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CoAl\textsubscript{x}Fe\textsubscript{2-x}O\textsubscript{4} (X=0.1, 0.2) \textsubscript{a} 월절의 교환상호작용 및 중성자 회절 연구

EXCHANGE INTERACTION AND NEUTRON DIFFRACTION ON CoAl\textsubscript{x}Fe\textsubscript{2-x}O\textsubscript{4} (X=0.1, 0.2)

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요 약 문

Magnetic and structural properties of CoAl\textsubscript{x}Fe\textsubscript{2-x}O\textsubscript{4} with x=0.1, 0.2 have been investigated with thermal analysis (TG-DTA), x-ray, neutron diffraction, Mössbauer spectroscopy and magnetization measurements. Neutron diffraction measurements of CoAl\textsubscript{0.1}Fe\textsubscript{1.9}O\textsubscript{4} were obtained at various temperature ranges from 10 to 816 K. Neutron diffraction at 10 K revealed a cubic spinel space group Fd\textsubscript{3}m with ferrimagnetic long range order. Mössbauer spectra were collected from 4 to 820 K. It is found that Debye temperatures of tetrahedral(A) and octahedral(B) site for CoAl\textsubscript{0.1}Fe\textsubscript{1.9}O\textsubscript{4} are \( \theta_A = 746 \)\textdegree, \( \theta_B = 204 \) K, respectively, and for CoAl\textsubscript{0.2}Fe\textsubscript{1.8}O\textsubscript{4}, \( \theta_A = 709 \), \( \theta_B = 197 \) K, respectively. The temperature dependence of the magnetic hyperfine field in \( ^{57}\text{Fe} \) nuclei at the A and B sites was analyzed on the Néel type molecular field theory of magnetism. For the sample CoAl\textsubscript{0.1}Fe\textsubscript{1.9}O\textsubscript{4}, the A–B and A–A superexchange interaction were antiferromagnetic with the strengths of \( J_{A-B} = -23.8 \) and \( J_{A-A} = -18.0 \) \( k_B \), respectively, while the B-B superexchange interaction was ferromagnetic with a strength of \( J_{B-B} = 5.6 \) \( k_B \). Also for the sample CoAl\textsubscript{0.2}Fe\textsubscript{1.8}O\textsubscript{4}, the strengths of the A–B, A–A, and B–B interaction were \( J_{A-B} = -21.3 \), \( J_{A-A} = -19.6 \), and \( J_{B-B} = 4.8 \) \( k_B \), respectively. The changes of exchange interactions with Al substitution are interpreted on the basis of cation distributions and bond lengths. It is interpreted that a noticeable strength of the A–A interaction are closely related to the covalency effects and neutron diffractions accord with these results.