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ULTRASOUND VELOCITIES AND MAGNETOMECHANICAL COUPLING IN Fe-Co-Ni-Zr-Cu-Nb-B ALLOY STRIPS AFTER HEAT TREATMENT

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The magnetic field and beat-treatment dependences of the ultrasound velocities at constant magnetic field (c_H) and at constant magnetic induction (c_B) and magnetomechanical coupling were investigated in $Fe_{62.5}Co_6Ni_{7.5}Zr_6Cu_1Nb_2B_{15}$ alloy strips in an as-quenched state and after annealing above the Curie temperature. After annealing above 350°C (up to 390°C) the magnetomechanical coupling coefficient (k) was three times higher than that for asquenched state (0.10-012), i.e. k = 0.32-0.37. The minimum values of the c_H (= 3.6 km/s) were observed after annealing in the temperature range from 350 to 390°C at 75-100 A/m. There are equal or somewhat higher values of bias field for the minimum of the c_H than in some other iron-rich amorphous alloys. Effect dc was very small for as-quenched samples. When the samples reached the magnetic saturation, the domain stucture vanished and then the Hooke's law was valid, i.e. $E_H = E_B = E$, where E was then material constant, known as Young's modulus and then the ultrasound velocities are also material constant.

INTRODUCTION

The aim of this work was to investigate the magnetic field and heat-treatment dependences of the ultrasound velocities and the magnetomechanical coupling coefficient in $Fe_{62,5}Co_6Ni_{7,5}Zr_6Cu_1Nb_2B_{15}$ alloy [1] strips after annealing above the Curie temperature.

1. EXPERIMENTAL

The amorphous ribbons were produced from the melt using rapidly quenched method. Ultrasound velocities at constant magnetic field *(c_H)* and at constant magnetic induction *(c_B)* and the magnetomechanical coupling coefficient (k) as the functions of magnetic field and heat-treatment in the $Fe_{62.5}Co_6Ni_{7.5}Zr_6Cu_1Nb_2B_{15}$ alloy samples were investigated. The stripshape samples (40 mm long, 2 mm wide and about 22 μm thick) in as-quenched state and after annealing for 1 h in vacuum from 350 to 390°C were measured using resonant antiresonant method. The ultrasound velocities c_H and c_H and the magnetomechanical coupling coefficient *(k))* were determined from the resonant (f_r) and antiresonant (f_a) frequencies (Fig. *1*, f_r at the maximum, Z_{max}, and f_a at the minimum, Z_{min} impedances), i.e. $c_H \approx 2lf_r$, $c_B \approx 2lf_a$ and $k \approx (\pi/2)(1-f_r/f_a)^{1/2}$. where l = 40 mm. The amplitude of the alternating magnetic field was equal to 2-3 A/m. The magnetic bias field (H) was increased to the technical saturation (1200 A/m for as-quenched samples and 500-700 A/m for the annealed samples).

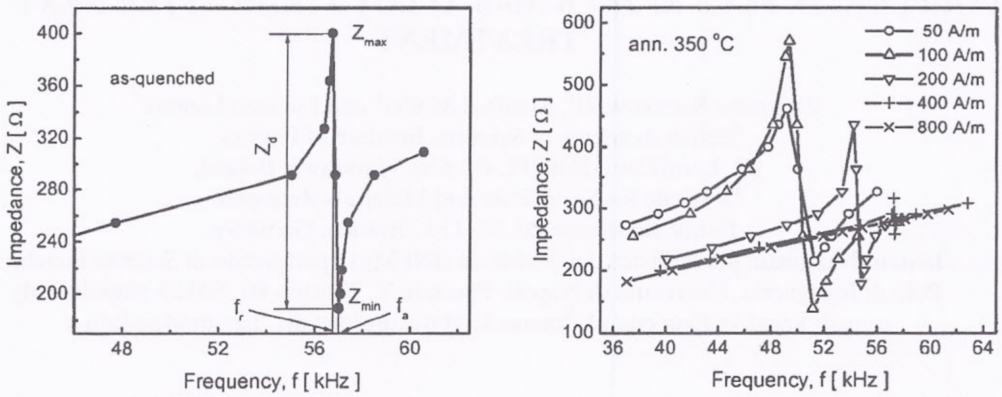

Fig. 1. Impedance moduli (Z) vs. frequency *(f)* for as quenched sample (at bias field equal to 200 A/m) and for the strip annealed at 350°C at 50, 100, 200, 400 and 800 A/m.

2. RESULTS, DISCUSSION AND CONCLUSIONS

The results for magnetc field dependence of the ultrasound velocities c_H and c_H and the magnetomechanical coupling coefficient (k)) in the strips in as-quenched state and after annealing for 1 h in vacuum from 350 to 390°C are presented in Figures 2 and 3.

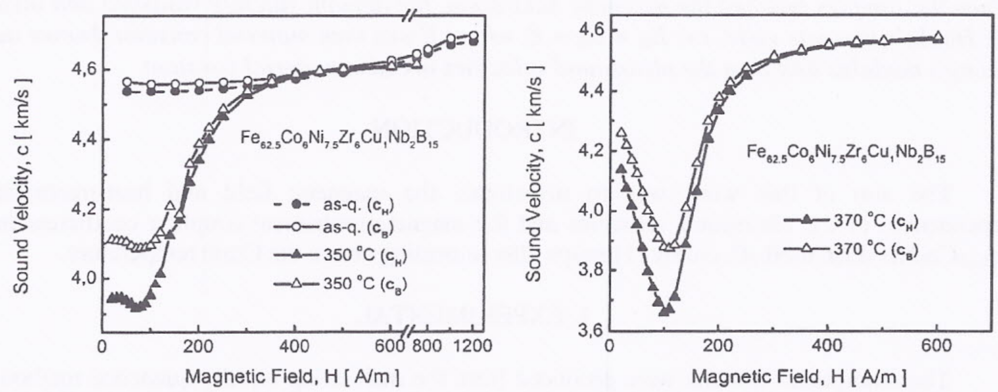

Fig. 2a. Ultrasound velocities at constant magnetic field *(c_H)* and at constant magnetic induction *(c_B)* vs. magnetic field *(H)* for as-quenched (as-q.) sample and samples annealed in vacuum for lh at 350 and 370°C in the $Fe_{62.5}Co_6Ni_{7.5}Zr_6Cu_1Nb_2B_{15}$ alloy strips.

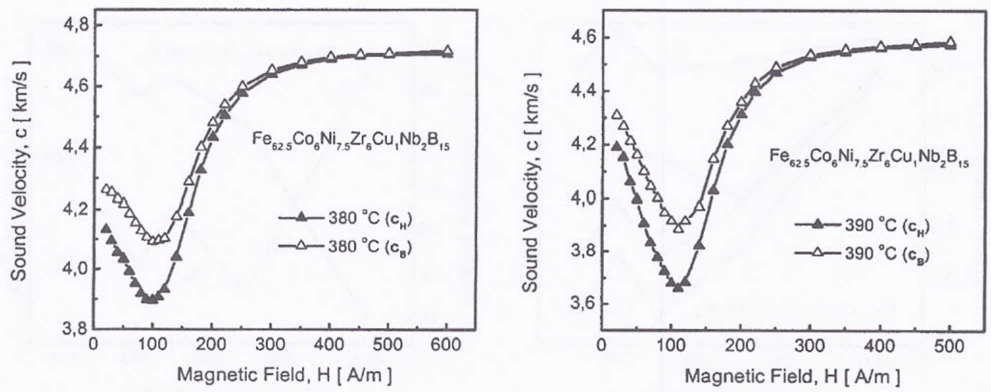

Fig. 2b. Ultrasound velocities at constant magnetic field *(c_H)* and at constant magnetic induction *(c_B)* vs. magnetic field *(H)* for as-quenched (as-q.) sample and samples annealed in vacuum for lh at 350, 370, 380 and 390°C in the $Fe_{62.5}Co_6Ni_{7.5}Zr_6Cu_1Nb_2B_{15}$ alloy strips.

After annealing at 350-390°C the magnetomechanical coupling coefficient (k) was three times higher than that for as-quenched state (0.10-012), i.e. k = 0.32-0.38. The minimum values of the ultrasound velocities was equal to 3600 m/s and maximum reached 4600 m/s.

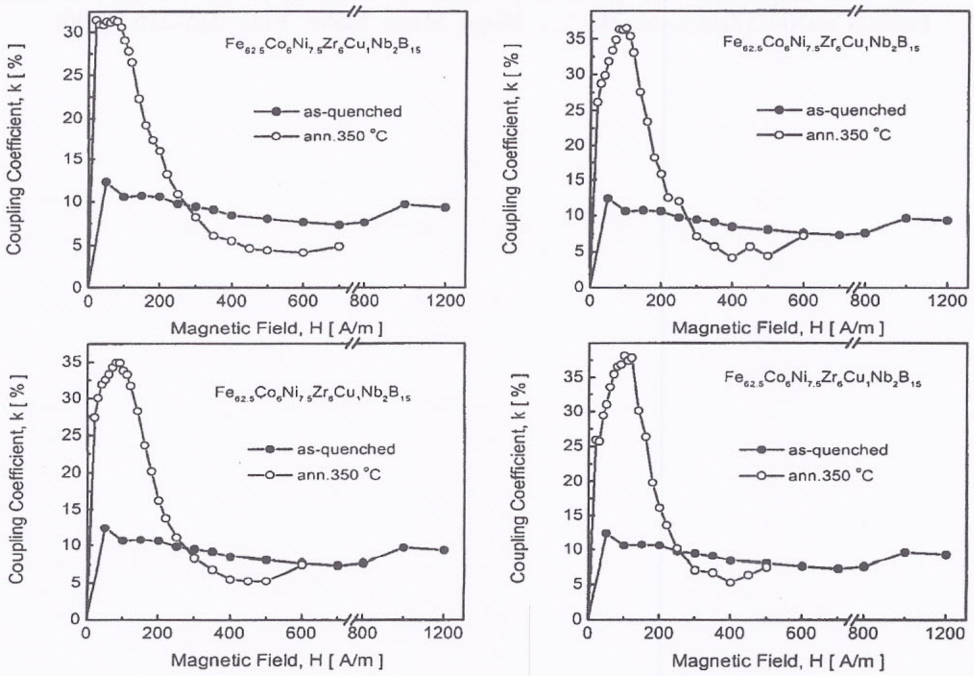

Fig. 3. Magnetomechanical coupling coefficient *(k) vs.* magnetic field *(H)* for as-quenched (as-q.) sample and samples annealed in vacuum for lh at the temperatures of 350, 370, 380 and 390°C in the Fe62.5Co6Ni~.5Zr6Cu1Nb2B15 alby strips.

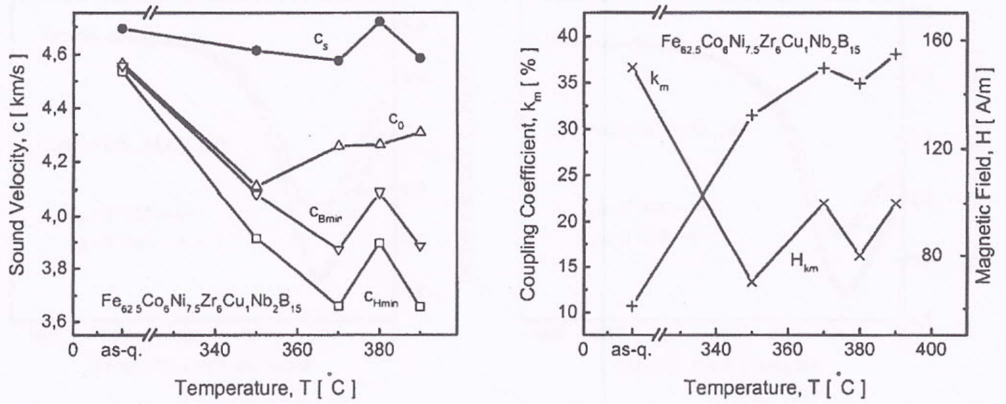

Fig. 4. Ultrasound velocities for demagnetization state ($c_{H0} = c_{B0} = c_0$), for the technical magnetic saturation ($c_{Hs} = c_{Bs} = c_s$), maximmum values of the magnetomechanical coupling coefficient (k_m), minimum values of ultrasound velocities (c_{Hmin} *and* c_{Bmin}), and values of the magnetic bias fields for the k_m, i.e. H_{km}, vs. annealing temperature (T).

REFERENCES

1. L. Lanotte, G. Ausanio, M. Carbucicchio, V. Iannotti and M. Miiller, Coexistence of very soft magnetism and good magnetoelastic coupling in the amorphous alloy Fe62.5Co6Ni~.5Zr6Cu~NbZB15, J. Magn. Magn. Mater. Vols. 215-216, 2000.