Atomic migration in $MgFe_{2-x}Cr_xO_4$

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Mg–Cr ferrite has been studied with Mössbauer spectroscopy, x-ray diffraction, and vibrating sample magnetometer. The crystal structure for this system is spinel structure, and the lattice constant is in accord with Vegard's law. The Mössbauer spectra consist of two six-line patterns corresponding to Fe^{3+} at the tetrahedral (A) and octahedral (B) sites. The Curie temperature decreases linearly with Cr concentration, suggesting the superexchange interaction Fe(A)–O–Fe(B) link is stronger than that for the Fe(A)–O–Cr(B) link. Debye temperatures for the A and B sites of $MgFe_{1.9}Cr_{0.1}O_4$ are found to be $\theta_A = 515 \pm 5$ K and $\theta_B = 265 \pm 5$ K, respectively. Atomic migration of $MgFe_{1.9}Cr_{0.1}O_4$ starts near 350 K and increases rapidly with increasing temperature to such a degree that 50% of the ferric ions at the A sites have moved over to the B sites by 600 K. The temperature dependence of both the magnetic hyperfine field and magnetization of $MgFe_{1.9}Cr_{0.1}O_4$ is explained by the Néel theory of ferrimagnetism using three superexchange integrals: $J_{A-B} = -17.9k_B$, $J_{A-A} = 1.9k_B$, and $J_{B-B} = 7.1k_B$. [S0021-8979(00)40808-X]