

Mössbauer Studies of Cation Distribution in $\text{Zn}_x\text{Co}_{0.5-x}\text{Fe}_{2.5}\text{O}_4$ Microspheres

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The crystal structure of $\text{Zn}_x\text{Co}_{0.5-x}\text{Fe}_{2.5}\text{O}_4$ ($x = 0, 0.25, 0.5$), prepared by a solvothermal reaction method, showed cubic spinel structure with space group $Fd\bar{3}m$ based on Rietveld refinement. The lattice constant a_0 increased linearly with the Zn concentration from $x = 0$ to 0.5. Field emission scanning electron microscope (FE-SEM) measurements showed that the size of the monodispersed particles was around 300–400 nm. With increasing Zn concentration, the saturation magnetization increased from 80.3 to 109.7 emu/g, while the coercivity at 293 K decreased from 893 to 46 Oe, respectively. The magnetocrystalline anisotropy constants (K_1) were determined as 1.62, 1.32, and 1.16×10^6 erg/cm³ for $x = 0, 0.25$, and 0.5, respectively, based on the law of approach to saturations (LAS) method. We have investigated the cation distribution by Mössbauer spectroscopy, closely related to K_1 . We have analyzed the recorded Mössbauer spectra as 3 sets with six-lines of tetrahedral **A** site, and octahedral **B**₁ and **B**₂ sites both at 4.2 and 293 K. From the isomer shift values, the valence states of **A** and **B**₁ site were determined to be ferric (Fe^{3+}), while that at **B**₂ site to be ferrous (Fe^{2+}). The corresponding area ratio of **A** site decreased from 40 to 30 % while that of **B** site increased from 60 to 70% as the Zn concentration changed from $x = 0$ to 0.5 both at 4.2 and 293 K. Here, the changes in the area ratios of **A** and **B** sites are due to the changes in the cation distributions at the **A** and **B** sites, being originating from the randomly substituted Zn ions in $\text{Zn}_x\text{Co}_{0.5-x}\text{Fe}_{2.5}\text{O}_4$ microspheres.

Index Terms— $\text{Zn}_x\text{Co}_{0.5-x}\text{Fe}_{2.5}\text{O}_4$ microspheres, Mössbauer spectroscopy, cation distribution, magnetocrystalline anisotropy.