Enhancement of the Matteucci Effect in amorphous glass-coated microwires

Michail Kozachok[a], Kornel Richter[a, b, c]

[a] *Faculty of Electrical Engineering and Informatics, Technical University in Kosice, Kosice, 042 00 Slovakia*
[b] *Cassovia New Industry Cluster (CNIC), Trieda SNP 457/1, Kosice 040 11 Slovakia*
[c] *Slovak academy of sciences, Watsonova 47, 040 01, Kosice, Slovakia*

Amorphous glass-coated microwires are composite material that consists of a metallic nucleus covered by a glass coat. When microwires are produced from an alloy with positive magnetostriction coefficient a single domain wall motion can be observed. In this contribution, we study the specific Matteucci effect in amorphous glass coated microwires. A thermal treatment is used to modify the mechanical properties of microwires with regard to a high voltage induced by domain wall motion. The circular component of the field is quantified by pure current-induced domain wall depinning process.

Keywords: ferromagnetic domain wall, magneto-optics, microwire

1. Introduction

Thin magnetic microwires are characterized by peculiar fast domain wall motion [1]. Recently, it was shown that the combination of the high speed of the domain wall and a very small misalignment of the surface magnetization leads to the remarkable Matteucci Effect (DWME) [2] even without application of a torsion. This effect stems from a very small component of the circular magnetization built in to microwires during manufactory process. This circular component gives rise to the electrical voltage induced at the ends of the wire during domain wall propagation. The effect is visible in two different processes: (a) in domain wall depinning and (b) by domain wall motion. While the circular component of the surface magnetization can be effectively tailored by mechanical torsion, it remains an open question how the DWME could be enhanced through proper thermal treatment of the samples.

In this contribution, we tailor the magnetic properties of amorphous glass-coated microwires to enhance the DWME. It is shown that thermal annealing of microwires with and without applied torsion remarkably increases the DWME. The presence of the small circular component is verified by Magneto-optical Kerr effect (MOKE) [3] and current-induced domain wall depinning measurements.

2. Results and discussion

Thermal treatment of microwires at 200°C with applied torsion remarkably increases the circular component of a magnetization in FeSiB microwire. This leads to the improved DWME during domain wall propagation. In turn, the DWME by domain wall depinning seems to be not affected. To investigate the properties of a magnetization at the place of a domain wall depinning, we use a novel method based on a pure current induced domain wall motion.

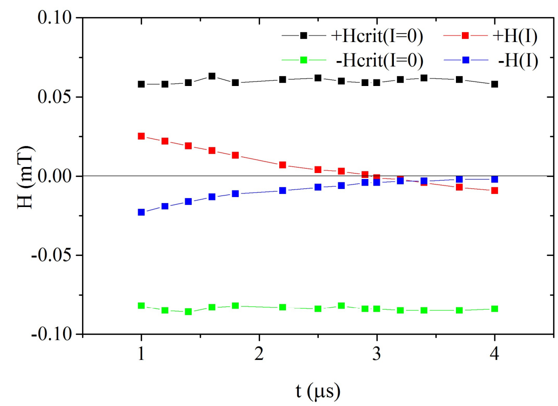

Figure 1: Critical field as a function of the duration of electrical current pulse.

Figure 1 shows the dependence of a field-assisted domain wall depinning field as a function of the current pulse applied to the microwire. At some value of the critical duration of the electrical pulse, the domain wall is depinned from the end of wire even without application of the magnetic field. The effect can be understood in terms of a very small circular component of the magnetization that interacts with Oersted field of applied current that can move the domain wall. Detail analysis allow us to make a rough estimation of the circular magnetization component.

The direct observation of a surface magnetization are performed by our new MOKE laser-based setup [3]. Specific peaks in DWME are correlated to the domain wall distortions induced by interaction of a domain wall with defect.

References

[1] P. Corte Leon, et al., Applied MaterialsToday **26**, (2022) 101263.
[2] A. Jimenez, et al., Phys. Status Solidi A **218**, (2021), 2100284.
[3] O. Vahovsky, et al. JMMM **483**, (2019) 266.

Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00560.