MAGNETOMECHANICAL COUPLING FACTOR IN AMORPHOUS Fe_<81> (Si・B・C)_<19> RIBBONS

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MAGNETOMECHANICAL COUPLING FACTOR IN AMORPHOUS $Fe_{81}(Si \cdot B \cdot C)_{19}$ RIBBONS

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INTRODUCTION

The amorphous iron base material is one of the most popular ferromagnets, and the magnetic properties such as the magnetization[1], Curie temperature[1] and the magnetostriction[2,3] were reported. We reported[4] that the magnetostriction of the amorphous $Fe_{80}P_{13}C_7$ and $(Fe \cdot Co)_x Si_y B_z$ ribbons was large, and the value was about the same as the absolute value in metallic nickel. The large magnetostriction and the zero crystalline anisotropy found in this amorphous ribbon are ideal characteristics for high magnetostrictive materials. The magnetomechanical coupling factor is the most important dynamic transducer characteristics, and the giant ΔE effect is the change in Young's modulus E with the applied field. We also reported in a previous paper that the iron rich amorphous ribbons such as $Fe_{80}P_{13}C_7$ and $(Fe \cdot Co)_x Si_y B_z$ exhibited a giant ΔE effect and a remarkably large magnetomechanical coupling factor K[5,6,7].

In this paper, we report the results of measuring the magnetomechanical coupling factor k of the amorphous $Fe_{81}(Si \cdot B \cdot C)_{19}$ ribbons with high flux density which were annealed in the magnetic field.

MAGNETOMECHANICAL COUPLING FACTOR

In this experiment $Fe_{81}(Si \cdot B \cdot C)_{19}$ was selected instead of $(Fe \cdot Co)_x Si_y B_z$ in the previous experiment[5,7]. The magnetomechanical coupling factor k was measured by a mechanical resonance method. The measurement apparatus was the same as that reported preciously[5,7]. The magnetomechanical coupling factor k could be determined from the resonance and the antiresonance frequencies for the ribbons annealed in a magnetic field of about 1200 Oe applied across the ribbon. In Fig. 1

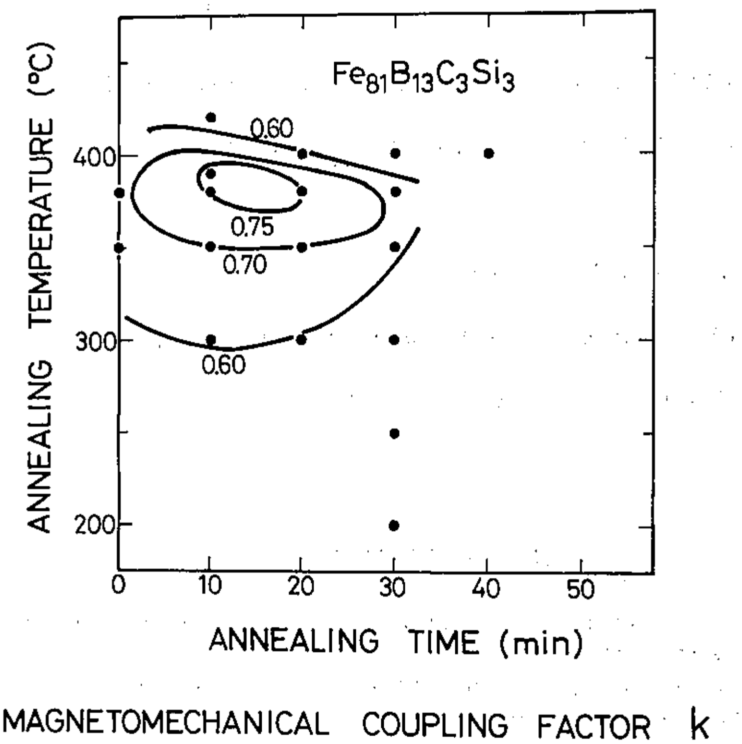

Fig. 1 Maximum magnetomechanical coupling factor k of the $Fe_{81}Si_3B_{13}C_7$ ribbon as functions of the annealing temperatures and the annealing time.

is shown the maximum magnetomechanical coupling factor k of the ribbons $Fe_{81}Si_3B_{13}C_3$ as a function of the annealing temperature and the annealing time. In this figure, the value of the coupling factor k are shown by using contour lines. The maximum values of the factor k observed in this experiment was 0.75 for the ribbon which was annealed at 390°C for 15 minutes. We applied this annealing condition to other ribbons, as a result, the ribbons with the composition $Fe_{81}Si_3B_{15}C_1$, and $Fe_{81}Si_4B_{14}C_1$ had also the same magnetomechanical coupling factor 0.75 as that with the composition $Fe_{81}Si_3B_{13}C_7$. This value is the largest in magnetostrictive materials ever reported.

GIANT ΔE EFFECT

To observed the giant ΔE effect, the same apparatus was employed.

The Young's modulus in each bias field was calculated from the resonance frequency. In Fig. 2 is shown the maximum ΔE effect of the ribbon as a function of the composition of the ribbons. Before this experiment,

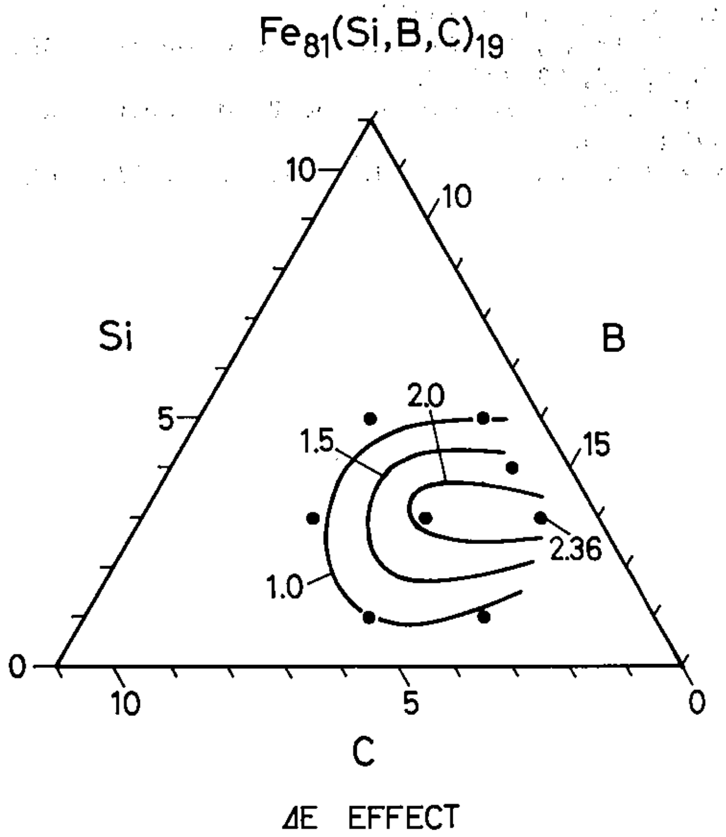

Fig. 2 Maximum ΔE effect as a function of the composition.

the ribbons were annealed at 390°C for 15 minutes in a magnetic field of 1200 Oe applied across the ribbon. In this figure, the contour lines show the normalized change in Young's modulus between the magnetically saturated state E_s and the minimum Young's modulus E_0, ie., $\Delta E/E_0 = (E_s-E_0)/E_0$. The largest ΔE effect was obtained for the ribbon with the composition $Fe_{81}Si_3B_{15}C_1$, and the value $\Delta E/E_0$ was 2.36. In order to obtain this value a fairly low bias field about 3 Oe was desirable. The value of 2.36 is also the largest in all of the other magnetostrictive materials.

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