Magnetic Force Microscopy Imaging of the Magnetic Domains in Co Y-branch Structures

K. McLaughlin, M. Matsunaga, X. Wei, Z. Chen, J.P. BirdY. Ochiai, and N. Aoki

Throughout our experiments we attempt to illustrate the various domain structures in a Y-branch composed of Cobalt that result from different external magnetic fields. The field characteristics include: permanent or temporary exposure, single or double, and the magnitude of the field itself. Also, the orientation in which the sample is exposed to the field is changed throughout the experiments. We utilized Magnetic Force Microscopy (MFM) to measure the relative attraction or repulsion between the tip and the sample, which allows us to represent the domain structure based on the magnetization of the tip. Observing the domain structure within the Y-branch samples provides further insight into induced magnetic behavior; furthermore, the goal of such understanding is to enable the usage of such structures in electronic devices. In addition, these results can be utilized to enhance or compare to the existing simulations. Our results consist of: non-uniform domain structures for temporary single magnet exposure, polarized domain structures for permanent dual magnet exposure, non-uniform domain structures for temporary dual magnet exposure, and partially polarized domain structures for permanent single magnet exposure.

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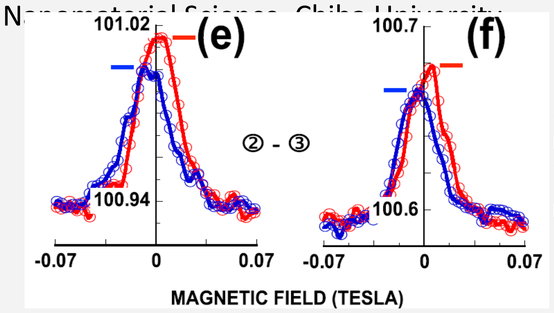
Introduction:

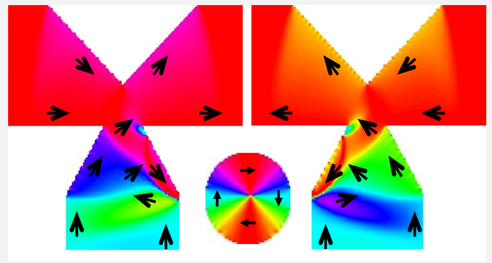
We observed the magnetic domains of Co Y-branch structures that resulted from different external magnetic fields.

Background:

A suggested vortex effect , determined by simulations, results in a change in the magneto-resistance that is determined by the field direction.



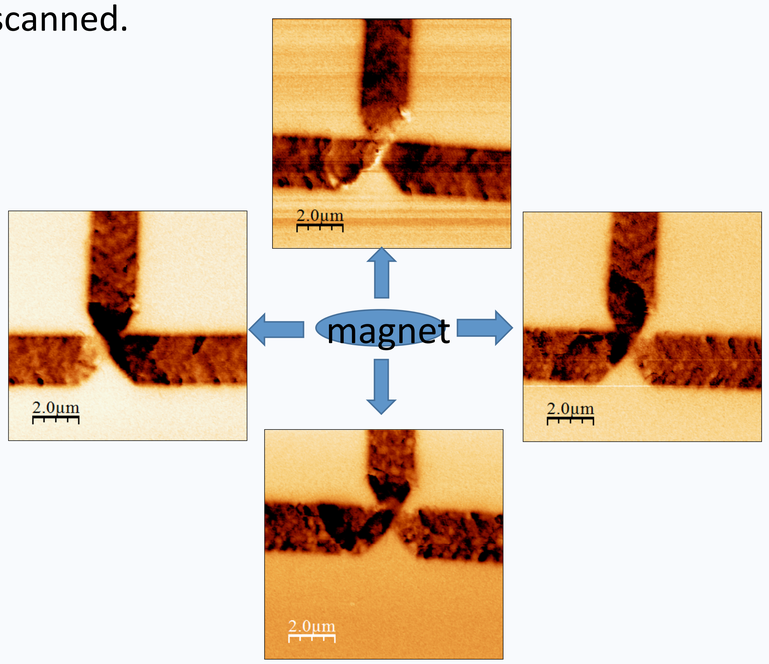
Left: y-axis magnetization
Right: x-axis magnetization



Color: magnitude
Arrow: N-pole

Single Magnet with Temporary Field:

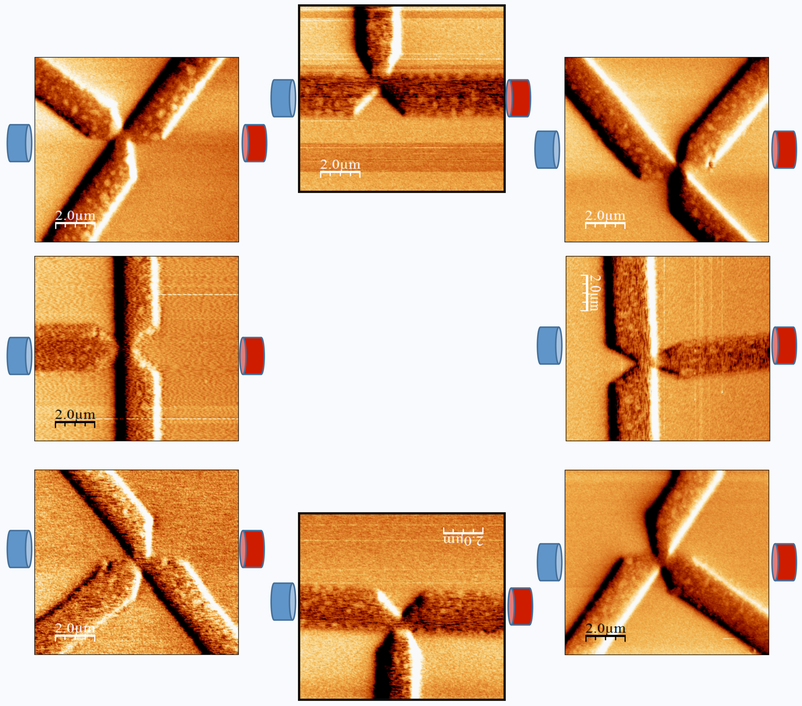
A single magnet was brought close to the sample for 10 seconds, removed, and then the sample was scanned.



Non-uniform magnetic domains

Dual Magnet with Constant Field:

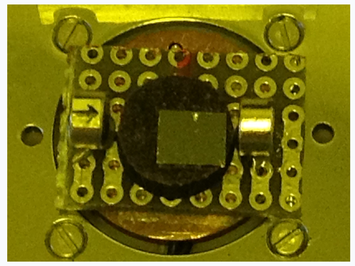
The sample was scanned while in a magnetic field created by two magnets.



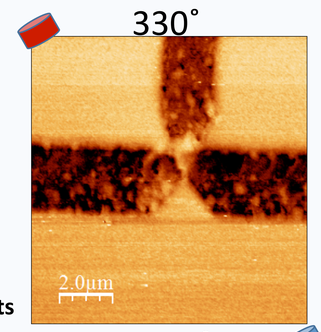
Polarized magnetic domains

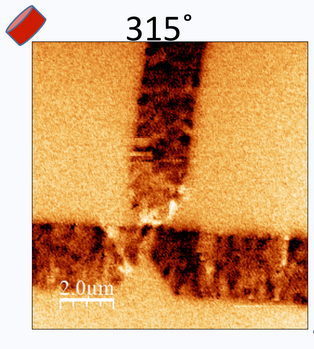
Dual Magnet with Temporary Field:

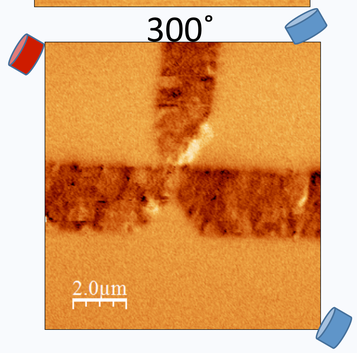
The sample was placed in a dual magnet magnetic field for 10 seconds, then scanned without the field.



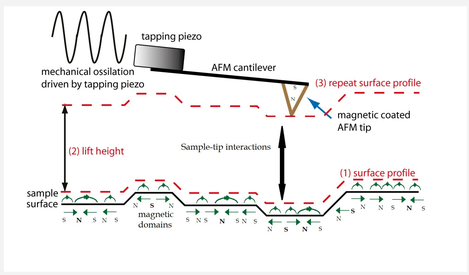
Stage used for Dual Magnet experiments







Non-uniform magnetic domains



How MFM works:
A stronger north pole results in a darker coloration, whereas a stronger south pole results in a lighter coloration.

Possible Application:

One idea is to use these structures for computing, because they are non-volatile and provide faster memory processing.

Acknowledgements:

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