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Crystallization and Mössbauer Studies of the $Fe_{78}Al_4Nb_5B_{12}Cu_1$ Alloy

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A melt-spun $Fe_{78}Al_4Nb_5B_{12}Cu_1$ alloy with an ultra-thin ribbon has been studied by X-ray diffraction, Mössbauer spectroscopy, and vibrating sample magnetometry. The average hyperfine field $H_{hf}(T)$ of the amorphous state shows a temperature dependence of

$$[H_{hf}(T) - H_{hf}(0)]/H_{hf}(0) = -0.53(T/T_C)^{3/2} - 0.21(T/T_C)^{5/2} \quad \text{for } T/T_C < 0.7,$$

indicative of spin-wave excitation. The quadrupole splitting just above the Curie temperature T_C is 0.42 mm/s, whereas the quadrupole shift below T_C is zero. The Curie and the crystallization temperatures are T_C =450 K and T_x = 703 K, respectively, for a heating rate of 5 K/min. The occupied area ratio of the α-Fe phase flash-annealed at 723 K is 59% and remains unchanged. The crystallization temperature of the flash-annealed alloy becomes lower, and the formation of an α-Fe is easier than that of the conventional alloy. The flash-annealing technique is effective in improving the high-frequency soft magnetic property of the nanocrystalline $Fe_{78}Al_4Nb_5B_{12}Cu_1$ alloy.