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MAGNETIC PROPERTIES OF QUASI-BINARY $Fe_{80}T_3B_{17}$ AMORPHOUS ALLOYS[1]

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In the present paper there was studied the influence of the iron substitution in the $Fe_{83}B_{17}$ amorphous eutectic alloy by the T-element (T = Ni, Co, Mn, Cr, V, Ti and some 4*d* and 5*d* elements) on some magnetic quantities and amorphous-crystalline transformation. The results are interpreted in relation to the tendency of cluster formation in the alloy, which may be connected with the affinity of the T-element with the boron.

МАГНИТНЫЕ СВОЙСТВА КВАЗИДВУХКОМПОНЕНТНЫХ АМОРФНЫХ СПЛАВОВ $Fe_{80}T_3B_{17}$

В работе изучается влияние замещения железа Т-элементом (Т = Ni, Co, Mn, Cr, V, Ti и другие 4*d* и 5*d* элементы) в аморфном эвтектическом сплаве $Fe_{83}B_{17}$ на некоторые магнитные величины и на переход аморфного состояния в кристаллическое. Результаты интерпретируются в связи с тенденцией образования кластеров в сплаве, что можно объяснить сродством Т-элементов и бора.

I. INTRODUCTION

Magnetic properties of amorphous alloys on the basis of iron are appreciably influenced by a relatively small content of another transition element. The alloying seems to be a powerful method to improve some physical properties too [1—3]. In this paper the influence of substitution of Fe in the eutectic $Fe_{83}B_{17}$ amorphous alloy with the T-element (Ni, Co, Mn, Cr, V, Ti and some 4*d*, 5*d* elements) on the coercive force H_c, the Curie temperature T_c^a and the amorphous-crystalline transition has been investigated.

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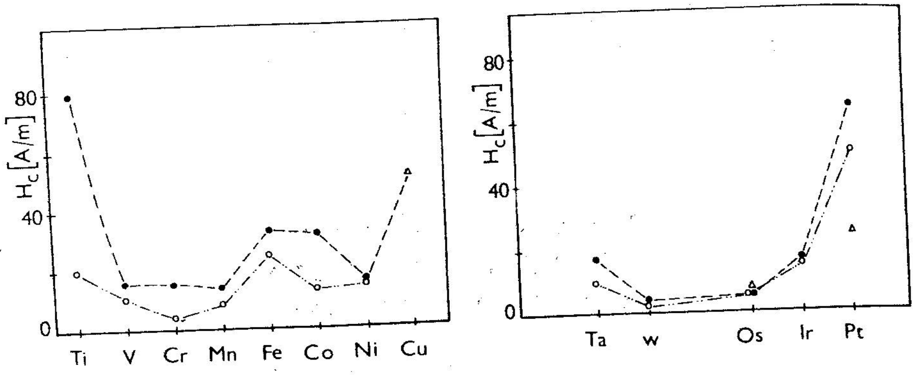

Fig. 1. Coercive force of the quasibinary $Fe_{80}T_3B_{17}$ (T=Ni, Co, Mn, Cr, V, Ti and some 4*d* and 5*d* elements) amorphous alloys for some different melt overheating temperatures. (–●– 1520 K, –O– 1620 K, –Δ– 1820 K)

II. SAMPLES AND EXPERIMENTAL METHODS

The amorphous samples were produced by the melt spinning wheel method [4]; and the alloys were quenched from two or three different melt temperatures depending on the miscibility of the T-element. In all cases the T-content was 3 at. % disregarding the deviation caused by the alloying difficulties (V, Ti, Mn). The amorphous state of the samples was checked by X-ray diffraction. The magnetic measurements were made by the Foner vibrating sample magnetometer and by an astatic magnetometer.

III. RESULTS AND DISCUSSION

Fig. 1 shows the coercive force of the as-quenched ribbons for two different melt overheatings (1520 and 1620 K). The coercive force decreases with increasing overheating in most cases. This tendency confirms the earlier results on the eutectic Fe-B alloy [5]. The substitution of iron in this alloy by some T-elements leads to a decrease of the coercive force. After quenching from 1520 K only three exceptions could be observed — Ti and Pt increased the coercive force and Cu causes also an increase in spite of the high quenching temperature (1820 K). In the mentioned cases clustering or the tendency for the two-phase nature of the melt is highly suspected. Of course the origin of clustering for alloys with Ti, Pt and Cu is quite different. The high affinity of Ti to boron and the limited solubility of Ti in iron may lead to the formation of Ti-B rich clusters in the melt, forming simultaneously Fe-B regions with a low boron content. The existence of clusters is here confirmed by the observed decrease of H_c with melt overheating and by the

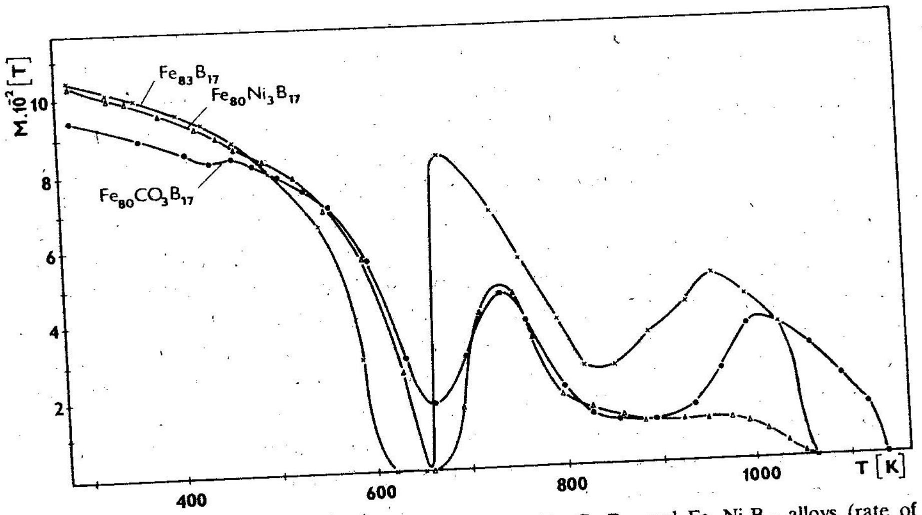

Fig. 2. Thermomagnetic curves for amorphous $Fe_{83}B_{17}$, $Fe_{80}Co_3B_{17}$ and $Fe_{80}Ni_3B_{17}$ alloys (rate of temperature increase 1.7 K/min).

measured $H_c(T)$ curve, which indicates crystallization in this alloy already at a low temperature. For the origin of clustering in an alloy with Cu probably the limited solubility of Cu in iron has an important role. The nature of clustering in an alloy with Pt seems to be complicated because of the small affinity of Pt to boron and the

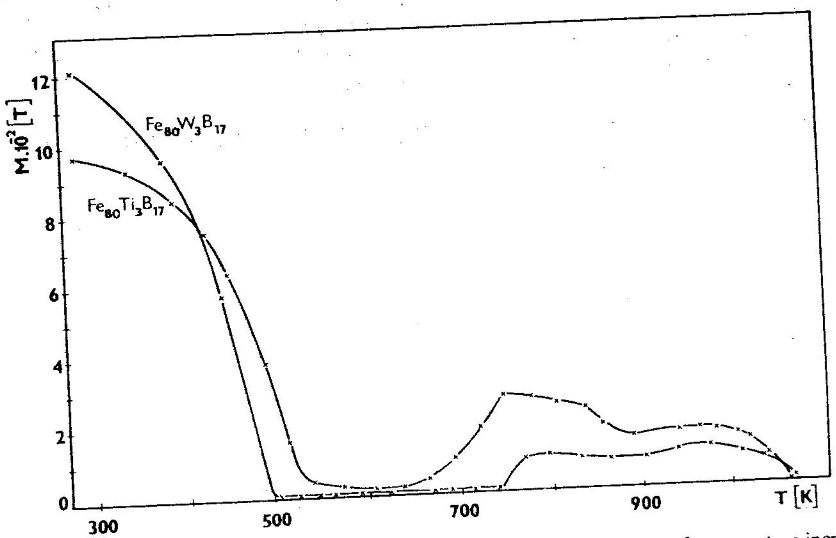

Fig. 3. Thermomagnetic curves for amorphous $Fe_{80}Ti_3B_{17}$ and $Fe_{80}W_3B_{17}$ (rate of temperature increase 1.7 K/min).

good miscibility of Pt with iron. Supposing that coercive force is caused by the domain wall displacements [6], the calculated values of H_c, M_s, d (M_s is the saturation magnetization and d the sample thickness) for the as-quenched ribbons suggest that the role of the strain-magnetostriction anisotropy, the change in ferromagnetic exchange and the possibility of clustering are highly pronounced.

Fig. 2 shows the thermomagnetic curves for $Fe_{83}B_{17}$, $Fe_{80}Co_3B_{17}$ and $Fe_{80}Ni_3B_{17}$, respectively. (The magnetizations M were measured in the constant field 2400 A/m on the decreasing branch of the hysteresis loop). The shape of the measured curves for these alloys is quite similar. This is well understood on the basis of the nearly equal stability of Fe, Co and Ni borides, as well as of the nearly identical magnetization of the first crystallization products. The shape of the thermomagnetic curves in Fig. 3 significantly differs from the previous ones. It is evident that T-elements with a high affinity to boron cause a pronounced separation of crystallization temperature from T_c^a. (The anomalous nature of $Fe_{80}Ti_3B_{17}$ is also obvious from the thermomagnetic curve). It seems that the T-elements, which raise the thermal stability, lower the stability of the ferromagnetic arrangement and lower the T_c^a as compared to the eutectic Fe-B alloy.

REFERENCES

[1] Naka, M., Tomizawa, S., Masumoto, T., Watanabe, T.: 2^{nd} *Int. Conf. on Rapidly Quenched Metals.* Massachusetts 1975.
[2] Donald, I. W., Davis, H. A.: 3^{rd} *Conf. on Rapidly Quenched Metals,* Brighton 1978.
[3] Lovas, A., Gránásy, L., Balla-Zámbó, K.: Király, J.: *Proc. Conf. on Metallic Glasses: Science and Technology.* Budapest 1980 (to be published).
[4] Liebermann, H. H., Graham, C. D. Jr.: IEEE Trans. Magn. MAG-*12* (1976), 921.
[5] Novák, L., Potocký, L., Lovas, A., Kisdi-Koszó, É., Takács. J.: J. Magn. Magn. Mater. *19* (1980), 149.
[6] Luborsky, F. E., Walter, J. L., Le Grand, D. G.: IEEE Trans. Magn. MAG-*12* (1976), 930.

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