Journal of the Korean Physical Society, Vol. 45, No. 3, September 2004, pp. 675∼679

Mössbauer Studies of Abnormal Relaxation Phenomena on Copper Doped Sulphur Spinel

Sam Jin Kim, Bae Soon Son and Chul Sung Kim*
Department of Physics, Kookmin University, Seoul 136-702

(Received 28 November 2003)

Samples of $Fe_{1-x}Cu_xCr_2S_4$ (x = 0.0, 0.1, 0.3, and 0.5) have been studied by using Mössbauer spectroscopy, X-ray diffraction, magnetization, and magnetoresistance (MR). Neutron diffraction on $FeCr_2S_4$ above 10 K shows that there is no crystallographic distortion and reveals a ferrimagnetic ordering, with the magnetic moment of Fe^{2+} (-3.52 μ_B) aligned antiparallel to Cr^{3+} (2.72 μ_B). A cusp-like anomaly is observed in both the field-cooled (FC) and the zero-field-cooled (ZFC) magnetization curves of the sample $x = 0.1$, near 130 K, under an applied field $H = 100$ Oe. The MR of the sample $x = 0.1$ shows a semiconducting behavior in the low-temperature region, and the metal-metal transition occurs near the Néel temperature. The charge state of iron ion for the sample $x = 0.1$ is ferrous (Fe^{2+}), whereas it is ferric (Fe^{3+}) for the sample $x = 0.3$. The Mössbauer spectra of the sample $x = 0.1$ show asymmetric line broadening, and this is considered to be due to dynamic Jahn-Teller relaxation. The unusual reduction of magnetic hyperfine field below 110 K is interpreted by the cancellation effect between the mutually opposite orbital current field (H_L) and Fermi contact field (H_C).

PACS numbers: 75, 71, 72
Keywords: Mössbauer spectroscopy, Magnetoresistance, Dynamic Jahn-Teller relaxation