Torsional and bending stress influence on magnetic properties of amorphous microwires

Alexander Chizhik[a], Arcady Zhukov[a,b], Valentina Zhukova[a]

[a] *University of Basque Country, Department of Polym. and Adv. Mater., Spain*
[b] *IKERBASQUE, Basque Foundation for Science, Spain*

The mechanisms of magnetization reversal related to anisotropy change were analyzed using magneto-optical Kerr effect in amorphous microwires with different signs of magnetostriction. The reversible switching between inclined magnetic states and transformation of different inclined states was controlled by external torsion stress. Also microwires were studied after bending and spiral stress annealing. We have found the effect of the transverse stress gradient on the motion of domain walls and the effect of the transverse stress gradient on the process of magnetic domain nucleation.

Keywords: amorphous magnetic microwires; magnetic domains; magneto-optic Kerr effect; magnetic anisotropy

1. Introduction

Magnetic microwires occupy a large segment in the application of industrial sensors. Being one of the recognized leaders in the field of magnetic sensors, they attract much attention from researchers working in related scientific fields. Within the framework of this problem, we conducted a systematic study of the surface magnetic properties of microwires using the magneto-optical Kerr effect (MOKE) method. We focused our efforts on studying the effect of external mechanical stresses, torsional and bending, on the surface anisotropy and, in turn, on the magnetic structure of the surface. The main idea of this work is to control the transformation of the domain structure caused by torsional and bending stress of various magnitudes and directions, and to determine stress-induced changes in the surface magnetization reversal.

2. Results and discussion

Torsional, bending and spiral mechanical stresses have been applied to amorphous microwire to transform the magnetic structure (Fig. 1). The influence of torsion stress on domain structure and magnetization reversal has been found (Fig. 1a). The limits of the stress-induced inclination of magnetization have been determined in Fe- and Co-rich microwires. The stress-induced rotation of surface magnetization occurs across the longitudinally magnetized state (Fe-rich) and transversally magnetized state (Co-rich). The jump between inclined states and the formation of the dynamic structure containing different magnetic states are reversible mechanisms of the magnetization reversal in magnetic microwires.

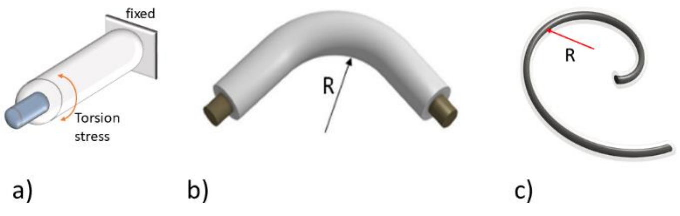

Figure 1: Torsion (a), bending (b) and spiral (c) mechanical stresses applied to the studied microwires. R is the radius of bending (b) and spiral (c).

Magnetic microwire was subjected to a bending-annealing-unbending procedure (Fig. 2b). A transition was observed from a two-domain structure at the unbent edge of the sample to a spiral structure in the transition zone and to a longitudinal domain wall in the central part of the sample.

Here we also present a method of preprocessing called spiral annealing (Fig. 1c) [2]. A gradual change in the anisotropy field was observed both within the microwire and on its surface. We have found a linear relationship between the local anisotropy field and the local geometric curvature of the sample.

References

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