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MÖSSBAURE STUDIES OF $Y_3Fe_{4.75}Al_{0.25}O_{12}$

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Al^{3+} substituted garnet $Y_3Fe_{4.75}Al_{0.25}O_{12}$ was fabricated by a sol-gel method. The crystallographic and ma gnetic properties of $Y_3Fe_{4.75}Al_{0.25}O_{12}$ have been studied with Mössbauer spectroscopy, X-ray diffraction (XRD), thermogravimetry analaysis (TGA), differential thermal analysis (DTA), and vibrating samples magnetometer (VSM). The crystal structure is found to be a cubic with the lattice constant a_0 = 12.361 2 ± 0.0005 Å. Mössbauer spectra of $Y_3Fe_{4.75}Al_{0.25}O_{12}$ measured at various absorber temperatures of 20 to 700 K. Its curie temperature T_C is found to be 555 ± 3 K. As the temperature increased toward T_C, a systematic line broadening effect in the Mössbauer spectra was observed and interpreted to originate fro m different temperature dependencies of the magnetic hyperfine fields at various iron sites. It results fr om the distribution ($_6C_n$) of Fe^{3+} and Al^{3+} at tetrahedral site. The isomer shifts indicated that the iron io ns were ferric at the octahedral *16a*-site and the tetrahedral *24d*-sites. The quadrupole splits showed tha t the orientation of the magnetic hyperfine field with respect to the principal axes of the electric field g radient was random. Mössbauer spectra was analyzed with 3 subspectra of Fe sites (*16a*$_1$, *16a*$_2$ and *24 d*), each hyperfine field of subspectra at 20 K were $H_{hf}(16a_1)$ = 550, $H_{hf}(16a_2)$ = 547, and $H_{hf}(24d)$ = 473 kOe, respectively. The average hyperfine field $H_{hf}(T)$ of the $Y_3Fe_{4.75}Al_{0.25}O_{12}$ shows a temperature d ependence of

$$[\, H_{hf}(T) - H_{hf}(0) \,] / H_{hf}(0) = -0.28(T/T_c)^{3/2} - 0.14(T/T_c)^{5/2}$$

for $T/T_N < 0.7$, indicative of spin-wave excitation. The area fractions of the Fe sites, 16a_1, 16a_2, 24d in $Y_3Fe_{4.75}Al_{0.25}O_{12}$ at 20 K were 25, 15, and 60 %, respectively. The saturation magnetization M_S was 21 emu/g at room temperature under an applied field of 10 kOe annealed at 1200 °C in air atmosphere for 6 hours.

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9. Soft Magnetic Materials and Applications

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