MAGNETIC AND MAGNETOIMPEDANE IMPEDANCE PROPERTIES OF COBALT-BASED AMORPHOUS RIBBONS WITH DIFFERENT GEOMETRIES

Pasynkova A.A.[1, 2], Timofeeva A.V.[1, 2], Lukshina V.A.[1], Kurlyandskaya G.V.[2]

[1)] M.N. Mikheev Institute of Metal Physics of the Ural Branch of the Russian Academy of Sciences, Russia

[2)] Institute of Natural Sciences and Mathematics, Ural Federal University, 620002 Ekaterinburg, Russia

E-mail: pasynkova_a@imp.uran.ru

A comparative analysis of the influence of geometric parameters on the features of the effective magnetic anisotropy and magnetoimpedance effect was carried out for Co-based amorphous ribbons in the as-quenched state and after relaxation annealing.

The giant magnetic impedance (GMI) effect consists in a significant change in the impedance of a ferromagnet when an external magnetic field is applied and a high-frequency current passes through it [1]. It is useful technique for the analysis of the effective magnetic anisotropy and dynamic magnetic permeability in the MHz frequency range [2]. Rapidly quenched Co-based amorphous ribbons with small negative magnetostriction constant is a good model material for studies of the effective magnetic anisotropy [3]. The length, width and ratio of width/length are very essential contributing to the shape anisotropy peculiarities. As-quenched and ribbons after a relaxation annealing usually had longitudinal effective magnetic anisotropy and one-peak type response for the field dependence of GMI [3]. In this work, the structure, magnetic, and GMI properties of Co-based ribbons with different parameters of the effective magnetic anisotropy were comparatively studied.

Fe3Co67Cr3Si15B12 amorphous ribbons were obtained by rapid quenching. Ribbons with 0.8 mm (S1) and 2 mm (L1) width were prepared. Annealing at 350°C for 1 hour without load (S2 and L2, respectively) was done for frozen stresses relaxation. The thickness of the ribbons was about 32 µm for the 2 mm wide ribbons and 24 µm for the 0.8 mm wide ribbons, the length was 4.5 cm in both cases. An X-ray diffraction analysis (Bruker D8 Advance) and a study of magnetic hysteresis loops (MMKS-05) were carried out showing amorphous structure and longitudinal effective anisotropy in all cases. The GMI was studied using Agilent HP e4991A impedance analyzer. The GMI ratio of the total impedance Z was calculated as follows: $\Delta Z/Z = 100\% \cdot (Z(H) - Z(Hmax))/Z(Hmax))$, Hmax = 110 Oe. Figure 1 shows the frequency dependence of the maximum of the GMI ratio of the total impedance $(\Delta Z/Z)max$. In as-quenched state, GMI responses of L1 wide ribbons are very similar to the L2 in the frequency range up to 20 MHz. For higher frequencies, higher value of $\Delta Z/Z$ was observed for annealed ribbon confirming the lower level of the internal stresses. However, the relaxation annealing of narrow ribbons results in the remarkable increase of the maximum of $\Delta Z/Z$ ratio from about 200% for S1 to about 260% for S2. As in the case of L1 and L2 ribbons, peak of ΔZ/Z ratio after annealing slightly displaces toward the higher frequencies.

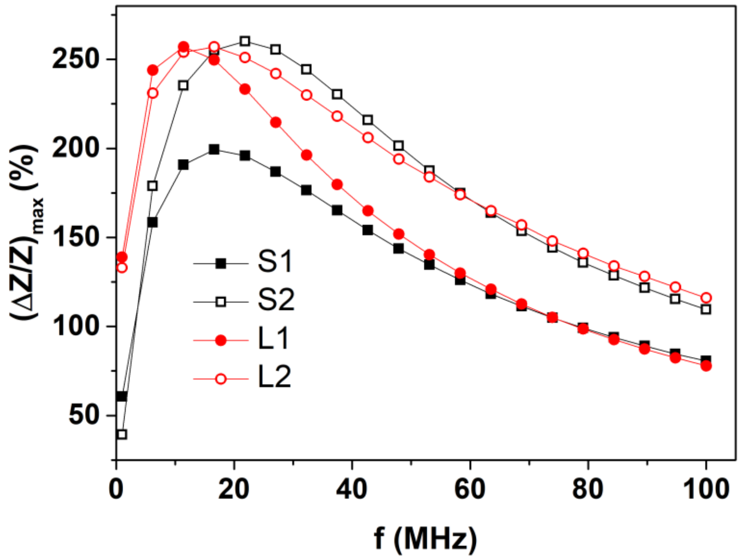

Fig. 1. Frequency dependence of the maximum of the GMI ratio for ribbons with different cross sections (S1, S2 - 0.8 mm, L1, L2 - 2 mm) and type of treatment (S1, L1 – as-quenched state, S2, L2 - after relaxation annealing).

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