Measuring in the magnetic field

Measuring in the magnetic field allows observing magnetic reversal processes and other effects that depend on the magnetic field. NT-MDT SI devices allow carrying out measuring in the longitudinal and perpendicular magnetic fields. The strength of the magnetic field is controlled by the build-in Hall effect sensor.

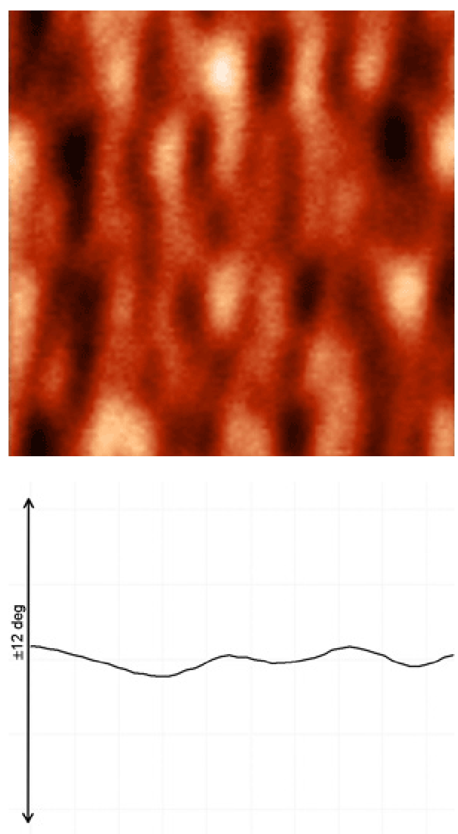
Local magnetization measuring in the very small objects is one of the most promising field in the nanotechnology investigations.

Investigation of ultra thin magnetic films will make possible the tenfold increase of capacity of storage devices; spintronics elements will lead to the development of fundamentally new computes, which "read/write/save" processes will be carried out on one single chip, magnetostriction may be useful for construction of nanoelectronic devices.

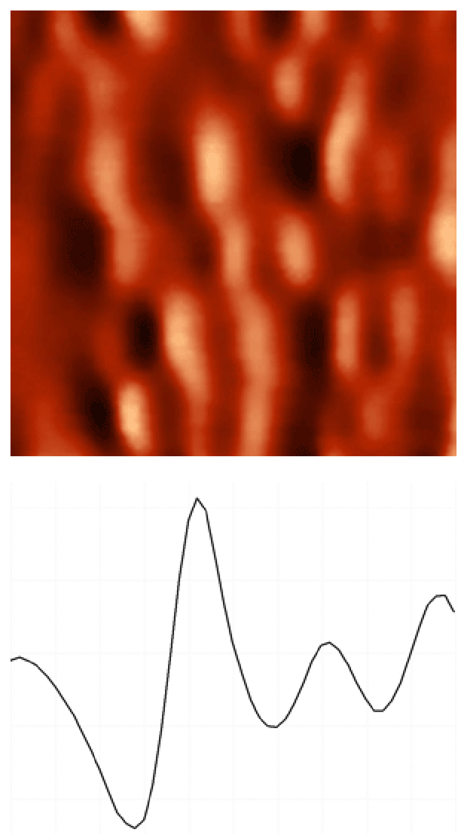
Magnetic-force microscopy (MFM) allows visualizing and manipulating the magnetization with resolution of tens of nanometer.

SPM features, that have the most importance for the work with magnetic samples:

- High sensitivity of measurements for the samples light magnetic interaction
- Proper choice of the probe
- Possibility of imposing external magnetic field (vertical or in-plain)



Air



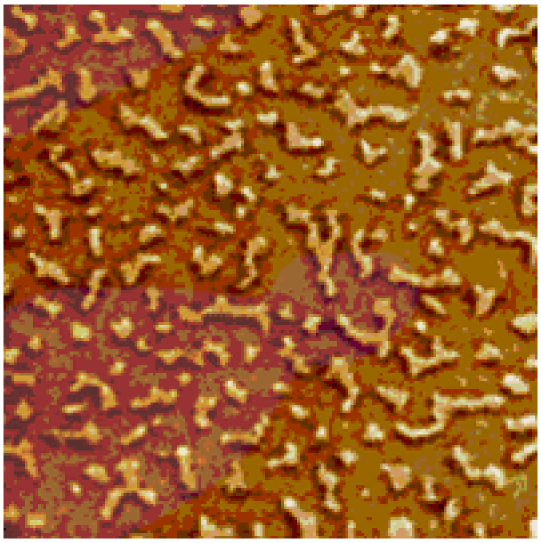
Vacuum

Sensitivity and resolution of magnetic-force microscopy can be raised by several ways. The easiest way is placing the measuring system (sample, scanner and registration system) in the low vacuum conditions. For example, 10^{-2} Torr vacuum is enough for the tenfold gain of the phase contrast for the two-pass dynamic MFM. In this case the "signal/noise" ratio gains fivefold. The deep vacuum (up to 10^{-8} Torr) allows raising the sensitivity even greater but comparing to the low vacuum the difference is insignificant.

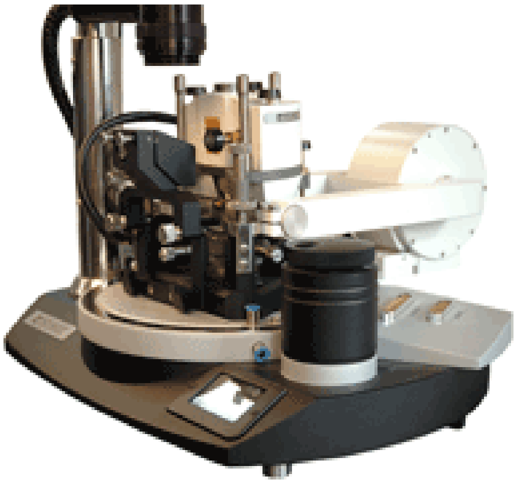
Probe is another important factor that affects the resolution and sensitivity of MFM. The quantity of the magnetic coating must be enough for "feeling" the sample's magnetic attraction but at the same time the probe must be sharp enough to provide high spatial resolution. NT-MDT SI offers AFM silicon probes with CoCr magnetic coating of the tip for the magnetic measuring. Cr protects the magnetic layer from the oxidation. The thickness of the coating is 30-40 nm.

For the investigation of some magnetic effects one needs to apply the external magnetic field to the sample. Usually, it creates certain difficulties because the regular scanning probe microscopes have details that can be magnetized. As the result any measurements of the external field may lead to the distortion of AFM image. In the first NT-MDT SI device for the magnetic measurements (1998) there was a scanner without any magnetic parts. Now the company has developed a special device on the NTEGRA nanolaboratory platform, which measuring head and base unit are made of non-magnetic materials that allows avoiding the shift of the probe while switching on/off the magnetic field.

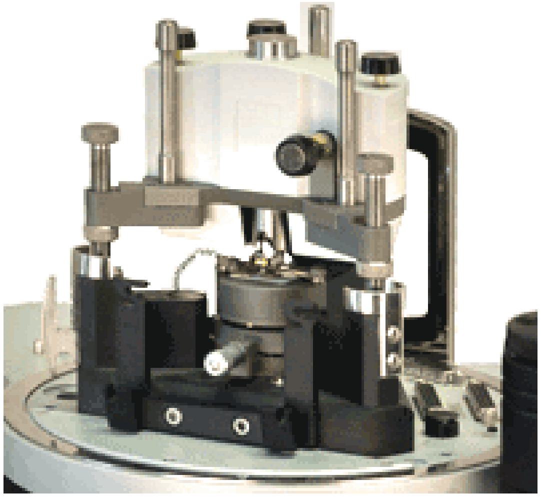
The scanner is equipped with close loop control sensors that correct the shift of piezoceramics and provide exclusively precise positioning of the probe. Beside that, NTEGRA nanolaboratory has a capability of applying the external magnetic field up to +/-0.2 T in-plane the surface and +/-0.02 T perpendicular flat (vertical field).



Magnetic domain structure of ultra thin cobalt film (1.6 nm) 4,5x4,5 µm. The samples provided by dr. A. Maziewski, Uniwersytet w Bialymstoku, Poland.



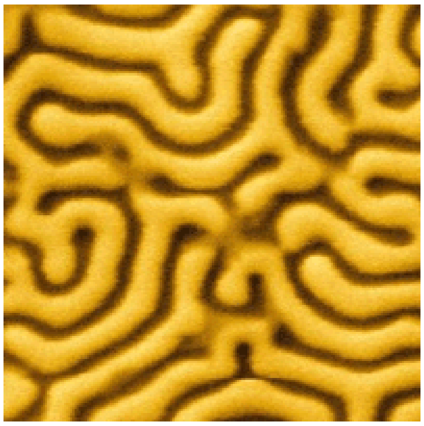
a) generator of the in-plane magnetic field



б) generator of the vertical magnetic field

The generator of the in-plane magnetic field serves for the creation of magnetic field orientated in the flat of the sample. It consists of exciting coil with magnetic wires. For measuring the value of the magnetic field at one of the poles of the wires, there is a Hall detector with scale range up to 2 kgauss.

The generator of the vertical magnetic field serves for the creation of magnetic field normal to the flat of the sample. It consists of exciting coil with build-in Hall detector with scale range of 500 gauss, and a sample holder.



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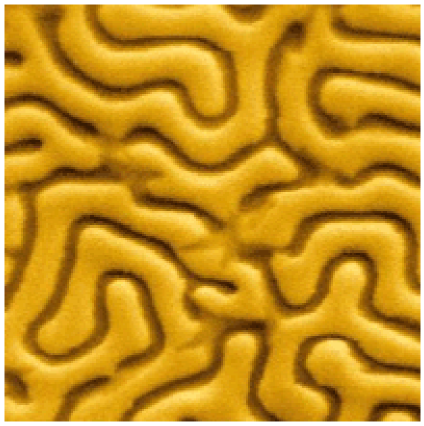

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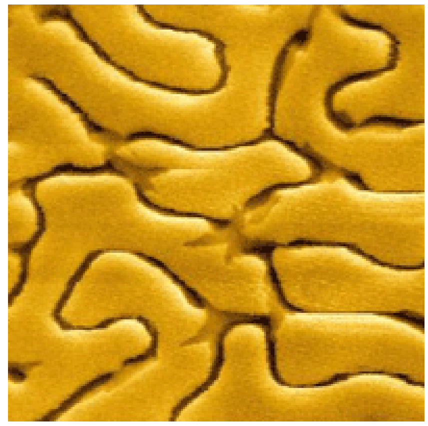

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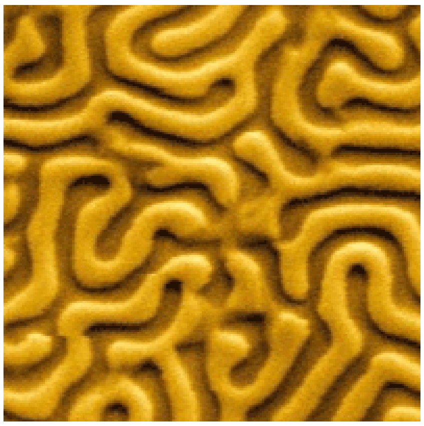

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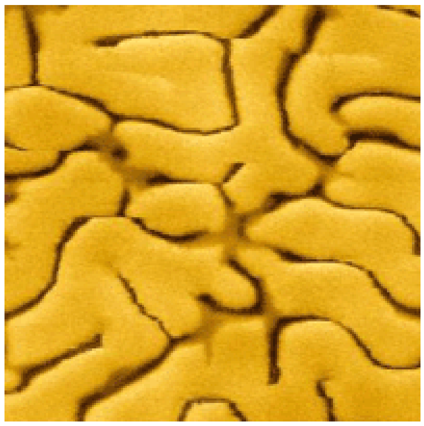

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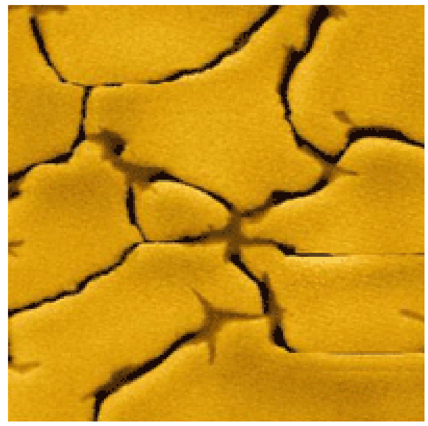

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Film of yttrium-ferrous garnet in the presence of vertical magnetic field. The images of the same part of the surface 90x90 µm. The samples are provided by prof.F.V.Lisovskiy, Radioelectronic institute.