Engineering of magnetic properties of Co-rich microwires by Joule heating

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The performance of magnetic devices can be significantly improved if the used materials will present higher GMI effect. Considering that the predicted theoretical maximum GMI ratio (about 3000%) [1] is few times superior to the experimentally reported it is expected that technology improvement involving development of effective post-processing method will allow achievement of higher GMI ratio. Consequently considerable efforts have been paid to studies of the post-processing on GMI ratio of various magnetic materials, such as wires, ribbons, thin films and multilayers [2].

It is expected that Joule heating due to the induced magnetic anisotropy [3] can further improve the GMI effect. Up to know only limited number of experimental results on effect of current annealing on GMI effect are reported [2]. Additionally, the best GMI performance is observed in amorphous magnetic wires exhibiting excellent magnetic softness. Current annealed $Co_{67}Fe_{3.9}Ni_{1.5}B_{11.5}Si_{14.5}Mo_{1.6}$ microwires present excellent magnetic softness with low magnetic anisotropy field of about 25 A/m and coercivity of 2 A/m (see Fig. 1).

We have investigated the GMI response of the current-annealed glass-coated microwire. From the obtained dependence we determined the optimal current annealing conditions and obtained considerable improvement of $\Delta Z/Z_{max}$ – values from 550% to about 650% after appropriate current annealing conditions (see Fig. 2).

The analysis of the GMI ratio as a function of the frequency opens new lights to understand the distribution of the magnetic anisotropy inside the microwire.

References

[1] L. Kraus, *J. Magn. Magn. Mater.*, 195 (1999), 764-778.

[2] A. Zhukov, M. Ipatov, M. Churyukanova, A. Talaat, J.M. Blanco and V. Zhukova, *J. Alloys Compound.*, 727 (2017), 887-901.

[3] F.E. Luborsky and J.L. Walter, *IEEE Trans. Magn. Mag.*, 13(2) (1977), 953-956.

Figures

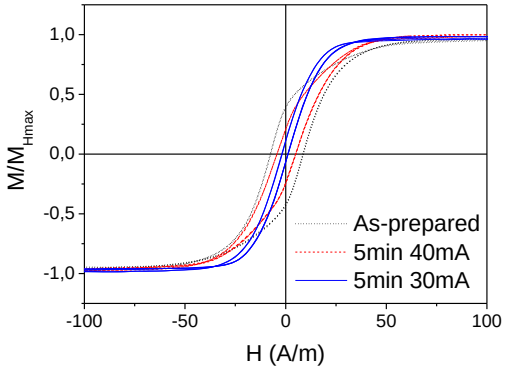

Figure 1: Hysteresis loop of as-prepared and current annealed $Co_{67}Fe_{3.9}Ni_{1.5}B_{11.5}Si_{14.5}Mo_{1.6}$ amorphous glass-coated microwire.

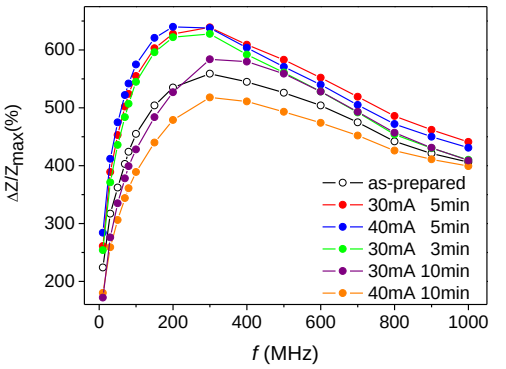

Figure 2: $\Delta Z/Z_{max}(f)$ dependences observed in as-prepared and current-annealed microwire at different annealing conditions.