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 Kim¹, Hee Kyung Kim¹, Young Ran Park¹, Geun Young Ahn², Chul Sung Kim², Jae Yun Park³

¹Department of Physics, Konkuk University, Seoul 143-701, South Korea
²Department of Physics, Kookmin University, Seoul 136-702, South Korea
³Department 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 compositon 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 measurements 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 Co³⁺ ion,[1] is reduced in intensity. The 1.65-eV structure, due to d-d CT transition between octahedral Co³⁺ and tetrahedral Co²⁺ ions also suffers from reduction in strength as x increases. These results indicate that the Fe³⁺ ions substitute octahedral Co³⁺ sites mostly for low Fe compositions. The result of CEMS measurements on the Co_{3-x}Fe_xO_4 films revealed that Fe has Fe²⁺ as well as Fe³⁺ 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 Fe³⁺ 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.