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Effect of Ni substitution on *Y*-type barium ferrite

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Here, we have investigated the crystal structure and magnetic properties of Ni-substituted *Y*-type barium ferrite. The single-phased $Ba_2Co_{2-x}Ni_xFe_{12}O_{22}$ ($x = 0.0, 0.5, 1.0$) samples were synthesized by solid-state reaction method. The crystal structure of samples was determined to be rhombohedral with *R-3 m*. The Rietveld refinement showed that the unit cell volume (V_u) of the samples decreased with increasing Ni contents because the ionic radius of the Ni^{2+} is smaller than that of Co^{2+}. Saturation magnetization (M_s) and coercivity (H_c) of $Ba_2Co_{2-x}Ni_xFe_{12}O_{22}$ were also decreased with Ni concentration. The temperature dependence of the magnetization curve of $Ba_2CoNiFe_{12}O_{22}$ under 100 Oe showed the magnetic structure transitions from helimagnet to ferrimagnet around 204 K and from ferrimagnet to paramagnet around 720 K. While the spin transition temperature (T_S) of the samples decreased with Ni substitution, the Curie temperature (T_C) increased with increasing Ni contents. The Mössbauer spectra analysis showed the coexistence of Fe ions at six sub-lattices with different occupancy ratio. Also, from temperature dependence of isomer shift value and magnetic hyperfine field (H_{hf}), we determined that Fe ions were at high spin Fe^{3+} state. In addition, we have observed an abrupt change in H_{hf} around 204 K, corresponding to the helimagnet to ferrimagnet phase transition shown in zero-field-cooled curve. Also, the experimentally observed increase in H_{hf} with Ni contents can be attributed to the change in the super-exchange interaction.
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