Magnetic properties and the crystallization of amorphous $Fe_{83}B_9Nb_7Cu_1$

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The amorphous state of ferromagnetic $Fe_{83}B_9Nb_7Cu_1$ and its nanocrystallization have been studied by x-ray, Mössbauer spectroscopy, and magnetic moment measurements. In the amorphous state at 13 K, the Mössbauer spectrum exhibits an essentially symmetric hyperfine field distribution with a half-width of 72 kOe. The average hyperfine field $H_{\mathrm{hf}}(T)$ of the amorphous state shows a temperature dependence of $[H_{\mathrm{hf}}(T)-H_{\mathrm{hf}}(O)]/H_{\mathrm{hf}}(O)=-0.48(T/T_C)^{3/2}-0.22(T/T_C)^{5/2}$ for $T/T_C<0.7$, indicative of spin-wave excitation. The quadrupole splitting just above the Curie temperature T_C is 0.43 mm/s, whereas the average quadrupole shift below T_C is zero. The Curie and crystallization temperatures are determined to be $T_C=393$ K and $T_x=775$ K, respectively, for a heating rate of 5 K/min. The occupied area of the nanocrystalline phase at the optimum annealing temperature is about 33%–71%. It is notable that the magnetization of the amorphous phase decreases more rapidly with reduced temperature than those of nanocrystalline ferromagnets, suggesting the presence of the distribution of exchange interactions in the amorphous phase or high metalloid contents. [S0021-8979(96)30808-6]