# BROADBAND MICROWAVE ABSORPTION IN CO-BASED AMORPHOUS RIBBONS

Timofeeva A.V.[1], Volchkov S.O.[1], Pasynkova A.A.[1], Melnikov G. Yu.[1], Kurlyandskaya G.V.[1]

[1)] Department of Magnetism and Magnetic Nanomaterials, Ural Federal University, 620002 Ekaterinburg, Russia
E-mail: selenanastya.1998@mail.ru

Ferromagnetic resonance of $Fe_3Co_{67}Cr_3Si_{15}B_{12}$ amorphous ribbons was measured using Rohde&Schwartz ZVA-67 Vector Network Analyzer in a wide frequency range 1–15 GHz.

Ferromagnetic resonance (FMR) is a powerful tool for evaluation characteristics of dynamic magnetic permeability, magnetic anisotropy, the degree of homogeneity and internal stresses of amorphous ferromagnets [1]. FMR is the selective absorption by a ferromagnet of an electromagnetic field energy at frequencies coinciding with the fundamental precession frequency of magnetic moments in an internal magnetic field. Classic technique of the FMR measurements is a cavity perturbation for which the cavity is tuned to a particular frequency. However, the study of magnetodynamic properties in a wide frequency range become more and more requested in the modern research and technological applications. One of the phenomenon dealing with the dynamic magnetic permeability in a wide frequency range is magnetoimpedance (MI) [2]. Previously, method of the measurements of FMR characteristics using a network analyzer in the frequency range up to 12 GHz was described and tested in the case of microwires and rapidly quenched wires [3]. In this work, we have tested the method for obtaining FMR spectra in a wide frequency range of 1–12 GHz in a coaxial line for Co-based ribbons interesting for MI applications.

Amorphous ribbons of $Fe_3Co_{67}Cr_3Si_{15}B_{12}$ composition were obtained by quenching on a rapidly rotating drum. Study of FMR of Co-based ribbons (width – 0.8 mm and length – 3.4 mm) was conducted using Rohde&Schwartz ZVA-67 VNA for frequencies 1–15 GHz. Both as-quenched and stress-annealed ribbons were studied. The reflection coefficient $S_11$ was measured and the external magnetic field up to 4 kOe was applied parallel to the ribbon axis. Sample holders were made based on SMA S-2454 connectors, electric contacts with samples were done with conductive paint. $S_11$ values corresponded to output at various values of applied magnetic field. Figure 1 shows the dependence of reflection coefficient $S_11$ on the value of the applied magnetic field (here the minimum position can be associated with the resonance field $H_res$). The $H_res$ according to the theory can be defined by the Kittel formula [4] (the anisotropy field of the ribbons was measured previously). The experimental results obtained by the method presented in the work correlated well with the theoretical dependence (Fig. 1b). The comparative analysis of the magnetodynamic characteristics of ribbons in the broadband range showed very close similarity for both quenched state and after stress annealing due to very high magnetic softness and small value of the magnetic anisotropy field.

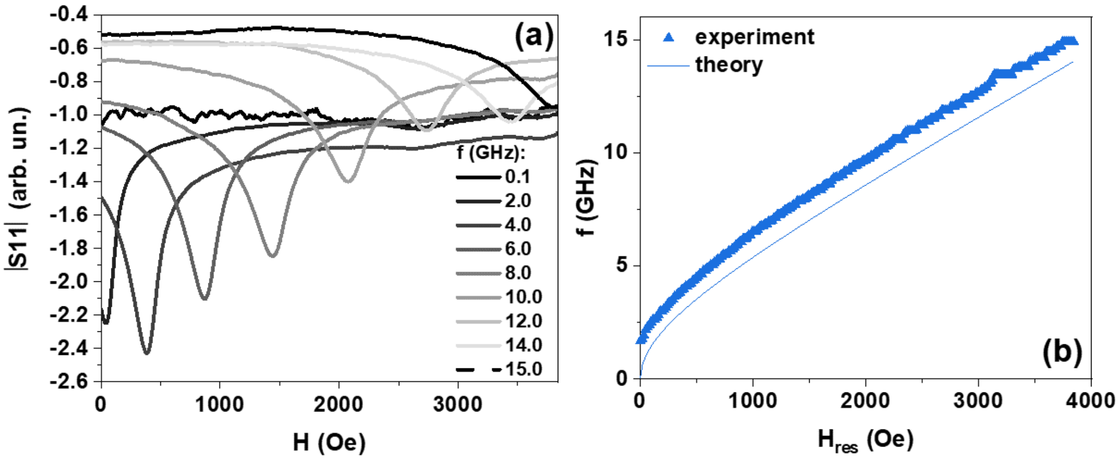


Figure 1 – Field dependence of $S_{11}$ parameter for $Fe_3Co_{67}Cr_3Si_{15}B_{12}$ amorphous ribbon in the as-quenched state (a). Comparison of the frequency dependence of the FMR resonance fields obtained experimentally and using Kittel approximation (b).

*This research was funded by Ministry of Science and Higher Education of the Russian Federation, grant number FEUZ-2020-0051.*

1. S. M. Bhagat. Ferromagnetic Resonance, Metals Handbook. 10, 267, (1986).
2. G. Kurlyandskaya, V. Levit, Biosens. Bioelectron. 20, 1611, (2005).
3. R. El Kammouni, G. Infante, J. Torrejon, M. R. Britel, J. Brigui, M. Vazquez, Phys. Stat. Sol. A 208, 520, (2011).
4. C. Kittel, Introduction to Solid State Physics. Wiley, New York, (1996).