Crystallographic and magnetic properties of nanocrystalline $Fe_{78}Al_4Nb_5B_{12}Cu_1$ alloys

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(Received 6 November 2000; accepted for publication 20 November 2001)

The effects of crystallographic change induced during the annealing process upon the magnetic properties of nanocrystalline $Fe_{78}Al_4Nb_5B_{12}Cu_1$ alloy were investigated by using x-ray diffraction, Mössbauer spectroscopy, and macroscopic magnetometry. Special focus was concentrated on the structures of interfacial layer, which is a region between nanocrystallite and amorphous matrix. To examine the differences in the crystallographic and the magnetic properties associated with the thermal treatments, amorphous samples were annealed in two different ways, i.e., flash annealing and conventional annealing. The Mössbauer spectra were analyzed to decompose into three or four components, and revised Vincze method was used to extract the distributions of hyperfine parameters. Interfacial layers were found to have a considerable crystalline order. Flash annealing advances the crystallization process earlier than the conventional annealing. As a result, the fraction of the crystalline phase produced by flash annealing is much higher than that produced by conventional annealing performed at the same temperature. At annealing temperature of as high as 550 °C, second-stage crystallization started and crystalline Fe_2B phase was created. The deterioration in soft magnetic properties at this high annealing temperature was attributed this crystallographic change. [DOI: 10.1063/1.1433932]