SD12

Mössbauer Studies on Superparamagnetic behavior of Co-Ga Ferrite Nanoparticles

Seung Wha Lee[1], Chul Sung Kim[2]*

[1]Department of Physics, Chungbuk National University, Gaesin-Dong, Sang-Dang Gu, Cheongju, 361-763, Korea
[2]Department of Physics, Kookmin University, 861-1 Jeongneung-Dong, Seongbuk-Gu, Seoul, 136-702, Korea

*Corresponding author: cskim@kookmin.ac.kr, Phone: +82 02 910 4752, Fax: +82 2 910 5170

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 $CoGa_{0.1}Fe_{1.9}O_4$ is fabricated by a sol-gel method. The superparamagnetic properties of powders were investigated with XRD, SEM, Mössbauer spectroscopy, and VSM. $CoGa_{0.1}Fe_{1.9}O_4$ powders were annealed at 523 K had spinel structure and behaved superparamagnetically. The estimated size of superparammagnetic $CoGa_{0.1}Fe_{1.9}O_4$ 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 $CoGa_{0.1}Fe_{1.9}O_4$ 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 $CoGa_{0.1}Fe_{1.9}O_4$ annealed 523 K were calculated to be 3.0×10^5 ergs/cm^3. 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 $CoGa_{0.1}Fe_{1.9}O_4$ 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 $CoGa_{0.1}Fe_{1.9}O_4$ nanoparticles show a different magnetization process when the sample is cooled below the blocking temperature with an external magnetic field. It is considered that $CoGa_{0.1}Fe_{1.9}O_4$ powder that was annealed at 523 K is available for biomedicine application such as hyperthermia, drug delivery system and contrast agents in MRI.

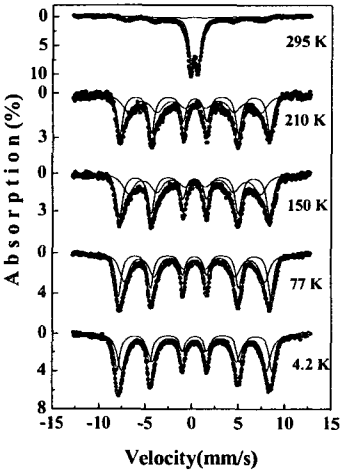

Fig. 1. The Mössbauer spectra of $CoGa_{0.1}Fe_{1.9}O_4$ at various temperatures.

REFERENCES

[1] Perdo Tartaj, Maria del Puerto Morales, Sabino Veintemillas-Veraguer and Carlos J Serna. J. Phys. D: Appl. Phys., **36** R182 (2003).
[2] S. W. Lee, K. C. S. Kim, J. of Magnetics. **10**, 84 (2005).

SD13

Half Metallic Ferromagnetism of Mn Doped AlSb: A First Orinciples Study

Gul Rahman*, Sungle Cho, and Soon Cheol Hong

Department of Physics, University of Ulsan, San 29, Mugeo 2-dong, Nam-gu, Ulsan 780-749, Korea

*Corresponding author: grnphysics@yahoo.com, Phone: +82 52 259 2926, Fax: +82 52 259 1963

Ferromagnetic $III_{1-x}Mn_xV$ semiconductors [1] are under intensive investigation as a potential basis for new generation of spintronic devices. In these diluted magnetic semiconductors (DMS) the ferromagnetism is believed to arise from the exchange interaction between holes having primarily a *p*-orbital character and *d* electrons localized at the Mn sites. Hence Mn, which functions both as a magnetic ion and an accepter and have high magnetic moment, is mostly used magnetic impurity in DMS. The discovery of ferromagnetism in $Ga_{1-x}Mn_xAs$ [2]attracted much attention to III-V DMS. The other promising candidate for spintronic devices is believed to be half metallic ferromagnets. Much attention has been paid to hypothetical zinc-blende(z-b) phase of transition metal chalcogenides[3] and pnictides[4]which show half metallic ferromagnetism.

Here we investigate theoretically the magnetic and electronic structure of Al_{1-x} Mn_x Sb which can be used for practical applications in the field of semiconductor electronics.

We employed the spin-polarized, full potential linearized augmented plane wave (FLAPW) method within the generalized gradient approximation to study the electric and magnetic properties of $Al_{1-x}Mn_xSb$ (x=0.25, 0.50, 0.75, and 1.0). We assumed that Mn atoms substitute Al ones. For each compound we optimized the lattice constant. We observed that $Al_{1-x}Mn_xSb$ is ahalf metal ferromagnet. The Fermi level shifts towards high energy with the increase of Mn concentrations. At the end composition i.e MnSb, the Fermi level touches the conduction band edge and MnSbis nearly half metal. Interestingly the minority spin gap (~1.0 eV) is insensitive to Mn concentrations.

The total magnetic moment per formula of $Al_{1-x}Mn_xSb$ remains to be 4.0 μ_B independently on Mn concentration due to its half-metallicity. The induced magnetic polarization of the nearest Sb atom is antiparallel to that of Mn atom, which means that valence-band carriers having mainly Sb *p* character interact antiferromagnetically with Mn spins. On the other hand the parallel magnetic polarization is found at the Al site.

The detailed magnetic and electronic properties of $Al_{1-x}Mn_xSb$ will be discussed in this conference.

REFERENCES

[1] H.Ohno et.al, Phys. Rev. Lett **68**, 2664 (1992)
[2] H. Ohno et.al, Appl. Phys. Lett. **69**, 363 (1996).
[3] Wen-Hui et.al, Phys. Rev. Lett **91**, 037204 (2003)
[4] B. Sanyal et.al, Phys. Rev. B **68**, 054417 (2003)