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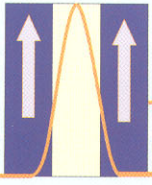

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Local spin structure of spinel $Cd_{0.9}Zn_{0.1}Fe_2O_4$investigated by external magnetic field Mössbauer spectrometry.

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Introduction

Cadmium ferrite ($CdFe_2O_4$) has the normal spinel structure, AB_2O_4, which belongs to the cubic space group Fd3m. Its octahedral B site ions, Fe^{3+}, form the three-dimensional network of corner-sharing tetrahedra. Cadmium ferrite is well known as one type of geometrically frustrated system.[1,2] Magnetic neutron scattering measurements to determine the interactions between the Fe ions was concluded that the frustration in cadmium ferrite is driven mainly by the strong nearest-neighbor antiferromagnetic interaction. Zinc ferrite ($ZnFe_2O_4$) has also normal spinel structure and is geometrically frustrated antiferromagnet. At present, little information is available in the literature about local spin structure on zinc substituted bulk cadmium ferrites. To better understand, the behaviors of ferrite spinels, we investigated the local spin structure of $Cd_{0.9}Zn_{0.1}Fe_2O_4$with smaller non-magnetic Zn^{2+} ions than Cd^{2+} ions, using zero- and in-field Mössbauer spectroscopy.

Experiment

Synthesis of the $Cd_{0.9}Zn_{0.1}Fe_2O_4$sample was prepared by high temperature solid state reaction method. A mixture of the proper proportions of CdO, ZnO, and Fe_2O_3 powders was ground, and pressed into a pellet at 60,000 N/cm^2. The mixture was heated at 920 ^{0}C for 24 h. Again heat treated at 920 ^{0}C for 12 h and finally sintered at 920 ^{0}C for 30 m. It is quenched at air. Crystalline structure of the sample was examined by x-ray diffraction with Cu K_α radiation. Mössbauer spectrometer of the electromechanical type was used in the constant acceleration mode. A ^{57}Co source in a rhodium matrix was used at room temperature.

Results and discussion

An analysis of x-ray diffraction pattern by Rietveld refinement method using FULLPROF program shows that the sample has a cubic spinel structure (space group Fd3m) with a lattice constant a_0 = 8.682±0.001Å. Mössbauer spectra of $Cd_{0.9}Zn_{0.1}Fe_2O_4$have been taken at various absorber temperatures. All the spectra below Néel temperature are asymmetrical and show broad six lines. The line broadening of Mössbauer spectrum comes from various origins such as distributions of internal field, quadrupole splitting, and isomer shift and also dynamical effect.[3] The Néel temperature (T_N) is found to be 20 ± 1 K. The isomer shifts at room temperature for the B patterns is found to be 0.24 mm/s, respectively, relative to iron metal, which indicates that an iron ion at B site is ferric. The hyperfine field values at 4.2 K for B patterns are found to be 468 and 496 kOe, respectively. Figure 1 shows the Mössbauer spectra at various temperatures in the external magnetic field of 4.8 T. In Mössbauer spectroscopy, if lines 2 and 5 of the six lines hyperfine pattern do not collapse when an external field ia applied parallel to γ-rays, a canted structure must exist. From the area ratios, $A_{2,5}/A_{1,6}$, of the second (or fifth) line to the first (or sixth) lines, it is possible to deduce the average canting angles. The lines 2 and 5 do not vanish below about 20 K. The canting angles and the average magnetic hyperfine fields H_{hf}(B)are obtained from the vector relationship between H_{hf}, H_{ex}, and H_t. The values are given in Table I.

[1] C. Cheng, Phys. Rev. B 78, 132403 (2008).

[2] K. Kamazawa, S. Park, S. H-. Lee, T. J. Sato, and Y. Tsunoda, Phys. Rev. B 70, 024418 (2004).

[3] L. K. Leung, B. J. Evans, A. H. Morrish, Phys. Rev. B 8, 29 (1973).

T (K)	H_t (B) (kOe)	$A_{2,5}/A_{1,6}$	θ(degree)	H_{hf} (B) (kOe)	ϕ(degree)
4.2	504	0.56	50	411	42
10	445	0.75	58	210	63

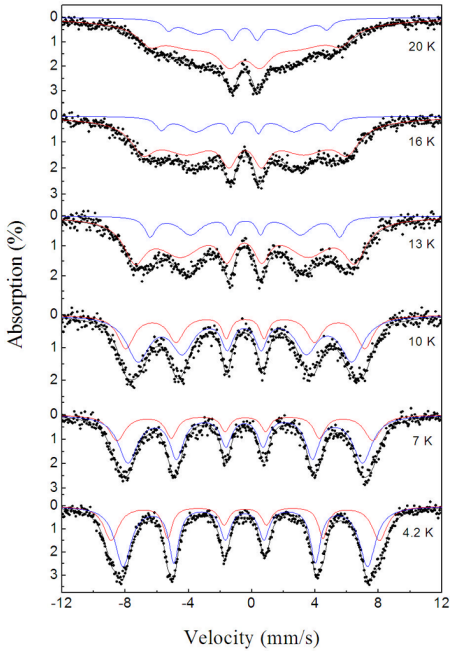

Fig. 1. Mössbauer spectra of $Cd_{0.9}Zn_{0.1}Fe_2O_4$ at the various temperatures under a longitudinal field of 4.8 T.

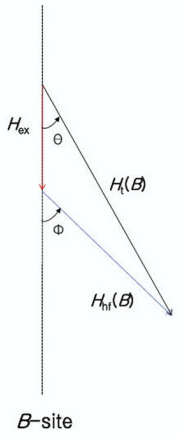

Fig. 2. Vector relationship between H_{hf}, H_{ex}, and H_t.