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MAGNETOSTRICTION PROPERTIES OF AMORPHOUS Fe-B ALLOYS[1]

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In the presented paper the magnetostriction of $Fe_{100-x}B_x$ $(13<x<23)$ amorphous alloys prepared at various technological parameters is studied. The melt cooling rate has an apparent influence on the magnetostriction and this may be connected with internal stresses in the as-quenched alloy. The influence of annealing in the magnetic field, resp. under the tensile stress on magnetostriction, was investigated too. The results are discussed in relation to the induced magnetic anisotropy.

МАГНИТОСТРИКЦИОННЫЕ СВОЙСТВА АМОРФНЫХ СПЛАВОВ Fe-B

В работе приведены результаты исследований магнитострикции аморфных сплавов $Fe_{100-x}B_x$ $(13<x<23)$, приготовленых различными технологическими параметрами. Скорость охлаждения расплава явно влияет на магнитнострикцию, что можно объяснить внутренными напряжениями в резко охлажденном сплаве. Исследовано также влияние отжига на магнитострикцию в магнитном поле или же при растягивающем напряжении. Полученные результаты рассматриваются в связи с индуцированной магнитной анизотропией.

I. INTRODUCTION

The magnetic properties of amorphous Fe-B alloys depend on technological parameters of their preparation [1] and their induced anisotropy may be developed by magnetic or stress annealing. The magnetostriction properties of these alloys are very interesting [2—4], the value of magnetostriction is relatively large and thus provides a good method for studying magnetomechanical properties. We studied the influence of the melt cooling rate on magnetostriction of $Fe_{100-x}B_x$ $(13<x<23)$ alloys and the correlation between induced anisotropy and magnetostriction.

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II. EXPERIMENTAL

For measurements thin (~ 20 μm) and narrow (1—2 mm) ribbons of amorphous alloys prepared by the spinning wheel method were used. Magnetostriction was measured using the opto-mechanical method, which enables to study the magnetostriction on free samples, subjected only to a small and variable external tensile stress σ. The saturation magnetostriction λ_s was determined from $\lambda(H)$ curves measured at different tensile stresses and then extrapolated to the zero stress.

III. RESULTS AND DISCUSSION

Fig. 1 shows the concentration dependence of λ_s in comparison with the results of [4]. Our results indicate that the cooling rate — as one of the technological

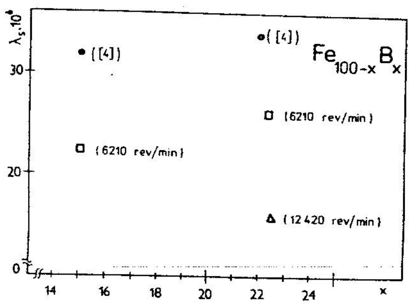

Fig. 1. Saturation magnetostriction λ_s in samples prepared at different melt cooling rates.

parameters of sample preparation — strongly influences the saturation magnetostriction. For example, the increase of the spinning wheel speed from 6210 to 12420 rev/min results in a cca 50 % lower magnetostriction. Also for lower boron concentration we obtained a lower value for λ_s than that in [4], which may be caused by the difference in conditions of preparation. The cooling rate influences also the coercive force, which increases with the increasing cooling rate [1]. This, together with our finding that magnetostriction decreased with the applied tensile stress in all the studied samples, indicates that tensile stresses are quenched-in into the ribbons at preparation. The comparison of properties of various alloys is therevore reasonable only for the same conditions of prepatation of the alloys.

We further investigated the magnetostriction of magnetic and stress-annealed Fe-B amorphous alloys. Fig. 2 shows the observed $\lambda_s(\sigma)$ curves for the stress-relief annealed samples and for samples annealed in a magnetic field of 4000 A/m or under the tensile stress of 400 MPa. The saturation magnetostriction of $Fe_{85}B_{15}$ alloys has the same value for samples annealed both with and without the magnetic field. It is interesting to note that also $\lambda_s(\sigma)$ curves lie very close to each other.

This heat treatment produced only a small induced anisotropy in these samples [5]. On the other hand in the $Fe_{77.6}B_{22.4}$ alloy the induced anisotropy is much larger and the $\lambda_s(\sigma)$ curves after annealing with and without the magnetic field are quite different. However, the influence of annealing under tensile stress is greater in both alloys and causes the reduction of the value of saturation magnetostriction. This suggests that ordering processes influence the magnetostriction of Fe-B alloys. It

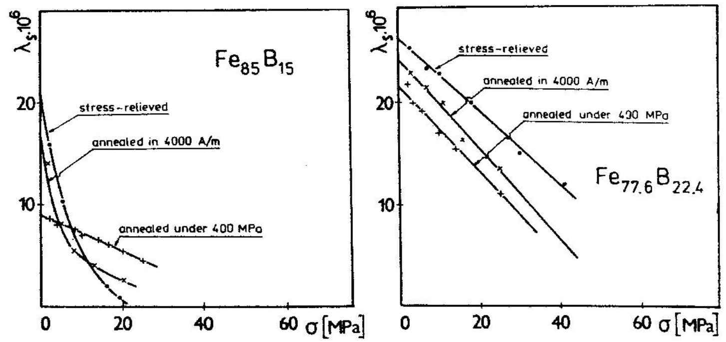

Fig. 2. Saturation magnetostriction λ_s on $Fe_{85}B_{15}$ and $Fe_{77.6}B_{22.4}$ samples in dependence on the tensile stress after stress relief annealing, after annealing in the magnetic field, resp. under tensile stress.

seems that annealing in the magnetic field as well as under tensile stress causes the same sort of microphysical changes of the structure, which in turn influence the magnetostriction.

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