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Asymmetric giant magneto-impedance in field annealed Co-based amorphous

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1. INTRODUTION

Recently, a lot of works on giant magneto-impedance (GMI) has been studied for soft magnetic Co-based amorphous wires and ribbons because they exhibit the high sensitive MI effect for magnetic sensor applications[1,2]. MI has been known as the effect of magnetic field on transverse permeability in ac current direction, where the permeability is associated with the wall motion and rotational magnetization[2,3]. The contribution from wall motion to MI is dominant over the rotational magnetization in the low frequency range. As the frequency increases over a few MHz in the Co-based amorphous materials, the wall motion is damped and rotational magnetization is responsible for MI effect[4]. In this work, we prepare the weak field annealed amorphous samples and present the change of GMI profiles as a function of annealing field and measuring frequency.

2. EXPERIMENTAL

The Co-based amorphous ribbons ($Co_{66}Fe_4NiB_{14}Si_{15}$) are annealed at temperature of 380 °C during 8 hours. Most of samples are annealed in air to develop the crystalline oxide coating, but some sample in partial pressure of 10^{-3} Torr to examine the effect of oxide coating. The earth's magnetic field is compensated by two dimensional Helmholtz coils. The annealing field, H_a is applied by a solenoid in sample axis direction during annealing, where the field varies from 50 mOe to 3 Oe.

The impedance Z is measured by HP4192A impedance analyzer using four terminals contacts. The longitudinal magnetic field is applied by a Helmholtz coil using step-like increasing and decreasing current by a software control. The magneto-impedance ratio is obtained from the relation;

$$\Delta Z / Z(\%) = \frac{[Z(H) - Z_{sat}] \times 100}{Z_{sat}}$$

where Z_{sat} is the impedance measured at H = 10 Oe. GMI profile is obtained by $\Delta Z / Z$ during the cyclic applied field.

3. RESULT AND DISCUSSION

GMI profiles during a cycle of magnetization for various measuring frequencies in an annealed sample at pressure of 10^{-3} Torr, and zero annealed field. In this sample, the profile shows a typical two peaks during a half cycle of magnetization. The profile in the air annealed sample of H_a less than 50 mOe also shows a typical behavior of two peaks. However, H_a increase over 100 mOe GMI peak of applied field, that is, parallel to annealing field decreases with H_a, showing asymmetry of GMI profile in the sample of H_a over 100 mOe. As the annealing field increases over 500 mOe, the asymmetry becomes profound. Eventually GMI in parallel field disappears and a drastic step-like change in GMI peak in antiparallel field is revealed. Asymmetry GMI phenomena is due to the bias field of permanent magnetic layer of sample surface, because we cannot observe such a profile in the without an oxide layer.

4. CONCLUSION

The giant magneto-impedance (GMI) has been measured in weak field annealed Co-based amorphous as a function of annealing field H_a and measuring frequency f. GMI profile measured at 0.1 MHz shows a typical behavior of two peaks in the sample of annealing field H_a less than 50 mOe. As the annealing field increases over 500 mOe, the asymmetry becomes profound, eventually drastic step-like change in GMI peak.

5. REFERENCES

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