New metastable structure of amorphous alloy $Fe_{85}B_{15}$ formed by ion bombardment

A. L. Pivovarov, S. P. Chenakin, and V. T. Cherepin
Institute of Metal Physics, Academy of Sciences of the Ukrainian SSR, Kiev

(Submitted 10 October 1989)
Pis'ma Zh. Eksp. Teor. Fiz. **50**, No. 10, 420–421 (25 November 1989)

The electron-diffraction method was used to study the structure of the amorphous alloy $Fe_{85}B_{15}$ which was bombarded with 5-keV Ar^+ ions in doses of $\geqslant 10^{19}$ cm^{-2}. The formation of a new amorphous structure, whose atomic spacing is larger than that of the alloy not subjected to bombardment, has been observed.

A bombardment of amorphous alloys by gas ions over a broad range of energies and radiation doses generally does not lead to their crystallization.[1] A partial crystallization of an amorphous alloy $Fe_{80}B_{20}$, in which α-Fe was separated, was observed by Hayashi and Sakamoto[2] upon bombardment of the alloy with 40-keV He^+ ions with doses in the range of 5×10^{17}–3×10^{18} cm^{-2}.

As a result of ion bombardment of the amorphous alloy, we have observed in it the formation of a new, metastable, amorphous structure and a crystal phase which formed as this structure began to decay.

A 30-μm-thick $Fe_{85}B_{15}$ tape was obtained by hardening the melt on a rotating wheel. The room-temperature samples of this alloy were bombarded by a 5-keV Ar^+ ion beam (2 mm in diameter) with a current density of 0.3 mA·cm^{-2} in an oil-free vacuum of 4×10^{-5} Pa at an angle of 30° to the surface. To dissipate the heat, we attached the $Fe_{85}B_{15}$ alloy foil to the copper substrate. The temperature of the alloy

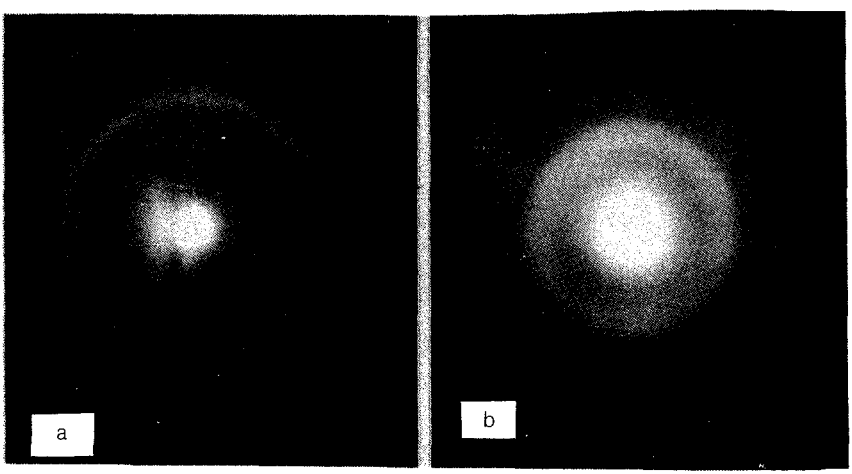

FIG. 1. Electron-diffraction picture of the amorphous alloy $Fe_{85}B_{15}$ (a) in the original state and (b) after bombardment of the sample with 5-keV Ar^+ ions in doses of 10^{19} cm^{-2}.

 0021-3640/89/220455-02$01.00

surface near the ion-bombardment region was held within 60 °C at the specified current density. The temperature was measured with a chromel-copel thermocouple. The structure of the bombarded samples was studied with an EMP-100 transmission electron-diffraction camera. The samples used for electron-diffraction analysis were prepared in the following manner: After bombarding the samples with a dose of 10^{19} cm^{-2} their surface was coated with lacquer and the foil on the reverse side of the sample, which was not exposed to ion bombardment, was thinned electrolytically.

The electron-diffraction pictures of the alloy, which was not exposed to ion bombardment, contained two diffuse rings, characteristic of the amorphous state (Fig. 1a). Bombarding the sample with Ar^+ ions in doses of 10^{19} cm^{-2} produced a new amorphous state which was characterized by a higher degree of disorder (a higher degree of amorphization) and larger (by almost 23%) atomic spacing than that of the initial amorphous structure, as indicated by the appearance of the new system with two, highly diffuse diffraction rings of smaller diameter (Fig. 1b). The experiments showed that the original structure either stratified into two amorphous phases, whose relative size varied, or the alloy changed almost completely to a new amorphous phase.

We express our gratitude to I. E. Kotenko for assistance with the experiment.

[1]A. K. Tyagi *et al.*, J. Nucl. Mater. **122/123**, 732 (1984).
[2]N. Hayashi and I. Sakamoto, Phys. Lett. A **88**, 299 (1982).

Translated by S. J. Amoretty