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Mössbauer studies of superexchange interaction in $Ni_{0.5}Cu_{0.5}Fe_2O_4$

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Abstract

$Ni_{0.5}Cu_{0.5}Fe_2O_4$ has been studied by Mössbauer spectroscopy and X-ray diffraction. The crystal is found to be a cubic spinel structure with the lattice constants $a_0 = 8.370 \pm 0.005$ Å. Mössbauer spectra of $Ni_{0.5}Cu_{0.5}Fe_2O_4$ were obtained at various absorber temperatures from 13 to 820 K. The iron ions at both A (tetrahedral) and B (octahedral) sites are found to be in ferric high-spin states. Its Néel temperature T_N is found to be 820 ± 2 K. The Debye temperatures for the A and B sites were found to be $\Theta_A = 443 \pm 5$ and $\Theta_B = 270 \pm 5$ K, respectively. The temperature-dependent magnetic hyperfine fields of ^{57}Fe nuclei at the tetrahedral (A) and octahedral (B) sites are analyzed by the Néel theory of ferromagnetism. The intersublattice A–O–B and intrasublattice A–O–A superexchange interactions were found to be antiferromagnetic with their strength $J_{A-B} = -25.8k_B$ and $J_{A-A} = -10.5k_B$, respectively, while the intrasublattice B–O–B superexchange interaction is ferromagnetic with its strength $J_{B-B} = 12.5k_B$.

Keywords: Mössbauer spectroscopy; Superexchange interaction