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Crystallographic and magnetic properties of $Y_3Fe_{5-x}Al_xO_{12}$

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Abstract

Al^{3+} -substituted garnet $Y_3Fe_{5-x}Al_xO_{12}$ ($x = 0.0, 0.25, 0.5, 0.75,$ and 1.0) was fabricated by a sol-gel method. The crystal structure $Y_3Fe_5O_{12}$ is found to be a cubic with the lattice constant $a_0 = 12.381 \pm 0.005 \text{ \AA}$. Mössbauer spectra of $Y_3Fe_{5-x}Al_xO_{12}$ were taken at various absorber temperatures ranging from 20 to 700 K. As the temperature increased toward T_N a systematic line broadening effect in the Mössbauer spectra was observed and interpreted to originate from different temperature dependencies of the magnetic hyperfine fields at various iron sites. It results from the distribution (${}_6C_n$) of Fe^{3+} and Al^{3+} at tetrahedral site. The isomer shifts indicated that the iron ions were ferric at the octahedral 16a site and the tetrahedral 24d sites. The quadrupole splitting showed that the orientation of the magnetic hyperfine field with respect to the principle axes of the electric field gradient was random.

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