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Mössbauer and Neutron Diffraction Studies on Co–Al Ferrite

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Abstract. Al substituted $CoAl_xFe_{1-x}O_4$ (x = 0.1, 0.2, 0.3, and 0.5) have been studied with X-ray and neutron diffraction, Mössbauer spectroscopy and magnetization measurements. Neutron diffraction at 10 K for $CoAl_{0.1}Fe_{1.9}O_4$ revealed a cubic spinel structure of ferrimagnetic long range ordering, with magnetic moments of Fe^{3+}(A)($-4.18\ \mu_B$), Fe^{3+}(B)($4.81\ \mu_B$), Co^{2+}(B)($2.99\ \mu_B$), respectively.

The temperature dependence of the magnetic hyperfine field in ^{57}Fe nuclei at the tetrahedral (A) and octahedral (B) sites was analyzed based on the Néel theory of magnetism. In the sample $CoAl_{0.1}$-$Fe_{1.9}O_4$, the intersublattice A–B interaction and intrasublattice A–A superexchange interaction were antiferromagnetic with strengths of $J_{A-B} = -23.3\ k_B$ and $J_{A-A} = -17.6\ k_B$, respectively, while the intrasublattice B–B superexchange interaction was found to be ferromagnetic with a strength of $J_{B-B} = 5.5\ k_B$. With increasing Al substitution the A–B and B–B interaction decreased but the A–A interaction increased. It is interpreted that the reduction of magnetic moment in Fe^{3+}(A) and a noticeable strength of the A–A interaction are closely related to the covalency effects.

Key words: Co–Al ferrite, superexchange interaction, Mössbauer spectroscopy, neutron diffraction, Debye temperature.