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MAGNETOMECHANICAL COUPLING IN $Fe_{73,5}Cu_1Nb_1Ta_2Si_{13.5}B_9$ ALLOY STRIPS AFTER ANNEALING UP TO 700°C AND ITS DEPENDENCE ON MAGNETIC FIELD

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A magnetomechanical coupling in the $Fe_{73.5}Cu_1Nb_1Ta_2Si_{13.5}B_9$ metallic glass strips in as-quenched state and after annealing in vacuum at the temperature range from 100 to 700°C was investigated. The maximum values of the magnetomechanical coupling coefficient (k) were obtained after annealing at 450°C (km = 0.38). Decrease of the magnetomechanical coupling (to 0.2 after annealing at 470°C, to 0.15 after annealing at 500°C, and to zero after annealing at 700°C) and a drop of the saturation magnetostriction (λ_s) of this alby from (23-25) x 10^{-6} for as-quenched state and after annealing at 450°C to 10 x 10^{-6} after annealing at 500°C, and to about 2 x 10^{-6} after annealing at 550°C is connected with the forming of the nanocrystalline phase. The ultrasound velocities in the strips depending on the heattreatment and magnetic bias field were changing from 3600 to 5300 m/s.

INTRODUCTION

The aim of this work was to compare the results of the influence of heat-treatment in vacuum at the temperature range from 100 to 700°C on the magnetomechanical coupling in the $Fe_{73,5}Cu_1Nb_1Ta_2Si_{13,5}B_9$ metallic glass strips. In Finemet-type $Fe_{73,5}Cu_1Nb_1Ta_2Si_{13,5}B_9$ alloys two atoms of tantalum instead two atoms of niobium were substituted [1].

1. EXPERIMENTAL

The amorphous ribbons were produced from the melt using rapidly quenched method. Strip-shape samples were cut from the 10 mm wide ribbon of the $Fe_{73,5}Cu_1Nb_1Ta_2Si_{13,5}B_9$ metallic glass [2]. The strips were 50 mm long, 5 mm wide and about 22 μm thick.

The magnetomechanical coupling coefficient (k) was calculated from the resonant frequencies (f_r, at the maximum impedances in Fig. 1) and the antiresonant frequencies (f_a, at the minimum impedances in Fig. 1), e.g.[2], i.e. $k \approx (\pi/2)(1 - f_r / f_a)^{1/2}$. he amplitude of the exciting AC magnetic field was equal to 2-3 A /m. The resonant frequencies were observed in the range from about 30 to 60 kHz.

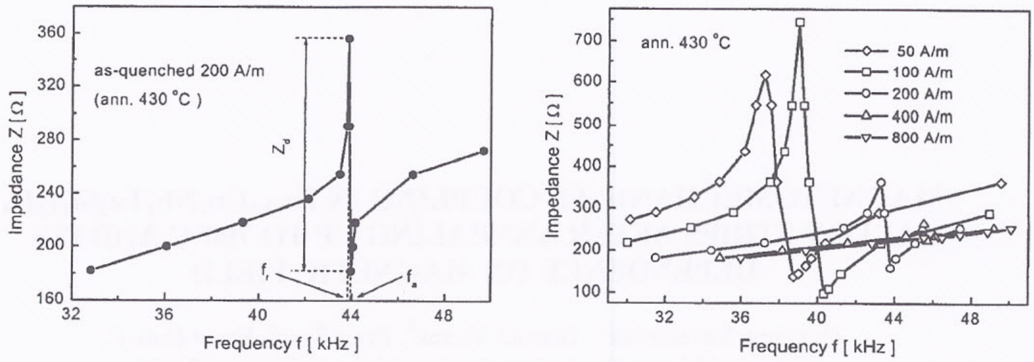

Fig. 1. Moduli of impedance (Z) vs. frequency (f) at magnetic bias field H = 200 A/m for as-quenched samples and at H = 50, 100, 200, 400 and 800 A/m after annealing at 430°C.

2. RESULTS

The dependence of the magnetomechanical coupling coefficient (k) on the magnetic bias field (I~ for the as-quenched samples and next annealed at the temperatures of 100, 300, 350, 400, 450, 500, 550 and 700°C are presented in Fig. 2.

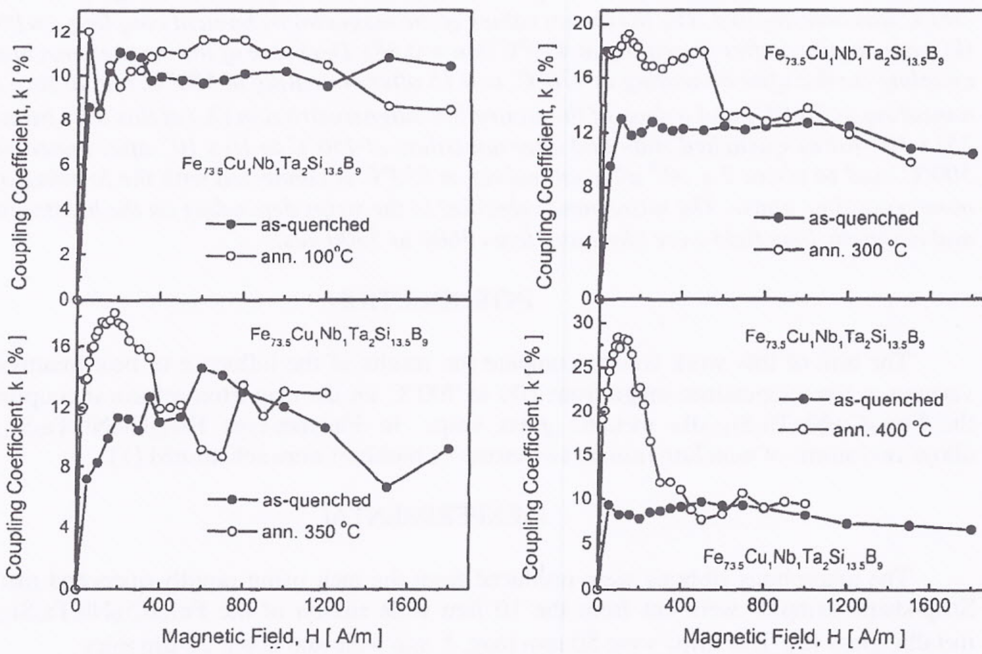

Fig. 2a. Magnetomechanical coupling coefficient (k) vs. magnetic bias field (*H*) for the as-quenched samples and annealed at the temperatures of 100, 300, 350 and 400°C. After annealing at the temperature of 700°C the magnetomechanical coupling vanished.

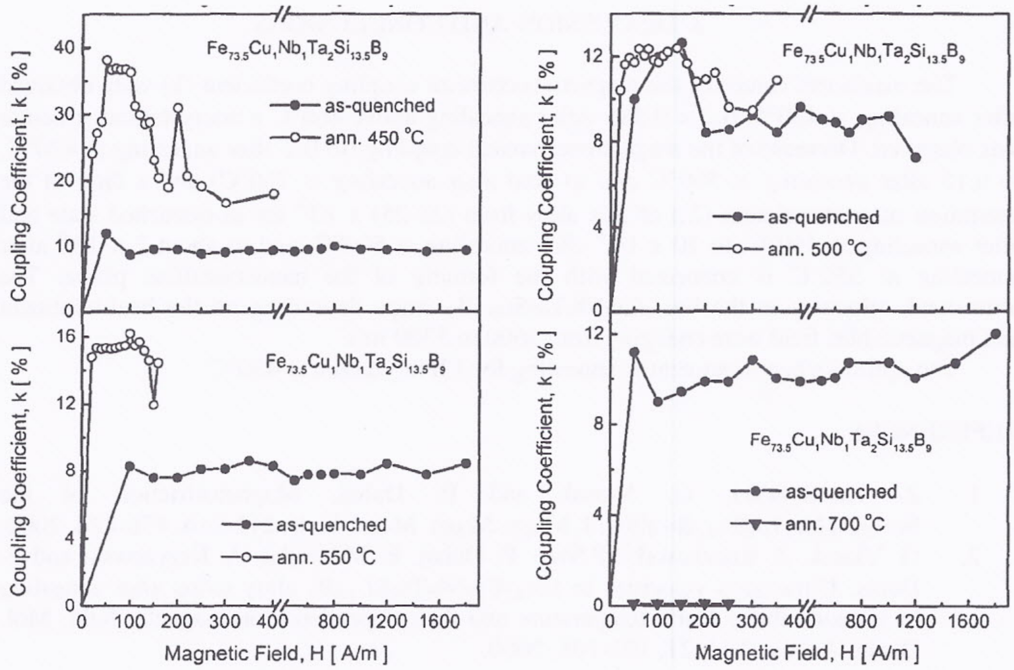

Fig. 2b. Magnetomechanical coupling coefficient (k) vs. magnetic bias field (1~ for the as-quenched samples and annealed at the temperatures of 450, 500, 550 and 700°C.

After annealing at the temperature of 700°C the magnetomechanical coupling vanished.

The maximum values of the magnetomechanical coupling coefficient (k_m), values of the magnetic bias field for k_m, (H_{km}) and saturation magnetostriction (λ_s) as the functions of the annealing temperature (T) up to 700°C are presented in Fig. 3

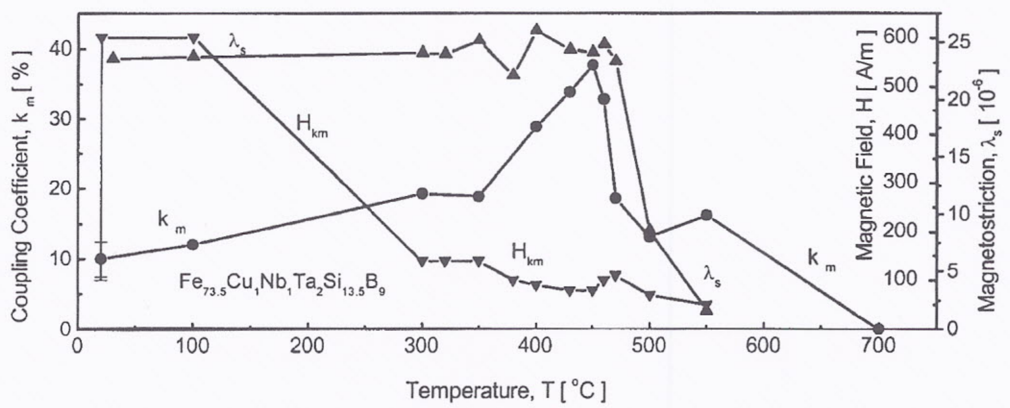

Fig. 4. The maximum values of the magnetomechanical coupling coefficient (k_m), values of the magnetic bias field for k_m, (H_{km}) and saturation magnetostriction (λ_s) vs. annealing temperature (T).

3. DISCUSSION AND CONCLUSIONS

The maximum values of the magnetomechanical coupling coefficient (k) were obtained after annealing at 450°C (k_m = 0.38). After annealing above 460°C a nocrystalline structure was observed. Decrease of the magnetomechanical coupling (to 0.2 after annealing at 470°C, to 0.15 after annealing at 500°C and to zero after annealing at 700°C) and a drop of the saturation magnetostriction (λ_s) of this alloy from (23-25) x 10^{-6} for as-quenched state and after annealing at 450°C, to 10 x 10^{-6} after annealing at 500°C, and to about 2 x 10^{-6} after annealing at 550°C is connected with the forming of the nanocrystalline phase. The ultrasound velocities in the $Fe_{73,5}Cu_1Nb_1Ta_2Si_{13,5}B_9$ strips depending on the heat-treatment and magnetic bias field were changing from 3600 to 5300 m/s.

The optimum beat-treatment is annealing for 1 h in vacuum at 450°C

REFERENCES

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