Journal of the Korean Physical Society, Vol. 58, No. 2, February 2011, pp. 276∼279

Spin-ordering Transition and Distortion of Local Sites in Spinel $Fe_{0.9}Cd_{0.1}Cr_2O_4$ by Using Mössbauer Spectroscopy

Woochul Kim and Chul Sung Kim*

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

(Received 13 December 2010, in final form 7 January 2011)

$Fe_{0.9}Cd_{0.1}Cr_2O_4$ has been studied with X-ray diffraction, Mössbauer spectroscopy, and vibrating sample magnetometry. The crystal structure of $Fe_{0.9}Cd_{0.1}Cr_2O_4$ is a normal cubic spinel with a lattice parameter $a_0 = 8.402$ Å. Mössbauer spectra were obtained at various temperatures ranging from 4.2 K to room temperature. Systematic changes in the Mössbauer spectrum with decreasing temperature from room temperature were found and attributed to the Jahn-Teller distortion. A change related to a structural transition was observed at around 105 K for $Fe_{0.9}Cd_{0.1}Cr_2O_4$. Below the T_N of 65 K, the spectrum displayed an asymmetric eight-line shape, indicating a large electric quadrupole contribution with spin ordering. Magnetic hyperfine and electric quadrupole interactions at 4.2 K were been fitted, yielding the following results: $H_{hf} = 186$ kOe for the magnetic hyperfine field, $\Delta E_Q = 3.41$ mm/s for the electric quadrupole splitting, $\theta = 75°$ for the polar angle of the direction of the magnetic hyperfine field, $\varphi = 87°$ for the azimuthal angle of the direction of the magnetic hyperfine field, $\eta = 0.02$ for the asymmetric parameter of the eltric field gradient (EFG), and $R = 2.7$ for the ratio of the electric quadrupole interaction to the magnetic dipole interaction. Sudden changes in the magnetic hyperfine field and the magnetization data was observed at around 28 K for $Fe_{0.9}Cd_{0.1}Cr_2O_4$, which is attributable to the spin reorientation, which gives rise to a change in the superexchange interaction. The magnetic hysteresis loop at 5 K indicated a strong coercivity force and unsaturated magnetization, which might result from the non-collinear spin structure in the sample.

PACS numbers: 71.70.Ej, 75.50.Gg, 76.80.+y
Keywords: Mössbauer spectroscopy, Spinel iron oxide, Jahn-Teller effect
DOI: 10.3938/jkps.58.276