ABSTRACTS

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Mössbauer spectroscopy and neutron diffraction studies of the ferrimagnetic semiconductor on Ga-substituted FeGa$_x$Cr$_{2-x}$S$_4$.

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Ga doped sulphur spinel FeGa$_x$Cr$_{2-x}$S$_4$ (x=0.1 and 0.3) have been studied with Mössbauer spectroscopy, neutron diffraction, x-ray diffraction, magnetization, and magnetoresistance (MR) measurements. Neutron diffraction patterns were obtained at various temperature ranges from 10 K to room temperature. Neutron diffraction on FeGa$_x$Cr$_{2-x}$S$_4$ (x=0.1) above 10 K shows that
there is no crystallographic distortion and reveals antiferromagnetic ordering, with the magnetic moment of Fe+2 (3.45 $\mu_B$) aligned antiparallel to Cr+3 (-2.89 $\mu_B$). It is concluded that Fe ions migrate from the tetrahedral (A) site to the octahedral (B) site with increase of Ga ions, by Rietveld refinement of X-ray diffraction and Mössbauer measurement. The Mössbauer spectra of the samples consist of the two doublets at room temperature. The electric quadrupole splitting of the A and B sites in Mossbauer spectra of the sample $x=0.1$, at 295 K, are 0.30 and 2.93 mm/s, respectively, While, they are 0.83 and 2.94 mm/s for the sample $x=0.3$, respectively. It gives a direct evidence that Ga ion stimulate asymmetric charge distribution of Fe ions in the A site. The temperature dependence of quadrupole interaction leads to the conclusion that orbital angular contribution plays an important role in FeGa$_x$Cr$_{2-x}$S$_4$ ($x=0.1$ and 0.3). The magnetoresistance exhibits a strong dependence on Arrhenius model at temperature below 100 K, probably due to an activated energy, while it shows a strong correlation on small polaron model at temperature above 200 K. The temperature dependence of quadrupole interaction leads to the conclusion that orbital angular contribution plays an important role in FeGa$_x$Cr$_{2-x}$S$_4$. 