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$CoAl_xFe_{2-x}O_4$(X=0.1, 0.2)물질의 교환상호작용 및 중성자 회절 연구

EXCHANGE INTERACTION AND NEUTRON DIFFRACTION ON $CoAl_xFe_{2-x}O_4$ (X=0.1, 0.2)

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요 약 문

Magnetic and structural properties of $CoAl_xFe_{2-x}O_4$ 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 $CoAl_{0.1}Fe_{1.9}O_4$ were obtained at various temperature ranges from 10 to 816 K. Neutron diffraction at 10 K revealed a cubic spinel space group *Fd3m* 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 $CoAl_{0.1}Fe_{1.9}O_4$ are θ_A=746, θ_B=204 K, respectively, and for $CoAl_{0.2}Fe_{1.8}O_4$, θ_A=709, θ_B=197 K, respectively. The temperature dependence of the magnetic hyperfine field in ^{57}Fe nuclei at the A and B sites was analyzed on the Néel type molecular field theory of magnetism. For the sample $CoAl_{0.1}Fe_{1.9}O_4$, the A-B and A-A superexchange interaction were antiferromagnetic with the strengths of J_{A-B} = -23.3 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 $CoAl_{0.2}Fe_{1.8}O_4$, 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.