

Thermal effect on the magnetoelastic properties of amorphous Fe-based metal ribbons treated by acid

E. A. Golygin¹, Y. S. Chen², J. G. Lin², A. A. Gavriluk¹, N. V. Morozova¹

¹Department of Physics, Irkutsk State University, Irkutsk, 664003, Russia

²Center for condensed matter sciences, National Taiwan University, Taipei 10617, Taiwan

Amorphous Fe-based metals are promising materials for the applications in modern industry. These materials have a number of unique magnetic, magnetoelastic and strength properties, such as high magnetostriction value, high permeability, low coercive force, and strong fatigue resistance. Due to their unique properties these materials can be used as sensing elements of magnetic field sensors and deformations sensors. Often the industry requirements include various device functions in aggressive environments. Due to these requirements, a high relevance study is the influence of highly corrosive environments on the temperature stability [1] of the Fe-based metal ribbons.

This work investigates the influence of temperature in the range of 20–240 °C, after HCl acid treatment and thermomagnetic treatment, on the field dependences of elastic modulus change (ΔE) in the amorphous $\text{Fe}_{67}\text{Co}_{10}\text{Cr}_3\text{Si}_5\text{B}_{15}$ ribbons made by rapid quenching from the melt. The sensitive non-destructive method of resonance–antiresonance is used to measure the field dependent ΔE . In addition, we use advanced experimental techniques (X-ray diffraction, ferromagnetic resonance, electronic beam microscope) to analyze the structure and morphology of samples to correlate the magnetoelastic and magnetic properties of our ribbons to their structural change, which may create some predictions for the further study.

In summary, for all samples with various treatment parameters, only a positive field effect on ΔE is observed. It can be explained by the low value of field induced magnetic anisotropy and a significant angular dispersion of magnetization, which is connected with the presence of chromium in the composition. A complex effect of the preliminary thermomagnetic treatment and the time of HCl acid treatment on the field dependent ΔE of amorphous metallic ribbons of the $\text{Fe}_{67}\text{Co}_{10}\text{Cr}_3\text{Si}_5\text{B}_{15}$ metal alloy ribbons is observed. For example, the samples with a preliminary thermomagnetic treatment at 410 °C show the most predictable field dependence of ΔE effect on the duration of acid treatment.

By varying the parameters of the thermomagnetic treatment and correctly tuning the composition of amorphous metal alloy, it is possible to achieve a high stability of the field dependences of ΔE against different time duration of exposure to the high-corrosivity environment. On the other hand, the pre-controlled acid treatment of amorphous metal alloys may allow the production of materials with predetermined magnetoelastic properties.

This work was supported by the Goszadanie of Russian Federation (Project № 3.1941.2017/PCh)

[1] A. A. Gavriluk, A. L. Semenov, E. A. Golygin, A. R. Gafarov, A. A. Zinchenko “Influence of Temperature on ΔE Effect in Amorphous Fe 64 Co 21 B 15 Ribbons” *The Physics of Metals and Metallography*, Vol. 114, No. 4, pp. 295–298 (2013).