Magnetic properties of polycrystalline Y-type hexaferrite $Ba_{2-x}Sr_xNi_2(Fe_{1-y}Al_y)_{12}O_{22}$ using Mössbauer spectroscopy

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ABSTRACT

Synthesis of the polycrystalline $Ba_{2-x}Sr_xNi_2(Fe_{1-y}Al_y)_{12}O_{22}$ (x = 0.0, 1.5, y = 0.00, 0.01, and 0.03) was accomplished by employing the polymerizable complex method. The samples were investigated for the crystallographic and magnetic properties by x-ray diffraction (XRD), vibrating sample magnetometer (VSM), and Mössbauer spectrometer. Based on the results of the refined XRD patterns, all samples were confirmed to have a rhombohedral structure with space group *R*-3*m*. Moreover, six distinguished sublattices were identified, which were four octahedral sites ($18h_{VI}$, $3b_{VI}$, $6c_{VI}$, and $3a_{VI}$) and two tetrahedral sites ($6c_{IV}$*, $6c_{IV}$). The lattice constant of a_0 and c_0 decrease via Sr, Al substitution because the ionic radius of Sr^{2+} (1.12 Å) is smaller than that of Ba^{2+} (1.34 Å), and the ionic radius of Al^{3+} (0.535 Å) is smaller than that of Fe^{3+} (0.645 Å). The zero-field-cooled (ZFC) measurement was applied at 100 Oe between 4.2 and 295 K and it revealed the spin transition temperature (T_S). Substitution of Sr ions increased T_S. Al ions were further substituted after the substitution of Sr ions, and T_S increased above room temperature. The Mössbauer spectra fit six distinguish sublattices: $18h_{VI}$, $3b_{VI}$, $6c_{IV}$, $6c_{IV}$*, $6c_{VI}$, and $3a_{VI}$. The isomer shift of all samples indicated that the charge state of Fe ions is Fe^{3+}. The Mössbauer spectra obtained with respect to temperature change confirmed the changes in the magnetic hyperfine field curves at *T*s.