

## A Study on the Magnetic Properties of Al-Doped Sulphur Spinel

Chin Mo Kim, Sam Jin Kim, and Chul Sung Kim

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

$\text{FeCr}_{2-x}\text{Al}_x\text{S}_4$  ( $x = 0.1, 0.3, \text{ and } 0.5$ ) samples were prepared by solid state reaction method. The crystallographic structure and magnetic properties of the fabricated compounds were investigated by X-ray diffraction (XRD), superconducting quantum interference device (SQUID) magnetometer, and Mössbauer spectroscopy. The crystal structure is determined to be a cubic spinel with the space group of  $Fd-3m$  and the lattice constants  $a_0 = 9.998, 10.004, \text{ and } 10.010 \text{ \AA}$ , respectively. The temperature dependence of magnetization, measured from 5 to 300 K, suggests that  $\text{FeCr}_{2-x}\text{Al}_x\text{S}_4$  ( $x = 0.1, 0.3, \text{ and } 0.5$ ) samples show ferrimagnetic behavior. The decrease of Néel temperature compared with  $\text{FeCr}_2\text{S}_4$  could be interpreted by weakening of the exchange interaction by substitution of nonmagnetic Al ions. Mössbauer spectra of  $\text{FeCr}_{2-x}\text{Al}_x\text{S}_4$  ( $x = 0.1, 0.3, \text{ and } 0.5$ ) were obtained at various temperatures ranging from 4.2 to 300 K. Isomer shift values of the samples at various temperatures for  $\text{FeCr}_{2-x}\text{Al}_x\text{S}_4$  ( $x = 0.1, 0.3, \text{ and } 0.5$ ) were  $0.50 \leq \delta \leq 0.73 \text{ mm/s}$ , relative to the Fe metal, which are consistent with the  $\text{Fe}^{2+}$  valence state.

*Index Terms*—Chalcogenide spinel, ferrimagnetic, Mössbauer, sulphur spinel.