Investigation of electrical and magnetic properties of triangular antiferromagnets

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We have synthesized magnetic Fe-doped $NiGa_2S_4$ and investigated its electrical and magnetic properties with a superconducting quantum-interference device magnetometer, Mössbauer spectroscopy, and a physical property measurement system. X-ray diffraction analysis at room temperature shows that the prepared samples are single phase with trigonal structure (*P-3m1*). From zero-field-cooled (ZFC) and field-cooled magnetization curves under 100 Oe between 4.2 and 200 K, we have measured the temperature-dependent susceptibility χ of $Ni_{1-x}Fe_xGa_2S_4$. A cusp is observed in the ZFC measurement for the samples with $x \geq 0.1$, which is due to the spin-freezing effect in the spin-glass system. Moreover, with increasing Fe concentration, the sample shows the antiferromagnetic behavior and the increase in freezing temperature T_f. This, in turn, suggests that the spin-averaged value of the sample increases and antiferromagnetic spin–spin interaction becomes stronger with Fe concentration. The temperature-dependent resistance of semiconducting $Ni_{1-x}Fe_xGa_2S_4$ ($x = 0.3, 0.5, 0.7, 0.9$) follows Arrhenius law $R = R_0\exp(E_0/k_BT)$ for the semiconducting temperature, with the gap energies E_0 of 210.6, 192.0, 135.6, and 126.4 meV, respectively. This increase in gap energy comes from the distortion of octahedral structure in the *a–b* plane direction.
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