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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 Fe^{3+}, such as Co^{2+}-Ti^{4+}, Co^{2+}-Sn^{4+}, Cr^{3+}, Mn^{3+} and Al^{3+}. Especially, when the substituted Al^{3+}, changes of structural and magnetic properties is very enlarged. In this study, the site occupancy and anisotropy distribution of Al substituted $BaFe_{12-x}Al_xO_{19}$ ($0.0 \leq x \leq 4.0$) have been studied with Mössbauer spectroscopy, x-ray diffraction, and vibrating sample magnetometry. Nanocrystalline $BaFe_{12-x}Al_xO_{19}$ ($0.0 \leq x \leq 4.0$) 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, M_S decreased linearly but the coercivity, H_c 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 $4f_1$+2*a* and 12*k* sites. As can be seen, the linewidths broaden, especially for the $4f_1$+2a sites, and the relative area for the 12k site gets larger as x increases. It can be seen that Al^{3+} ions have a strong preference for the $4f_1$+2*a* sites. However, when x > 2.0 the $4f_1$+2*a* sites are only slightly involved in the substitution.

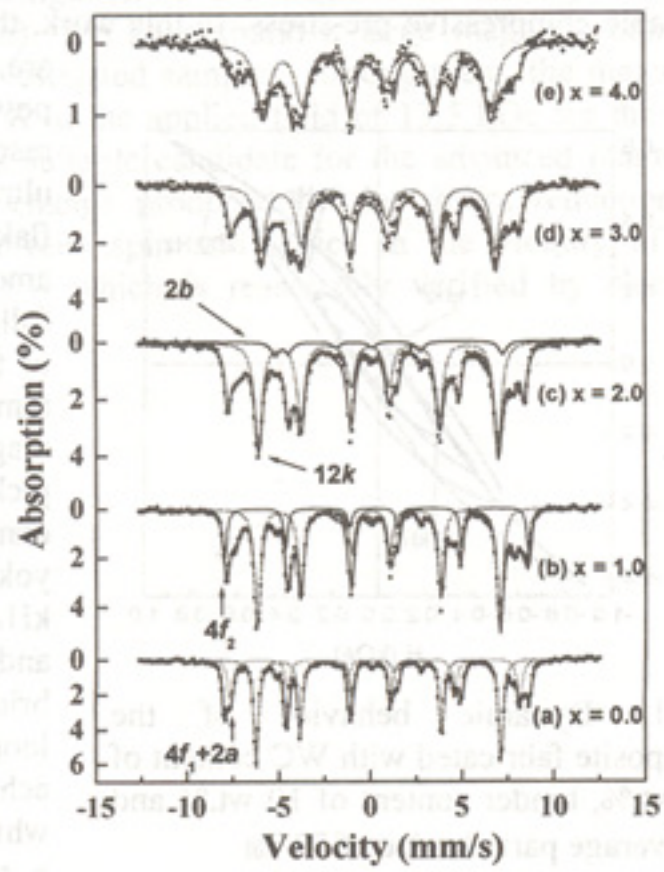

Fig. 1. Mössbauer spectra of $BaFe_{12-x}Al_xO_{19}$ for x=0.0 to x=4.0 at room temperature. Solid circles are experimental data. Solid lines are fits according to models described in the text.

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