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Magnetic properties and the crystallization of amorphous $Fe_{75.4}B_{14.2}Si_{10.4}$

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The amorphous state of ferromagnetic $Fe_{75.4}B_{14.2}Si_{10.4}$ and its crystalline phases after crystallization have been studied by Mössbauer spectroscopy and magnetic-moment measurements. The average hyperfine field $H_{hf}(T)$ of the amorphous state shows a temperature dependence of $[H_{hf}(T)-H_{hf}(0)]/H_{hf}(0)=-0.30(T/T_c)^{3/2}-0.16(T/T_c)^{5/2}$ for $T/T_c<0.7$, indicative of spin-wave excitation. The quadrupole splitting just above T_c is 0.46 mm/s, whereas the average quadrupole shift below T_c is zero. The Curie and crystallization temperatures are determined to be $T_c=701$ K and $T_x=827$ K, respectively, for a heating rate of 11 K/min. The final products of crystallization are found to be Fe_2B and a Fe–18.1 at.% Si alloy. The saturation magnetic moment of the amorphous state extrapolated to 0 K is found to be $2.05\mu_B$/Fe atom. The magnetization of the amorphous phase decreases more rapidly with reduced temperature than those of crystalline ferromagnets. This kind of rapid decrease can be described in terms of either a distribution of exchange interactions in the amorphous phase or high metalloid contents.