

INFLUENCE OF Co ON THE MAGNETIC PROPERTIES OF MICROCRYSTALLINE Fe-Si AND Fe-Al ALLOYS ¹⁾

ВЛИЯНИЕ Co НА МАГНИТНЫЕ СВОЙСТВА МИКРОКРИСТАЛЛИЧЕСКИХ СЛИВКОВ Fe-Si И Fe-Al

ZÁK, T. ²⁾, SCHNEEWEISS, O. ²⁾, BRNO

A practical application of the microcrystalline Fe-Si and Fe-Al based soft magnetic materials near the A₁B stoichiometry is restricted due to the low saturation flux density. To raise the total magnetic moment, the cobalt alloying of those soft magnetic materials was tried.

Ingot of Fe₇₃Si₂₅, Fe₆₈Co₁₃Si₁₈, Fe₆₈Co₁₀Ni₅Si₁₇, Fe₇₈Al₂₂ and Fe₇₇Co₁Al₂₂ alloys (each of about 150 g) were prepared by the melting in a rf furnace under the Ar atmosphere and casting in a copper mould. The purity of the components was ranging between 0.995 (Fe) and 0.9999 (Al). Microcrystalline ribbons of the cross section of about (0.04 × 3.0) mm² were cast from the melt by the double-roller quenching technique.

The ribbon samples in the as-quenched state usually do not reach the best soft magnetic properties. Therefore an appropriate heat treatment was considered. Thus also the samples after annealing at 530, 800, 1000 and 1100 °C for 1 hour in vacuum were investigated.

Among macroscopic magnetic characteristics, saturation magnetic polarization J_s and coercive force H_c were measured using the VSM and the Forster coercimeter, respectively. Distributions of hyperfine magnetic fields on Fe nuclei as well as their mean values were checked using the Mössbauer spectroscopy. Simultaneously the changes of the short range order (SRO) were followed from the spectra. The dependences of J_s and H_c on the heat treatment are shown in Figs. 1 and 2. Generally, the as-quenched state of all samples provides rather poor magnetic properties. A high value of J_s and a minimum H_c were reached after the annealing at 1100 °C, almost for all our ribbons. Concerning the improvement of the J_s value, the Fe₇₈Al₂₂ and Fe₆₈Co₁₀Ni₅Si₁₇ materials are rather equivalent. For the Fe-Si based alloy slightly lower H_c values were gained, which can be connected with its low magnetostriction [1]. For the Fe₇₈Al₂₂ and Fe₇₇Co₁Al₂₂Co₁ alloys, the heat treatment causes also changes in the distribution of hyperfine fields on Fe nuclei, which reflects changes in the SRO. The spectra of Fe₆₈Co₁₀Ni₅Si₁₇ and Fe₆₈Co₁₃Si₁₈ ribbons show also some subtle differences in the SRO after the annealing, namely at 1000 and 1100 °C. It can be assigned to the precipitation of (Fe, Ni)₃Si and Co₃Si microdomains. The mean value of the hyperfine magnetic field H_{hf} is in accordance with the corresponding mean macroscopic magnetic moment for all materials (Fig. 1). It follows from our results that the annealing of the as-quenched state in the temperature range between 1000 °C and 1100 °C is necessary to obtain good magnetic properties of these microcrystalline materials. There is no evidence of an improvement of the magnetic properties for

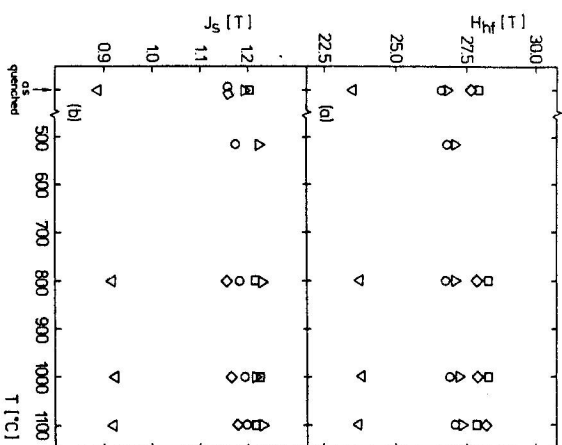


Fig. 1. Dependence of the mean hyperfine magnetic field H_{hf} (a) and saturation magnetic polarization J_s (b) on the annealing temperature

(∇ ... Fe₇₃Si₂₅, \diamond ... Fe₆₈Co₁₃Si₁₈,
 \square ... Fe₆₈Co₁₀Ni₅Si₁₇, Δ ... Fe₇₈Al₂₂,
 \circ ... Fe₇₇Co₁Al₂₂).

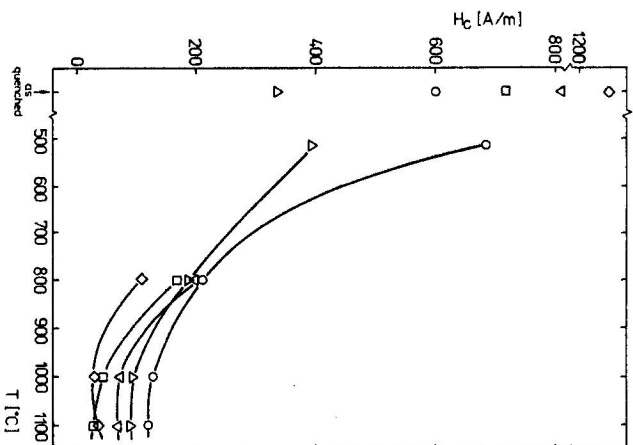


Fig. 2. Dependence of the coercive force H_c on the annealing temperature (symbols as in Fig. 1).

the Fe-Al alloy due to the cobalt alloying, but in both Fe-Si based alloys an increasing saturation and satisfactory values of the coercive force were obtained. To judge their ability to compete with Sendust some other parameters of technical importance should be proved (e.g. ac permeability).

REFERENCES

[1] Tsuyuz, N., Arai, K. I., Ohmori, K., Tomma, T.: IEEE Trans. Mag. MAG-18 (1982), 1424.

Received September 16th, 1988

Accepted for publication November 8th, 1988

¹⁾ Contribution presented at the 8th Conference on Magnetism, KOŠICE, 29. 8.—29. 1988
²⁾ Institute of Physical Metallurgy, Czechoslovak Academy of Sciences, 616 62 BRNO, Czechoslovakia