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Magnetic Properties of Nd-Fe-Ti-B-N Permanent Magnets

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Nd-Fe-Ti-B-N has been studied with X-ray diffraction, Mössbauer spectroscopy, and vibrating sample magnetometer(VSM). The alloys were prepared by arc-melting under an argon atmosphere. It was found from X-ray and Mössbauer measurements that Nd-Fe-Ti-B has a pure single phase, whereas Nd-Fe-Ti-B-N contains some α-Fe. $NdFe_{10.7}TiB_{0.3}N$ has a $ThMn_{12}-$ type tetragonal structure with $a_0 = 8.640$ Å and $c_0 = 4.811$ Å. The Curie temperature (T_C) is 833 ± 3 K. Mössbauer spectroscopy was performed at various temperatures ranging from 13 to 800 K, and each spectrum below T_C was fitted with the six subspectra of the Fe sites in the structure ($8i_1, 8i_2, 8j_2, 8j_1$, 8f, and α-Fe). The area fraction of the subspectra at 13 K are 10.2, 8.2, 16.5, 17.5, 44.2, and 3.3%, respectively. The magnetic hyperfine fields for the Fe sites decrease in the order $H_{\rm hf}(8i) > H_{\rm hf}(8j) > H_{\rm hf}(8f)$. The VSM data the above the Curie temperature show that the magnetic moments increase again. The average hyperfine field $H_{hf}(T)$ of $NdFe_{10.7}TiB_{0.3}N$ shows a temperature dependence of

$$[H_{hf}(T) - H_{hf}(0)]/H_{hf}(0) = -0.52(T/T_C)^{3/2} - 0.43(T/T_C)^{5/2}$$

for $T/T_C < 0.7$, indicative of spinwave excitation.