Atomic Migration and Superexchange Interaction in $Ni_{0.1}Cu_{0.9}Fe_2O_4$

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Abstract—**$Ni_{0.1}Cu_{0.9}Fe_2O_4$ was studied with X-ray diffraction and Mössbauer spectroscopy. The crystal structure was found to be a cubic spinel with the lattice constant $a_0 = 8.386 \pm 0.005$ Å. The Néel temperature was determined to be $T_N = 755$K for a heating rate of 5K/min. The Mössbauer spectra consisted of two six-line patterns corresponding to Fe^{3+} at the tetrahedral (A) and octahedral (B) sites. Debye temperatures for A and B sites were found to be 568 ± 5K and 194 ± 5K, respectively. Atomic migration of $Ni_{0.1}Cu_{0.9}Fe_2O_4$ starts near 350K and increases rapidly with increasing temperature to such a degree that 71% of the ferric ions from the A sites moved to the B sites at 550K. The temperature dependence of the magnetic hyperfine field of $Ni_{0.1}Cu_{0.9}Fe_2O_4$ was explained by the Néel theory of ferrimagnetism using three superexchange integrals: $J_{A-B} = -29.2k_B$, $J_{A-A} = -21.9k_B$, $J_{B-B} = 0.5k_B$.**

Index Terms—**Atomic migration, Mössbauer spectroscopy, $Ni_{0.1}Cu_{0.9}Fe_2O_4$ ferrite, superexchange integrals.**