

Magnetic anisotropy changes induced by high energy ion bombardment

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In the last years, a great effort has been done in the miniaturization of the magnetic systems. Of vital importance is to study the properties of these systems, called micro or nanomagnets because they present a novel magnetic behaviour associated to low – dimensional effects that can be used in a variety of applications such as magnetic storage, semiconductor industries, ultrasmall magnetic field sensors, etc.

In particular, in the magnetic storage, it has been necessary the development of thin multilayers, nanoparticles systems and ordered magnetic nanostructures. Several methods have been developed to fabricate such systems, like self-organization of nanoelements [1], electron beam lithography [2] or high energy ion irradiation [3]. The candidates to be used as materials for magnetic storage devices are FePt, FePd and CoPt alloys because they present high anisotropy and superparamagnetic limit at small dimensions.

The aim of this work is study the changes in the structural and magnetic properties of the thin films due to the irradiation with high energy ions. The sample is polycrystalline FePt thin film (35nm thick) growth by sputtering onto Si (100) at 400°C with a buffer layer of 28nm of Pt (111). From the hysteresis loops measured by VSM we know the anisotropy is mainly in plane, however, the sample presents a component out of plane.

Due to the irradiation with different ions (Br^+ y Cl^{2+}), energies and doses, the in plane or out of plane anisotropy is favored [4]

Moreover, since the irradiation has been done through a micrometric mask we have obtained a magnetic thin film patterned at the micrometer scale.

The structural changes have been studied by X- ray diffraction and TEM (Transmission electron Microscopy).

The magnetic characterization has been done by different techniques. The volume hysteresis loops are measured by VSM (Vibrating Sample Magnetometer). In order to compare the behavior between the irradiated and non irradiated areas we use surface techniques like Magnetic Force Microscopy (MFM) and Kerr Effect Microscopy (MOKE). The MFM data are in good agreement with the VSM measurements. We can observe the out of plane component of the magnetic moment, called dense stripe domains in the non irradiated area, and different magnetic behavior in the irradiated areas as a function of the irradiation parameters. In particular, in figure 1 we can observe the two areas: the non- irradiated region presents dense stripe domains and the irradiated area presents in plane domains.

We have also measured the Kerr effect in both regions. From the local hysteresis loops obtained with this technique, we note that the H_c (in plane direction) decreases due to the irradiation.

In addition, the in plane domains have been studied by Kerr effect microscope. The images are obtained applying the magnetic fields in different in plane directions (see figure 2.)

References:

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- [3] C. Chappert et al. Science 280, 1919 (1998)
- [4] M. Jaafar et al. in preparation.

Figures:

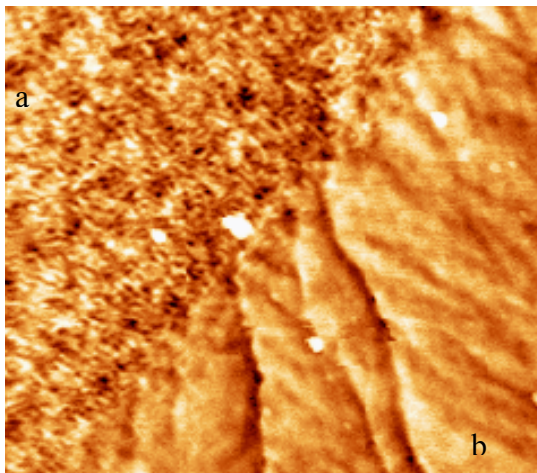


Figure 1- MFM data of the different regions (a) no irradiated, with the dense stripe domains and (b) irradiated with in plane domains. Image size: 65 μm x 65 μm

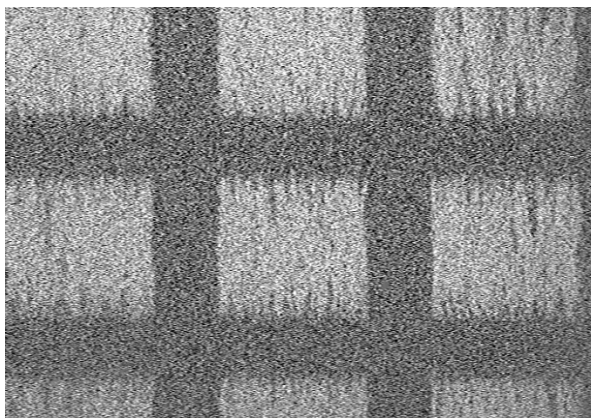


Figure 2- Magnetic domains image by Kerr Effect Microscopy. Image size: 170 μm x 130 μm