INFLUENCE OF THE QUENCHING CONDITIONS ON THE MAGNETIC AFTEREFFECT IN Fe-B METALLIC GLASSES[1]

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In the presented paper the influence of the melt overheating and of the cooling rate on the relaxation of the initial magnetic susceptibility was investigated. It was found that the magnetic after-effect factor $\Delta\chi/\chi_{30}$ increases with the increasing rotational speed of the quenching disc. This fact may be put in connection with the *"free volume"* and with the concetration of free boron atoms in the alloy.

ВЛИЯНИЕ УСЛОВИЙ ЗАКАЛКИ НА МАГНИТНОЕ ПОСЛЕДЕЙСТВИЕ В МЕТАЛЛИЧЕСКИХ СТЕКЛАХ Fe-B

В работе приведены результаты исследований влияния перегрева расплава и скорости охлаждения на релаксацию начальной магнитной восприимчивости. Обнаружено, что величина магнитного последействия $\Delta\chi/\chi_{30}$ возрастает с увеличением скорости вращения охлаждающего диска. Этот факт может быть связан со *«свободным объемом»* и с концентрацией свободных атомов бора в сплаве.

I. INTRODUCTION

As it was shown previously [1] in amorphous $Fe_{100-x}B_x$ alloys ($13<x<24$) the magnetic aftereffect can be detected. The disaccommodation strongly depends on the boron content and is the highest at a eutectic concentration. Since the magnetic properties of amorphous alloys depend on the technological parameters of their preparation [2, 3], the influence of the cooling rate and the melt temperature on the magnetic aftereffect may be expected. The study of this correlation is the aim of this work.

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II. EXPERIMTENTAL

The amorphous ribbons were prepared by the spinning wheel method, quenching the melt at 1570 and 1770 K at various cooling rates due to a varying angular velocity of the quenching disc. The initial magnetic susceptibility was measured by a mutual induction bridge at a 0.1 A/m a.c. field of 970 Hz. All measurements were performed on a set of straight samples in the as-quenched state after stressrelief annealing and after annealing in a 4000 A/m magnetic field.

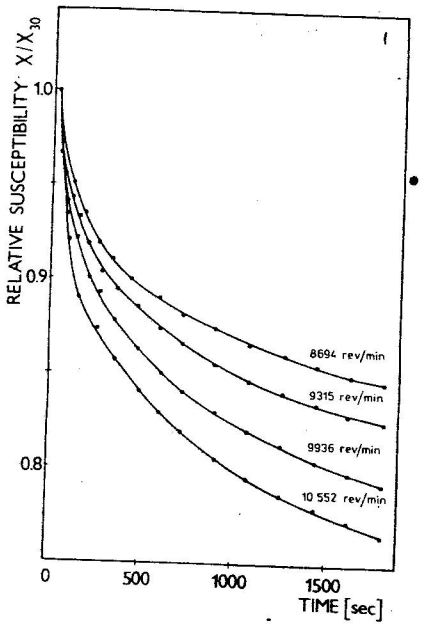

Fig. 1. Time dependence of relative susceptibility measured on as-quenched $Fe_{83.4}B_{16.6}$ samples prepared with various cooling rates. T_{melt} = 1570 K, T_{meas} = 330 K.

III. RESULTS AND DISCUSSION

Fig. 1. shows the relatively great influence of the cooling rate on the time decrease of the initial magnetic susceptibility of the as-quenched samples. The higher the cooling rate, the higher the change of susceptibility. Changing the rotational speed from 8694 rev/min to 10 557 rev/min the value of disaccommodation

$$\Delta\chi/\chi_{30} = \frac{\chi(t=30\text{ s}) - \chi(t=1800\text{ s})}{\chi(t=30\text{ s})}$$

increases (by about 10 %). This may be interpreted by assuming that the concentration of the interstitial boron atoms is higher because more "free volume" is frozen in at a higher cooling rate. The higher cooling rates result in lower values of the unrelaxed initial susceptibility (Fig. 2). The same tendency was found for magnetostriction [4]. It can be explained in both cases by higher internal stresses produced by higher quenching rates.

Investigating the concentration dependence of the magnetic after-effect in the as-quenched state at various cooling rates we detected the same tendency as in [1]. The role of internal stresses at various cooling rates can be seen by comparing Fig. 3a and Fig. 3b. After stress-relief annealing the same tendency can be found in

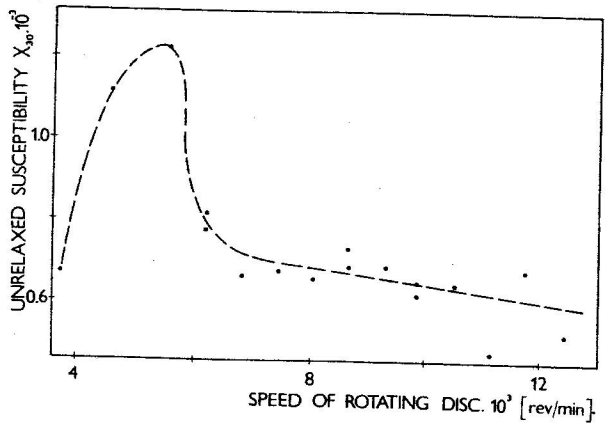

Fig. 2. Unrelaxed susceptibility as a function of the rotation speed of the disc (Φ = 76 mm) measured on as-quanched $Fe_{83.4}B_{16.6}$ samples at 330 K. T_{melt} = 1570 K.

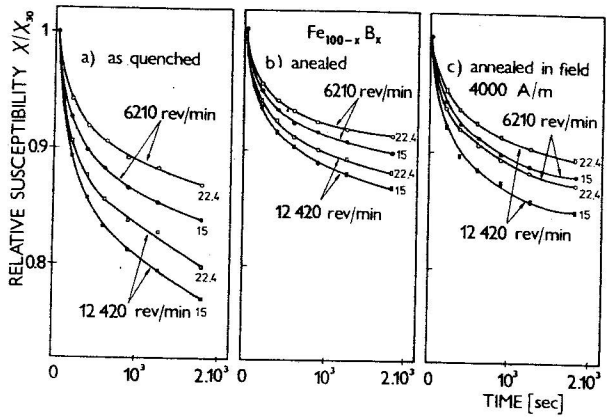

Fig. 3. Time dependence of relative susceptibility on samples containing 15 and 22.4 at. % B prepared by two cooling rates (using 6210 –●–, and 12420 –□– rev/min) quenched from 1770 K. T_{meas} = 330 K. a) in the as-quenched state, b) after stress-relief annaeling, c) after annaeling in a 4000 A/m magnetic field.

the dependence of the after-effect on both the cooling rate and the boron content, but the changes in both cases are smaller. Fig. 3c shows the time dependence of susceptibility for samples with the induced magnetic anisotropy due to annealing in the magnetic field (4000 A/m), which was performed analogously to the stress-relief annealing. Near the eutectic composition an equal increase of the magnetic aftereffect can be observed for both cooling rates. In alloys with a hypereutectic boron content the aftereffect increases at a lower cooling rate and vice-versa. Investigating the induced uniaxial magnetic anisotropy on the same samples in [3] a relatively large anisotropy was observed for a higher cooling rate. It seems that in these alloys the ordering process lowers the boron atoms mobility.

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