

Evidence of Spin Reorientation by Mössbauer Analysis

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We report the crystallographic and magnetic properties of $\text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4$ by means of X-ray diffractometer (XRD), a superconducting quantum interference device (SQUID) magnetometer, and a Mössbauer spectroscopy. In particular, $\text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4$ was studied by Mössbauer analysis for evidence of spin reorientation. The chalcogenide material $\text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4$ was fabricated by a direct reaction method. XRD analysis confirmed that $\text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4$ has a 2-dimension (2-D) triangular lattice structure, with space group $P\bar{3}m1$. The Mössbauer spectra of $\text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4$ at spectra at various temperatures from 4.2 to 300 K showed that the spectrum at 4.2 K has a severely distorted 8-line shape, as spin liquid. Electric quadrupole splitting, E_Q has anomalous two-points of temperature dependence of E_Q curve as freezing temperature, $T_f = 11$ K, and Néel temperature, $T_N = 26$ K. This suggests that there appears to be a slowly-fluctuating “spin gel” state between T_f and T_N , caused by non-paramagnetic spin state below T_N . This comes from charge re-distribution due to spin-orientation above T_f and T_N , due to the changing E_Q at various temperatures. Isomer shift value ($0.7 \text{ mm/s} \leq \delta \leq 0.9 \text{ mm/s}$) shows that the charge states are ferrous (Fe^{2+}), for all temperature range. The Debye temperature for the octahedral site was found to be $\Theta_D = 260$ K.

Keywords : mössbauer spectroscopy, spin reorientation, electric quadrupole splitting