Mössbauer studies of dynamic Jahn-Teller relaxation on the Cu-substituted sulphur spinel. S. Kim¹, B. Son¹, B. Lee² and C. Kim¹. Department of Physics, Kookmin University, Seoul, South Korea; 2. Department of Physics, Hankuk University of Foreign Studies, Yongin, Kyungki, South Korea

Samples of the copper doped Fe$_{1-x}$Cu$_x$Cr$_2$S$_4$ (x=0.1 and 0.3) have been studied with Mössbauer spectroscopy, x-ray diffraction, vibrating sample magnetometer (VSM), and magnetoresistance (MR) measurement. The crystal structure and cation distribution are determined to be cubic spinel with a space group $Fd3m$ by Rietveld refinements. The abnormal temperature dependence of magnetization on Fe$_{1-x}$Cu$_x$Cr$_2$S$_4$ is reported. In addition to a large irreversibility between the zero-field-cooling (ZFC) and the field-cooling (FC) magnetization with an applied field $H$=100 Oe, a cusp-like anomaly is observed in both FC and ZFC curves near the temperature 130 K. It moves toward the lower temperature region with increase of magnetic field, finally it shows a convex type maximum at 110 K, under the applied field of 5 kOe. We note that unusual increase of magnetization persists up to 110 K. The MR measurements show a semiconductor behavior in low temperature region and then metal-semiconductor transition occurs near the Neél temperature [1]. The Mössbauer spectra were measured from 4.2 K to room temperature. The asymmetric line broadening is observed for the sample Cu$_{0.1}$Fe$_{0.9}$Cr$_2$S$_4$ and considered to be dynamic Jahn-Teller relaxation. The unusual reduction of magnetic hyperfine field below 110 K can be interpreted in terms of cancellation effect between the mutually opposite orbital current field ($H_L$) and Fermi contact field ($H_C$). Isomer shift value of the sample at room temperature is 0.54 mm/s, which means that charge state of Fe ions is ferrous in character. The ratio of the electric quadrupole to the magnetic dipole interaction decrease rapidly up to 140 K, with increasing temperature, and then reaches 0 at Neél temperature. We interpret that the rapid decrease of interaction ratio, asymmetrical line broadening in Mössbauer spectra, and unusual increase of magnetization are closely related to the dynamic Jahn-Teller relaxation.