Atomic migration in Ni–Co ferrite

Chul Sung Kim, Seung Wha Lee, and Seung Iel Park
Department of Physics, Kookmin University, Seoul 136-702, Korea

Jae Yun Park
Department of Materials Science and Engineering, University of Inchon, Inchon 402-749, Korea

Young Jei Oh
Division of Ceramics, Korea Institute of Science and Technology, Seoul 130-650, Korea

Ni–Co ferrite has been studied with Mössbauer spectroscopy and x-ray diffraction. The crystal structure for this system is spinel, 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 Néel temperature increases linearly with Ni concentration, suggesting the superexchange interacion for the Ni–O–Fe link is stronger than that for the Co–O–Fe link. It is found that Debye temperatures for the A and B sites of $CoFe_2O_4$ and $NiFe_2O_4$ are found to be $\theta_A = 734$ K, $\theta_B = 248$ K, and $\theta_A = 378$ K, $\theta_B = 357$ K, respectively. The intensity ratio of the A to B patterns is found to increase at low temperatures with increasing temperature due to the large difference of Debye temperatures of the two sites and to decrease at high temperatures due to migration of Fe^{3+} ions from A to B sites. Atomic migration of $CoFe_2O_4$ starts near 400 K and increases rapidly with increasing temperature to such a degree that 69% of the ferric ions as the A sites have moved over to the B sites by 780 K. It is noted that, as the Ni concentration in cobalt ferrite increases, the Debye temperatures tend to decrease the migration at the A and B sites is slow.
 [S0021-8979(96)29908-5]