



ICAMD 2011

The 7th International Conference on Advanced Materials and Devices

December 7~9, 2011

Ramada Plaza Jeju Hotel, Jeju, Korea

Program and Abstracts

Organized by

- Applied Physics Division of the Korean Physical Society
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Studies of magnetic properties of Zn-doped Y-type hexaferrite

Chin Mo Kim, Jung-tae Lim and Chul Sung Kim

Department of Physics, Kookmin University, Seoul, 136-702, Korea

$\text{Ba}_2\text{Zn}_x\text{Co}_{2-x}\text{Fe}_{12}\text{O}_{22}$ samples were prepared by solid state reaction method. The crystallographic and magnetic properties of the prepared compounds were investigated by x-ray diffractometer (XRD), vibrating sample magnetometer (VSM), and Mössbauer spectroscopy. Base on x-ray diffraction measurements, the crystal structures were found to be hexagonal with space group $R3-m$. The lattice constants of $\text{Ba}_2\text{Zn}_x\text{Co}_{2-x}\text{Fe}_{12}\text{O}_{22}$ samples were $a_0 = 5.8738$ and $c_0 = 43.5808$ Å for $x=1$, $a_0 = 5.8638$ and $c_0 = 43.5259$ Å for $x=0$. The X-ray density (ρ_D) of $\text{Ba}_2\text{Zn}_x\text{Co}_{2-x}\text{Fe}_{12}\text{O}_{22}$ samples were 3.2741×10^{24} g/cm³ ($x=1$) and 3.2744×10^{24} g/cm³ ($x=0$), respectively. The saturation magnetization (M_S) and coercivity (H_C) of the $\text{Ba}_2\text{ZnCoFe}_{12}\text{O}_{22}$ at 295 K were found to be $M_S = 42.7$ emu/g and $H_C = 129$ Oe, respectively, while M_S and H_C of the $\text{Ba}_2\text{Co}_2\text{Fe}_{12}\text{O}_{22}$ at 295 K were found to be $M_S = 29.7$ emu/g and $H_C = 209$ Oe. The permeability of the $\text{Ba}_2\text{ZnCoFe}_{12}\text{O}_{22}$ was 1.307 for 18.7 Oe and reached the maximum value of 1.613. The temperature dependent magnetization measurement between 4.2 and 740 K showed that the magnetic properties of $\text{Ba}_2\text{ZnCoFe}_{12}\text{O}_{22}$ changed to paramagnetic from ferrimagnetic around 473 K and that of non-doped ($x=0$) sample changed to paramagnetic from ferrimagnetic around 597 K. We found that transition temperature (T_C) of $\text{Ba}_2\text{ZnCoFe}_{12}\text{O}_{22}$ was about 130 K, which is lower than the non-doped ($x=0$) sample. Moreover, we have observed that magnetic structure of Zn-doped ($x=1$) sample changes to helimagnetic from ferrimagnetic around 128 K as expected. The magnetic susceptibility followed a Curie-Weiss law with a positive θ_{CW} of 518 K, showing ferrimagnetic behaviors. We have also obtained Mössbauer spectra of $\text{Ba}_2\text{Zn}_x\text{Co}_{2-x}\text{Fe}_{12}\text{O}_{22}$ from 4.2 to 700 K. At 295 K, average value of isomer shift of the $\text{Ba}_2\text{ZnCoFe}_{12}\text{O}_{22}$ was 0.159 mm/s, indicating the Fe^{3+} valence state.