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INFLUENCE OF SURFACE LAYERS OF THE $Fe_{85.4}B_{14.6}$ AMORPHOUS RIBBON ON THE COERCIVE FORCE AND ON THE THERMOMAGNETIC BEHAVIOUR

JURÁNEK Z., KOLLÁR, P., POTOCKÝ L.[1], NOVÁK L.[2], Košice,
KISDI-KOSZŐ E.[3], Budapest

The magnetic properties of the amorphous ferromagnetic alloys prepared in the form of their ribbons by melt spinning as well as the mechanism of the crystallization processes in there materials depend strongly on the physical and chemical state of both surface layers. The relief structure on the surface contacting the cooling wheel and the microcrystals as well as stress regions on both surfaces play an important role. In this work we investigated the influence of the surface layers of the ferromagnetic ribbon on the surface magnetic properties, that is on the surface coercive force, surface magnetoelastic energy and amorphous-crystalline transformation during sample heating.

I. EXPERIMENTAL AND RESULTS

Measurements were made on the amorphous ferromagnetic $Fe_{85.4}B_{14.6}$ ribbons 43 μm thick. Surface magnetic properties were measured by a magnetooptical magnetometer, enabling to measure the magnetic polarization of their surface layer about 50 nm thick [4]. Surface magnetic polarization was measured on the sample surface after gradual etching. The total thickness of the layer removed by etching was 3.4 μm. The results of these measurements on the wheel side (w.s.) and on the air side (a.s.) of the non-etched sample as well as after the removal of the surface layers are given in Fig. 1. This figure shows the dependence of the surface coercive force and of the surface magnetoelastic energy on the sample thickness after the surface layer was removed. It follows from the obtained results that the material inhomogeneities responsible for the coercive force, above all the regions of mechanical stresses and microcrystals, are concentrated in a thin surface layer on both sides of the amorphous ribbon; this layer on the a.s. is up to 1 μm thick, and on the w.s. its thickness is up to 0.5 μm.

[1]) Faculty of Sciences, P. J. Šafárik University, 041 54 KOŠICE, Czechoslovakia
[2]) Institute of Experimental Physics, Slov. Acad. Sci., KOŠICE, Czechoslovakia
[3]) Central Research Institute for Physics, Hungarian Acad. Sci., BUDAPEST, Hungary

Small crystals of α-Fe in the form of thin discs with the linear dimension of about 10 μm were found in the a.s. surface layer by electron microscope observations [5]. The air side surface shows a relief structure as a consequence of the preparation technology — gas (air) bubbles are entrapped into this surface from the atmosphere by a rapid rotating wheel [2]. A microcrystalline structure is here formed as the consequence of the thermal isolating properties of gas bubbles separating the cooled melt from the cooling wheel. The chemical compositions of the microcrystals could not be identified unambiguously.

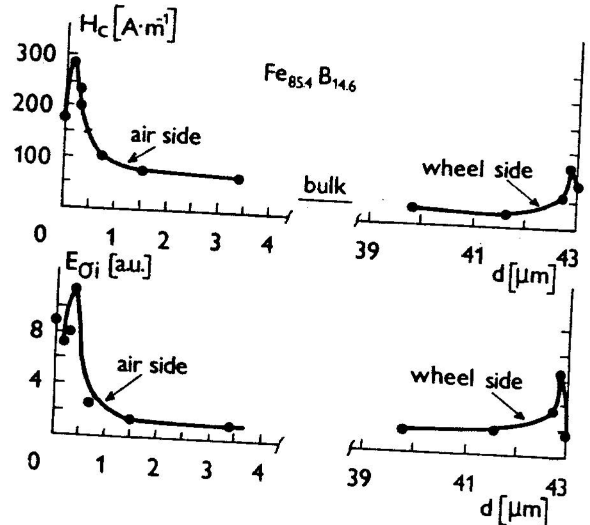

Fig. 1. Surface coercive force and magnetoelastic anisotropy energy vs. thickness of the ribbon

Fig. 2 shows the thermomagnetic curves from room temperature to 1100 K of the as-cast sample (full line) and after the removal of the 1.1 μm surface layer. This curve may be divided into a number of characteristic temperature ranges. The ferromagnetic state of the amorphous phase disappears at a temperature of about 550 K. The following increase of the magnetic polarization may be connected with the crystallization and the phases Fe_3B and α-Fe were identified. A further increase of the temperature causes the transformation of the crystalline phase Fe_3B into the ferromagnetic phases Fe_2B and α-Fe [6]. This process leads first to the increase of the magnetic polarization followed by the decrease and disappear of the magnetic polarization at $T \approx 1050$ K, in agreement with the Curie temperature of Fe_2B and α-Fe.

The removal of the a.s. surface layers has no apparent influence on the thermomagnetic curve (circles on the curve). After the removal of the w.s.

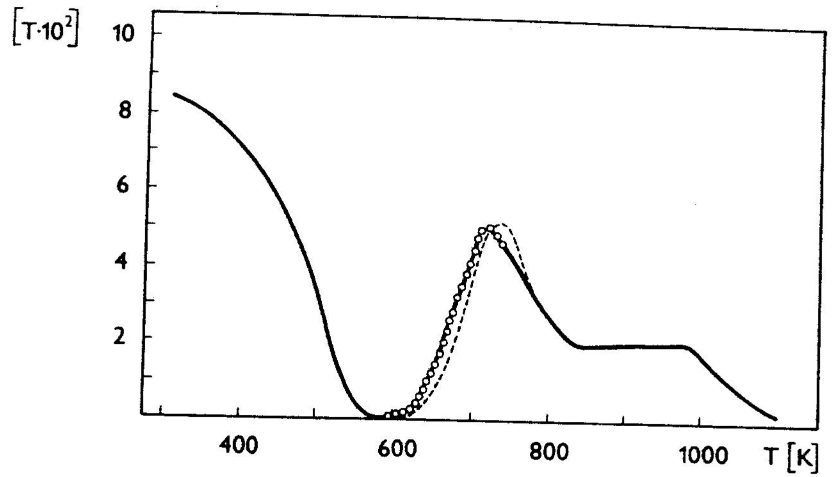

Fig. 2. Thermomagnetic curves for the $Fe_{85.4}B_{14.6}$ (external field 4000 $A \cdot m^{-1}$), as cast (full line), after removal at the 1.1 μm surface layer from the a.s. surface (circles on the curve) and from the w.s. surface (dashed curve)

surface layer by etching a rise of the crystallization temperature of the sample by about 10 K may be observed (dashed curve).

II. CONCLUSION

If may be assumed from these measurements that the microcrystalline layer removed from the wheel side contains more Fe_3B — and partially also α-Fe microcrystals than the bulk material does, and there the removed small crystals cannot act as crystallization nuclei during sample heating. It should be noted that the thermomagnetic curve of the sample with both sides etched is almost the same as the curve found for the sample with only the w.s. etched.

The obtained results indicate the important influence of the surface layer of the amorphous ribbon on the amorphous-crystalline transformation as well as on the macroscopic magnetic properties.

REFERENCES

[1] Kronmüller, H.: JMMM, *24* (1981), 159.

[2] Bech, W., Kronmüller, H.: Phys. stat. sol. (a) *79* (1983), 389.

[3] Luborsky, F. E., Shyk-Chin Huang, Fiedler, H. C.: IEEE Trans. Mag., MAG-*17* (1981), 3463.

[4] Kollár, P., Skyba, P., Potocký, L., Juránek, Z.: Elektrotechn. čas. SAV, *4* (1987), 000.

[5] Kisdi-Kosző, E., Potocký, L., Kollár, P., Juránek, Z., Vértesy, G.: *Proc. of SMM 7, Conf.* Blackpool 1985.
[6] Potocký, L., Novák, L., Kisdi-Kosző, E., Lovas, A., Takács, J.: Acta phys. slov. *29* (1979), 000.

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ВЛИЯНИЕ ПОВЕРХНОСТНЫХ СЛОЕВ $Fe_{85,4}B_{14,6}$ АМОРФНЫХ ЛЕНТ НА КОЭРЦИТИВНУЮ МОЩНОСТЬ И НА ТЕРМОМАГНИТНУЮ КРИВУЮ

Макроскопические магнитные свойства аморфных ферромагнитных сплавов приготовленных методом быстрого охлаждения расплава в виде тенких лент, как и динамика процессов кристаллизации, в значительной степени зависят от физико-химического состояния обеих поверхностей, прежде всего от присутствия релиефной структуры поверхности касающейся охлаждающего барабана и от присутствия микрокристаллов и областей напряжения в приповерхностных слоях. В настоящей работе изучено влияние этих нарушеных приповерхностных слоев на поверхностную коэрцитивную мощность, поверхностную магнитоупругую энергию и на температуру кристаллизации при постепенном нагревании образца.