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Crystallographic and Mössbauer Studies of Magnetic Device Materials of the In Substituted $FeIn_{0.1}Cr_{1.9}S_4$

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Crystallographic and Mössbauer studies of the sample $FeIn_{0.1}Cr_{1.9}S_4$ were investigated with Mössbauer spectroscopy, X-ray diffraction, and magnetization. The crystal structure was found to be a cubic spinel by using a Rietveld refinement of X-ray diffraction (space group $Fd3m$), with the lattice parameter $a_0 = 10.0294(3)$ Å. Mössbauer spectra of $FeIn_{0.1}Cr_{1.9}S_4$ were obtained at various temperatures ranging from 18 to 300 K. The magnetic hyperfine and the electric quadrupole interactions at 18 K were fitted, and yielded the following results: $H_{hf} = 144$ kOe, $\theta = 35.0°$, $\varphi = 0°$, $\eta = 0.89$, and $\Delta E_Q = (1/2)e^2qQ[1 + (1/3)\eta^2]^{1/2} = 1.92$ mm/s. The ratio of the electric quadrupole interaction to the magnetic dipole interaction (E2/M1) was found to be $R = 1.97$. Our study strongly suggests that R rapidly decreases to 77 K; simultaneously the Mössbauer spectra change from an 8-line to a 6-line pattern. The Debye temperature of the $FeIn_{0.1}Cr_{1.9}S_4$ is found to be $\Theta = 252 \pm 5$ K.

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