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# Abstracts

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# Mössbauer study of magnetic anomaly and crystallographic distortion in spinel $FeCr_2O_4$

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In recently years, the $AB_2O_4$-type spinel oxides have attracted renewed attention because of their possible application as new functional materials as well as many interesting phenomena such as magnetoelectric, magnetoelastic, and Jahn-Teller effects [1,2]. In contrast with the detailed structural studies of $FeCr_2O_4$, the exploration of magnetic hyperfine interaction with magnetic and structural phase transitions in spinel $FeCr_2O_4$ is very few. Polycrystalline $FeCr_2O_4$ powder was prepared by using a solid state reaction method. The crystallographic and magnetic properties of powder was characterized by X-ray diffraction (XRD), Mössbauer spectroscopy, and superconducting quantum interference device (SQUID) magnetometer. The crystal structure at room temperature was found to be single phase of cubic normal spinel structure (space group $Fd\bar{3}m$) with lattice constant $a_0$ = 8.3827 Å by the Rietveld refinement method. Mössbauer spectra of $FeCr_2O_4$ have been taken at various temperatures ranging from 4.2 to room temperature. The Mössbauer spectra of $FeCr_2O_4$ show asymmetrical eight lines due to large electric quadrupole interactions including the contribution of lattice distortion below $T_N$. The magnetic hyperfine field and electric quadrupole interaction for the sample at 4.2 K have been fitted with Mössbauer hyperfine parameters of $H_{hf}$ = 192 kOe, $\theta$ = 87°, $\phi$ = 54°, $\eta$ = 0.2, $\Delta E_Q$ = -3.24 mm/s, and $R$ = -2.5. A sudden change in both the magnitude of magnetic hyperfine field and its slope below 40 K suggests that magnetic phase transition related to the spiral spin ordering takes place abruptly. Each line of the Mössbauer spectra becomes broadest at the cubic-to-tetragonal transition temperature of 135 K, which is considered to be due to the Jahn-Teller effect of $Fe^{2+}$ ions. Isomer shift at room temperature is 0.76 mm/s, which means that the charge state of the Fe ions was ferrous in character. Temperature dependence of magnetization show ferrimagnetic property with a large coercivity of 7,765 Oe at 5 K. We observed a magnetic anomaly near 40 K, which correspond to the temperatures where the spiral component appears. The magnetic anomaly observed below $T_N$ is caused by a large $J_{Fe\text{-}Cr}$ coupling between the $Fe^{2+}$ site and the $Cr^{3+}$ spins. The Néel temperature ($T_N$) was determined to be 72 K.

[1] S. Bordács, D. Varjas, I. Kézsmárki, G. Mihály, L. Baldassarre, A. Abouelsayed, C. A. Kuntscher, K. Ohgushi, and Y. Tokura, *Phys. Rev. Lett.* **103**, 077205 (2009).
[2] Y. J. Choi, J. Okamoto, D. J. Huang, K. S. Chao, H. J. Lin, C. T. Chen, M. van Veenendaal, T. A. Kaplan, and S-W. Cheong, *Phys. Rev. Lett.* **102**, 067601 (2009).