ICAME 2005

SEPTEMBER 5-9, 2005
MONTPELLIER FRANCE

Programme and Abstracts

International Conference on the Applications of the Mössbauer Effect

LE CORUM
Conference Centre

Esplanade Charles de Gaulle
Montpellier, France

MÖSSBAUER AND OPTICAL INVESTIGATION OF $Co_{3-x}Fe_xO_4$ THIN FILMS GROWN BY SOL-GEL PROCESS

Kwang Joo Kim[1], Hee Kyung Kim[1], Young Ran Park[1], Geun Young Ahn[2], Chul Sung Kim[2], Jae Yun Park[3]

[1]*Department of Physics, Konkuk University, Seoul 143-701, South Korea*
[2]*Department of Physics, Kookmin University, Seoul 136-702, South Korea*
[3]*Department of Materials Science and Engineering, University of Incheon, Incheon 402-749, South Korea*

Crystallographic transformation, magnetic, and optical properties of $Co_{3-x}Fe_xO_4$ thin films have been investigated by X-ray diffraction (XRD), vibrating sample magnetometry (VSM), spectroscopic ellipsometry (SE), and conversion electron Mössbauer spectroscopy (CEMS). $Co_{3-x}Fe_xO_4$ samples were prepared as thin films on Si(100) substrates with thickness of about 1 μm by a sol-gel method employing spin-coating process.

As shown Figure 1, XRD spectra exhibit the crystallographic transformation of normal to inverse spinel phase with Fe composition in the $Co_{3-x}Fe_xO_4$ films. It is seen that the same phase as in Co_3O_4 is maintained up to x = 0.55 with gradual increase of the cubic lattice constant with x. The XRD data also indicate the coexistence of two phases between x = 0.76 and 0.93. The result of magnetic-property measurements by VSM on the $Co_{3-x}Fe_xO_4$ films revealed a strong ferrimagnetic behavior above x = 0.76. Optical measurments on the $Co_{3-x}Fe_xO_4$ films by SE revealed that the imaginary part of the dielectric function of $Co_{3-x}Fe_xO_4$ in the 1.5 – 4 eV photon-energy range evolves as the Fe composition changes. As the Fe composition increases, the 2.8-eV absorption, due to p-d charge-transfer (CT) transition between O and octahedral Co^{3+} ion,[1] is reduced in intensity. The 1.65-eV structure, due to d-d CT transition between octahedral Co^{3+} and tetrahedral Co^{2+} ions also suffers from reduction in strength as x increases. These results indicate that the Fe^{3+} ions substitute octahedral Co^{3+} sites mostly for low Fe compositions. The result of CEMS measurements on the $Co_{3-x}Fe_xO_4$ films revealed that Fe has Fe^{2+} as well as Fe^{3+} ionic valence at high Fe compositions. CEMS spectrum of $Co_{2.07}Fe_{0.93}O_4$ film is exhibited in Fig. 2. It is found that the Fe^{3+} cations occupy both tetrahedral and octahedral sites as x increases.

* This work was supported by the financial support of Konkuk University made in the program year of 2004.

[1] K. J. Kim, Y. R. Park, D. H. Hyun, and S. H. Lee, J. Appl. Phys. **96** (2004) 1975.

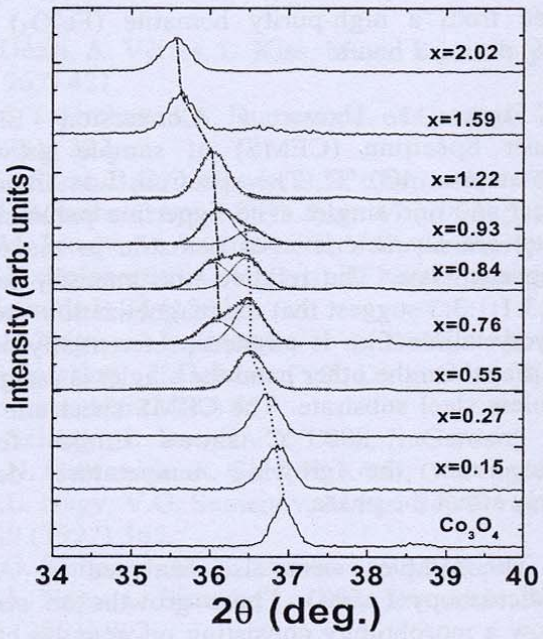

Figure 1. XRD (311) peak of $Co_{3-x}Fe_xO_4$ films.

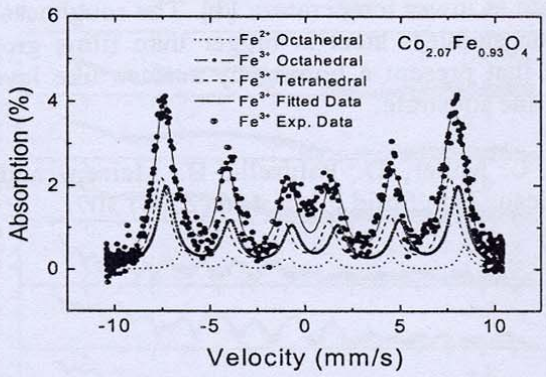

Figure 2. CEMS spectrum of $Co_{2.07}Fe_{0.93}O_4$ thin film at room temperature.