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Site occupancy and anisotropy distribution of Al substituted Ba-ferrite with high coercivity

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M-type barium hexagonal ferrite has been intensively investigated as a material for permanent magnets, high-density recording media, and microwave device. Recently, most of the research has emphasized the modification of magnetic properties by the substitution of Fe³⁺, such as Co⁷⁺-Ti⁴⁺, Co³⁺-Sn⁴⁺, Co³⁺, Mn³⁺ and Al⁵⁺. Especially, when the substituted Al⁵⁺, changes of structural and magnetic properties is very enlarged. In this study, the site occupancy and anisotropy distribution of Al substituted BaFe₁₂ₓAlₓO₁₉ (0.0 ≤ x ≤ 4.0) have been studied with Mössbauer spectroscopy, x-ray diffraction, and vibrating sample magnetometry. Nanocrystalline BaFe₁₂ₓAlₓO₁₉ (0.0 ≤ x ≤ 4.0) powders were fabricated by the sol-gel method. The result of XRD measurement shows that the lattice a and c parameters are decreased with increasing x from a = 5.901 Å and c = 23.243 Å for x = 0.0, to a = 5.818 Å and c = 22.754 Å for x = 4.0. With increasing x, the saturation magnetization, Ms, decreased linearly but the coercivity, Hc, greatly increased up to x = 2.0, and then slightly decreased over x > 2.0. Mössbauer spectra obviously changes with Al doping with a decrease in intensity from the 4f₁+2a and 12k sites. As can be seen, the linewidths broaden, especially for the 4f₁+2a sites, and the relative area for the 12k site gets larger as x increases. It can be seen that Al⁵⁺ ions have a strong preference for the 4f₁+2a sites. However, when x > 2.0 the 4f₁+2a sites are only slightly involved in the substitution.

References


![Mössbauer spectra of BaFe₁₂ₓAlₓO₁₉ for x=0.0 to x=4.0 at room temperature. Solid circles are experimental data. Solid lines are fits according to models described in the text.](image)

-191-