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Magnetic ordering in the frustrated system $FeSc_2S_4$

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Abstract

The sample of $FeSc_2S_4$ was prepared by solid reaction method. The crystallographic structure and the magnetic properties of the fabricated compound were investigated by X-ray, and superconducting quantum interference device (SQUID) magnetometer and Mössbauer spectroscopy. The polycrystalline $FeSc_2S_4$ confirmed the normal cubic spinel structure (space group Fd3m). The lattice constants a_0 and anion parameter u are 10.519 Å and 0.255, respectively. The Mössbauer spectroscopy has been studied for the $FeSc_2S_4$ at various temperatures, ranging from 4.2 K to room temperature. The spectra consist of two doublets at 4.2 K while a single line at room temperature. It is noticeable that the Mössbauer spectra of two doublet patterns with large electric quadrupole splitting (ΔE_Q) remain over the Néel temperature. Those are interpreted as a result of large electric quadrupole interaction compared to magnetic dipole interaction. The magnetic susceptibility measurements were performed with a SQUID magnetometer for temperatures $2 < T < 320$ K, in external fields up to 5 kOe. Magnetic behavior shows antiferromagnetic behavior and the magnetic superexchange interactions between the Fe ions are weakly antiferromagnetic. The paramagnetic susceptibilities follow Curie–Weiss (CW) law with CW temperature $\Theta_{CW} = -100$ K, and frustration parameter $f = -\Theta_{CW}/T_N$ is of the order of 1000. We conclude that two sublattices are coupled antiferromagnetically, leading to strong frustration effects.

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