MAGNETIC FORCE MICROSCOPY STUDY OF SOFT AMORPHOUS MAGNETIC FILMS WITH DILUTED ARRAYS OF ANTIDOTS

G. Rodríguez, H. Rubio, A. Pérez-Junquera, L. M. Álvarez-Prado, M. Vélez, J. I. Martín, J.M.Alameda
Depto. Física. Facultad de Ciencias. Universidad de Oviedo, Av. Calvo Sotelo s/n. 33007, Oviedo, Spain
fxx@condmat.uniovi.es

Nanostructuration processes in continuous thin magnetic films allow to introduce an extra spatially dependent shape anisotropy with a very small length scale. This capability could be used, for example, to fabricate concentrated arrays of holes in magnetic films for applications in ultrahigh magnetic density recording [1] avoiding the problems associated with the superparamagnetic limit that appear in small particle arrays. On the other hand, the nanostructuration process affects macroscopic properties such as magnetoresistance, coercive field or magnetic anisotropy. Thus, depending on antidot density (concentrated or diluted arrays [2]) and on array geometrical characteristics, nanostructuration can be used as a tool to engineer the magnetic properties of thin films.

In this work we have studied the magnetic configuration of several arrays of antidots in soft Co-based thin films. Arrays will be prepared in the diluted regime, i.e. with large interhole distances, so that the lithography-induced anisotropy is only a small perturbation on the original well defined uniaxial anisotropy of these films. The main goal of this study is to understand the interplay between material parameters and patterning induced effects on coercivity and domain wall pinning.

The samples have been fabricated by electron beam lithography and etching on amorphous Co_xSi_{1-x} and Co_xZr_{1-x} thin films (400Å thick) grown by sputtering. Several samples were fabricated varying the array spacing and aspect ratio (10x10μm, 10x5μm, 5x10μm), antidot shape (circular or ellipsoidal) and depth (250Å and 400Å). The magnetic configuration of each array was analyzed by Magnetic Force Microscopy (MFM). Transverse Kerr effect magnetometry and micromagnetic simulations complete this study.

The closure domain configuration around each antidot is characterized with MFM images revealing that in this diluted regime the patterned holes effectively act as individual defects (see Fig. 1 (a)). Differences between Co_xSi_{1-x} and Co_xZr_{1-x} samples, which present a radically different behavior in the MFM images (see Figs. 1 (a) and (b)), will be discussed with the aid of micromagnetic simulations.

MFM measurements show, in addition, the presence of Néel domain walls on Co_xSi_{1-x} samples and the capability of interact with them. The evolution of 180º Néel walls is studied as they travel across the antidot pattern. Wall pinning induced by antidot arrays is also observed and will be discussed in terms of the linear density of antidots along the wall.

Work supported by Spanish CICYT under grant MAT-2002-04543-C02-01

References:

[1] R. P. Cowburn, A. O. Adeyeye, J. A. C. Bland, Appl. Phys. Lett., **70** (1997) 2309.
[2] A. Pérez-Junquera, J. I. Martín, M. Vélez, J. M. Alameda, J. V. Anguita, F. Briones, E. M. González and J. L. Vicent, Nanotechnology, **15** (2004) S131.

Figures:

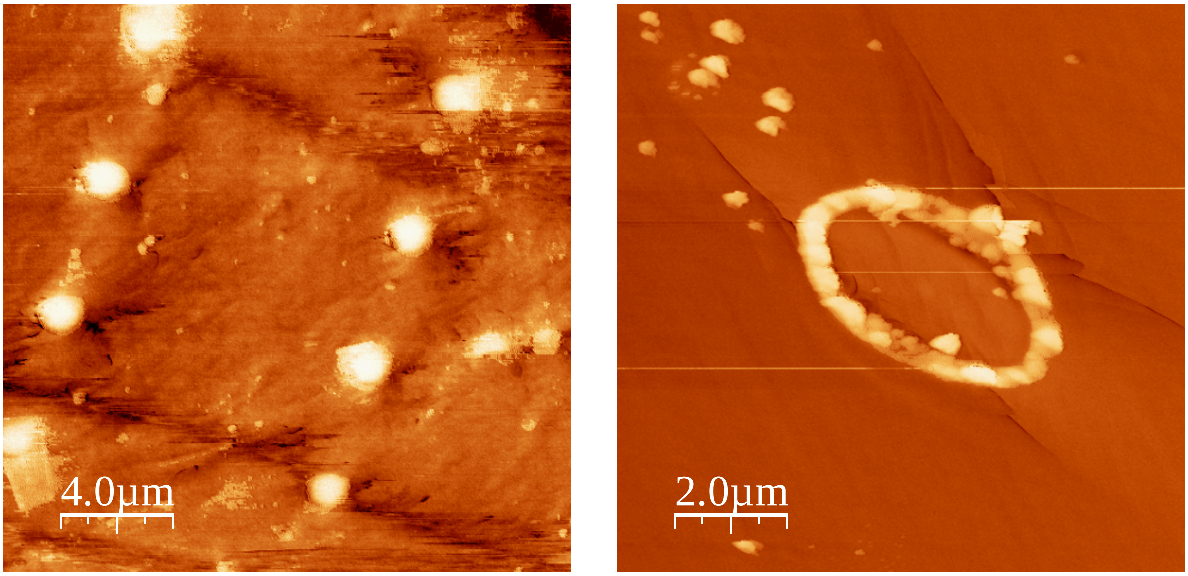

Fig 1: MFM images of antidot arrays on Co_xSi_{1-x} (a) and Co_xZr_{1-x} (b). Note the differences in magnetic contrast over the holes and the Néel walls in Co_xSi_{1-x}.