

Mössbauer Studies on Exchange Interactions in CoFe_2O_4

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Two polycrystalline samples of CoFe_2O_4 were prepared by slow cooling and quenching and studied using Mössbauer spectroscopy and X-ray diffraction. The crystals were found to have a cubic spinel structure with the lattice constants of the slowly cooled sample being $a_0 = 8.381 \text{ \AA}$ and the quenched sample being $a_0 = 8.391 \text{ \AA}$. 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 ferrimagnetism. For the slowly cooled sample, the intersublattice A – B superexchange interaction and intrasublattice A – A superexchange interaction were antiferromagnetic with a strength of $J_{A-B} = -25.0k_{\text{B}}$ and $J_{A-A} = -18.9k_{\text{B}}$, respectively, while the intrasublattice B – B superexchange interaction was ferromagnetic with a strength of $J_{B-B} = 3.9k_{\text{B}}$. In the quenched sample, however, their strengths were $J_{A-B} = -22.6k_{\text{B}}$, $J_{A-A} = -17.6k_{\text{B}}$, and $J_{B-B} = 3.9k_{\text{B}}$, respectively.

KEYWORDS: superexchange interaction, Mössbauer spectroscopy, Néel theory, Debye temperature, cobalt ferrite, magnetic hyperfine field