Center for Advanced Magnetic Materials  
The Korean Magnetics Society

## Sponsored by

Korea Science and Engineering Foundation  
Korean Federation of Science and Technology Societies  
Research Center for Spin Dynamics and Spin-Wave Devices

# Mössbauer Studies on Superparamagnetic behavior of Co-Ga Ferrite Nanoparticles

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Superparamagnetic nanoparticles have been used in biomedicine and biotechnology as contrast agents in magnetic resonance imaging (MRI) and as drug carriers for magnetically guided drug delivery. For biomedical applications the use of particles that present superparamagnetic behavior at room temperature is preferred [1-2]. Nanoparticles  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  is fabricated by a sol-gel method. The superparamagnetic properties of powders were investigated with XRD, SEM, Mössbauer spectroscopy, and VSM.  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  powders were annealed at 523 K had spinel structure and behaved superparamagnetically. The estimated size of superparamagnetic  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  nanoparticle is around 10 nm. The SEM micrographs indicate the distribution of grains with uniform size and have the spherical shape. The Mössbauer hyperfine spectra of nanosize  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  particles were taken at various temperatures from 4.2 to 295 K. As a result, blocking temperature  $T_b = 250$  K from Mössbauer spectroscopic measurements. The magnetic anisotropy constant of  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  annealed 523 K were calculated to be  $3.0 \times 10^5$  ergs/cm<sup>3</sup>. The hyperfine fields at 4.2 K for the *A* and *B* patterns were found to be 518 and 486 kOe, respectively. Magnetic properties of the superparamagnetic nanoparticle  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  annealed at 523 K were investigated with VSM from 60 to 300 K. At low temperatures, the sample annealed at 523 K, exhibits a hysteretic behavior, indicating that it has a ferrimagnetic phase. However, at room temperature, the ferrimagnetic hysteresis seems to have disappeared. As a typical blocking behavior of superparamagnetic nanoparticles, the  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  nanoparticles show a different magnetization process when the sample is cooled below the blocking temperature with an external magnetic field. It is considered that  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  powder that was annealed at 523 K is available for biomedicine application such as hyperthermia, drug delivery system and contrast agents in MRI.

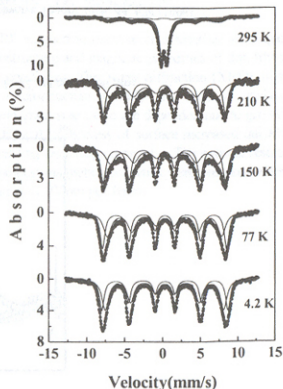


Fig. 1. The Mössbauer spectra of  $\text{CoGa}_{0.1}\text{Fe}_{1.9}\text{O}_4$  at various temperatures.

## REFERENCES

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