Mössbauer study of magnetic structure of cation-deficient iron sulfide $Fe_{0.92}S$

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We have investigated the magnetic hyperfine structure of iron sulfide $Fe_{0.92}S$ by Mössbauer spectroscopy and studied its magnetic properties. From the x-ray diffraction pattern, $Fe_{0.92}S$ is found to be a $3c$-type superstructure of the NiAs hexagonal structure. Magnetization curve at room temperature for $Fe_{0.92}S$ showed a ferromagnetic behavior unlike that for antiferromagnetic FeS. A peak type anomaly is observed in zero-field-cooled magnetization curve under 100 Oe. Mössbauer spectra were taken at various temperatures ranging from 4.2 to 615 K. The spectra consist of three-component subspectra arising from three magnetically nonequivalent sites in the $3c$ superstructure. The magnetic hyperfine fields of the three *A*-, *B*-, and *C*-sites at 4.2 K are found to be 328, 277, and 246 kOe, respectively. These values are in the ratio of 18:15:14, which is close to the ratio of the magnitudes of magnetic hyperfine field in 18, 14, and 13 interplanar superexchange links (Fe–S–Fe) of *A*-, *B*-, and *C*-sites in Fe_7S_8. The absorption intensity for *A*-, *B*-, and *C*-sites changes substantially over the temperature range from 570 K, suggesting that a vacancy rearrangement is taking place. Isomer shifts indicate Fe^{2+} states for all three sites. The Néel temperature (T_N) and the Debye temperature are found to be 615 ± 1 and 238 ± 5 K, respectively.
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