RC07

Dependence of Shape Anisotropy on Giant Magneto-impedance in Co-based Amorphous Wires for Magnetic Sensor

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Introduction

Giant Magneto Impedance effect is considered one of the most promising phenomenon for the development of new micro-magnetic sensors with high performance. Up until now, numerous researches have been conducted to optain optimized material properties for GMI value enhancement. Particularly, it was suggested that the shape anisotropy of Co-based amorphous wires is closely related to the GMI ratio. In this research, we have examined GMI properties of Co-based amorphous wires in various dimensions in order to clarify the relation between shape anisotropy and GMI ratio.

Experiment

Co-based amorphous wires with various dimensions were fabricated from Co-based amorphous ribbons through mechanical etching, photolithography and wet etching processes. The impedance of each amorphous wire was measured using four probe electrodes with Agilent 3458A Digital MultiMeter.

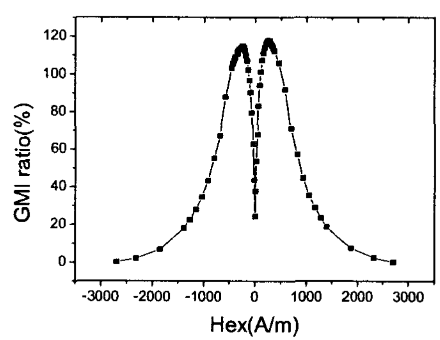

Fig. 1. GMI ratio of Co-based wire

Results and Discussion

Figure 1. shows the impedance variation of 100μm × 12μm (width×thickness) Co-based amorphous wire with the application of 8 MHz AC current. The GMI over 110% occurred at the field of 250A/m which shows that, in this high frequency regime, domain wall movement is utterly damped and the magnetization process is dominated by magnetization rotation. Additionally, the maximum peak around 250 A/m shows that the ferromagnetic resonance phenomena also contribute impedance variation of the sample. Since the amorphous magnetic material lacks well defined crystalline anisotropy, it is expected that the observed Impedance variation comes from geometrically induced anisotropy (shape anisotropy). We strongly believe that the additional measurements on the samples with different dimensions can verify this result.

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RC08

The Effect of Technological Parameters of the Amorphous Glass-Coated Microwires Fabrication on GMI.

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During the last few years the study of the giant magneto impedance effect (GMI) in the amorphous microwires has become the topic of an intensive research in the field of applied magnetism. The stability of the magnetic properties along the length of the amorphous glass coated microwires fabricated by the Taylor Ulitovsky technique is strongly dependent on such parameters as melting temperature, Tm, the speed of drawing, V, conditions of cooling, annealing temperature and some others. Therefore it is important to define the role of each technological parameter on the magnetic properties of microwires, in particular on the value of GMI.

For this purpose the samples of microwires $Co_{69,5}Fe_{3,4}Cr_{3,5}Si_{11,7}B_{11,9}$ alloy have been fabricated in different conditions. Tm was varied in the range of 1270-1310 °C and V in the range of 2-9 m/sec. The diameter of the metallic core was varied from 12 up to 30 μm and the width of the glass wall was varied from 1 up to 3 μm. The microwires were cooled in the stream of cold water; however, we have found out that the amorphous structure could be formed even without water cooling. This seems to be the result of the tension stress of the glass coating. It was found out that the decrease of the drawing speed from 8 m/sec down to 2 m/sec results in the decomposition of the amorphous phase and partial crystallization.

The real (R) and the imaginary (X) components of the impedance (Z) were defined in 5 mm samples of microwires in the frequency range of 1 - 50 MHz in the longitudinal magnetic field varied from 0 up to ± 36 Oe. As it could be predicted the GMI is strongly dependent on the technological parameters of the amorphous microwire fabrication. For instance, the value of $\Delta R/R(0) = (R(H)-R(0))/R(0)) \pm 100\%$ at 50 MHz varies from 20 up to 220% and the anisotropy field, Ha varies from 0 up to 18 Oe.

The GMI effect is high in the samples with a rather large diameter of the amorphous core. For the samples obtained by the optimal technology the effect of annealing in the temperature range of 200 - 450 °C on GMI was studied.