Time-resolved velocity of a domain wall in a magnetic microwire

E. Calle, A. Jiménez, M. Vázquez, R.P. del Real

PII: S0925-8388(18)32515-5

DOI: 10.1016/j.jallcom.2018.07.015

Reference: JALCOM 46730

To appear in: *Journal of Alloys and Compounds*

Received Date: 13 March 2018

Revised Date: 29 June 2018

Accepted Date: 2 July 2018

Time-resolved velocity of a domain wall in a magnetic microwire

E. Calle*, A. Jiménez, M. Vázquez and R.P. del Real

Materials Science Institute of Madrid, CSIC. 28049 Madrid. Spain

ABSTRACT

The dynamic process of nucleation, propagation, and braking of a single domain wall (DW) has been systematically determined in a Fe-based magnetostrictive microwire under an applied axial magnetic field. While in previous reports the Sixtus-Tonks experiments have provided partial information on the process (i.e., the average velocity), in the present study we report on the instantaneous processes involved in the propagation of the DW, as well as the transient process during the DW depinning. The experimental measurements were carried out using the spontaneous Matteucci effect induced during DW propagation due to the small helical magnetization component created during the fabrication process.

Keywords: Magnetic microwire, Time-resolved domain wall velocity, Amorphous materials, Electromotive force, Magnetisation, Magnetostriction

1. Introduction

Amorphous glass coated microwires (AGCMs) [1] show excellent magnetic softness and very good mechanical properties which make them very suitable for many technological applications such as magnetic, temperature or stress sensors [2, 3] or for the fabrication of metamaterials [4]. Magnetoelastic anisotropy is the most important parameter that determines their magnetic properties. Its origin is the coupling between the magnetostriction constant and the stresses induced during the fabrication process due to the difference in the thermal expansion coefficients of the glass and the magnetic material. Fe-based AGCMs show a large magnetoelastic anisotropy due to their magnetostriction constant (λ~10^{-5}). This anisotropy confers them a bistable magnetic behaviour characterized by a square hysteresis loop with a Barkhausen jump: the magnetization of the wire takes place by the depinning and propagation of a domain wall (DW) [5] from one end of the microwire when an axial magnetic field is applied. Coercive field, remanent magnetization, and high frequency behaviour can be improved by controlling the conditions (temperature and time) of a stress annealing of the microwire [6-8].

This bistability makes it possible to study the propagation of a single DW. Its motion has been widely studied including its average velocity as a function of the magnetic field and stress applied [9], the acceleration and braking of the DW by local magnetic fields (parallel and antiparallel to the main applied field) [10], and the nucleation of a reverse domain and propagation of the two DW's head-to-head and tail-to-tail in opposite directions [11]. All these measurements have been traditionally based on a classical Sixtus-Tonks system with several pickup coils that permits us to identify the direction of the DWs motion and determine the DW

*Corresponding author.
e-mail address: esther.calle@csic.es