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Mössbauer Studies on Ferrimagnetic $FeCr_{1.7}Al_{0.3}S_4$

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Polycrystalline Al-doped $FeCr_{1.7}Al_{0.3}S_4$ has been studied with X-ray diffraction, magnetization, and Mössbauer spectroscopy measurements. The crystal structure was found to be a cubic spinel with a space group of *Fd-3m*, and the lattice constant was 10.004 Å. The magnetic susceptibility followed the Curie-Weiss law with a positive $\theta_{cw} = 114$ K, showing a ferrimagnetic behavior. The value of the magnetization at 5 K was found to be 1.12 μ_B. Mössbauer spectra of $FeCr_{1.7}Al_{0.3}S_4$ were obtained at various temperatures ranging from 4.2 to 300 K. Both the magnetic hyperfine field ($H_{\rm hf}$) and the polar angle (θ) reached their maximum values at 60 K and had similar temperature dependences. However, the azimuthal angle (φ) remained constant at temperatures below 60 K and started increasing with temperature at temperatures above 60 K. From the Mössbauer spectra of $FeCr_{1.7}Al_{0.3}S_4$ at 4.2 K, we obtained the following Mössbauer parameters: $H_{\rm hf} = 128$ kOe, $\Delta E_Q = 2.42$ mm/s, $\theta = 20.0°$, $\varphi = 0.0°$, $\eta = 0.8$, and $R = 2.8$. The isomer shift of $FeCr_{1.7}Al_{0.3}S_4$ at 4.2 K was 0.83 mm/s relative to the Fe metal, which is consistent with the Fe^{2+} valence state.

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