08-03 **Magnetization reversal in epitaxial Fe-nanowires on GaAs(110)**

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We have studied the magnetization reversal processes of epitaxial Fe nanowires on GaAs(110) at 4.2 K using magnetoresistance measurements and OOMMF (object oriented micromagnetic framework) simulations.

Epitaxial Fe films on GaAs(110) were prepared in a UHV chamber. Low-energy electron diffraction investigations reveal the epitaxial growth of Fe as well as an expanded lattice in the out-of-plane direction due to the lattice mismatch between Fe and GaAs. The films are capped with Ag and Pt to avoid oxidation of the Fe films.

The anisotropy constants of the films are determined using ferromagnetic resonance at 9.8 GHz. These investigations reveal that in addition to the four-fold bulk anisotropy, a uniaxial anisotropy is present.

By means of an electron beam lithography process using a negative resist, the Fe films are structured into wires of different widths and different orientations, i.e. we prepared wires with the long wire-axis parallel or perpendicular to the magnetocrystalline easy-axis.

Magnetic force microscopy measurements at room temperature and in the remanent state show that for wide wires, for which the long-axes are parallel to the [-110] direction, the magnetization points transverse to the long wire-axis. This is due to the fact that the crystalline anisotropy is larger than the shape anisotropy, and is also supported by OOMMF simulations.

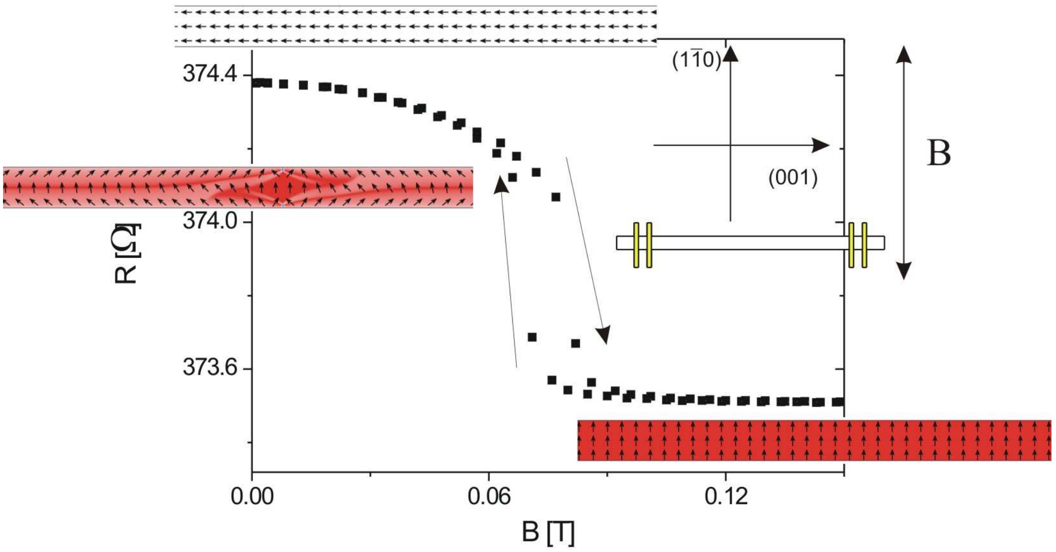

Fig. 1. Magnetoresistance at 4.2 K of a 2 µm wide wire with the long wire-axis parallel to the [001] easy-direction and the magnetic field applied parallel to the [-110] direction. The rectangles with arrows show the results of OOMMF simulations for various magnetic fields. The sketch in the upper right part of the figure shows schematically the orientation of the wire and the magnetic field.

Magnetoresistance measurements at 4.2 K are conducted for differently oriented wires. Figure 1 shows the magnetoresistance for a wire with the easy-axis of magnetization parallel to the long wire-axis with the external magnetic field applied perpendicular to the long wire-axis. The magnetoresistance behavior can be explained in terms of the anisotropic magnetoresistance effect [1], which predicts a dependence of the resistance on the angle between the current and the magnetization. A low resistance means that the magnetization is perpendicular to the current (which is parallel to the long wire-axis) and a high resistance means that the magnetization is perpendicular to the current. The magnetic anisotropy determined from these measurements is in good agreement with that obtained from ferromagnetic resonance measurements. Furthermore, OOMMF simulations support the observed resistance behaviour [2].

Figure 2 shows a magnetoresistance measurement for a wire with the long wire-axis transverse to the magnetocrystalline easy-axis. The magnetic field is applied parallel to the long wire-axis. The results of this measurement can be explained in terms of the anisotropic magnetoresistance. This measurement clearly shows that the effective easy-axis of magnetization lies transverse to the long wire-axis, as also measured by magnetic force microscopy.

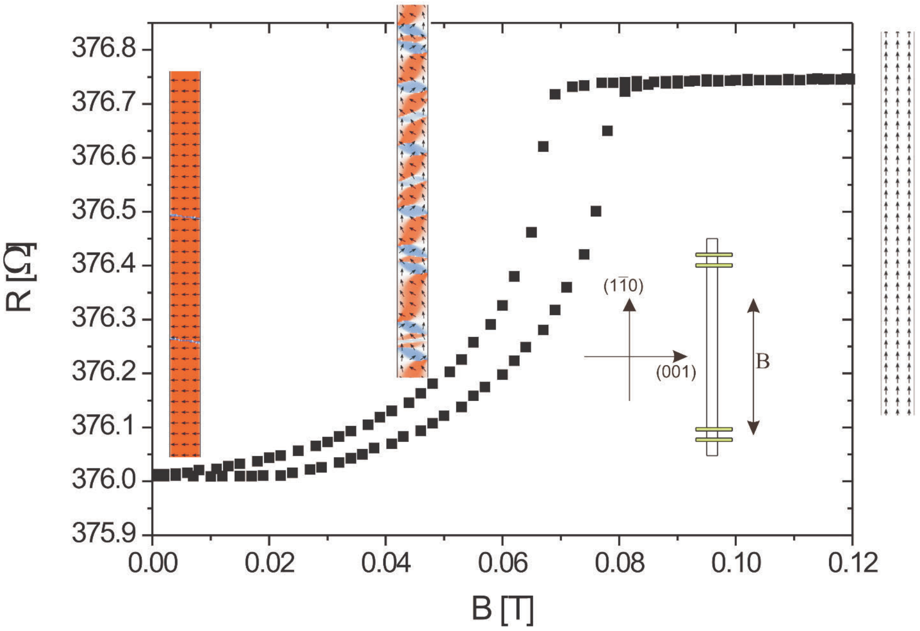

Fig. 2. Magnetoresistance at 4.2 K of a 2 μm wide wire with the long wire-axis parallel to the [-110] direction and the magnetic field applied parallel to the [-110] direction. The rectangles with arrows show the results of OOMMF simulations for various magnetic fields.

Further measurements on smaller wires show that a reorientation of the effective easy-axis of magnetization takes place with decreasing wire-widths due to the increasing influence of the shape anisotropy.

References

1. T. R. McGuire, R. I. Potter, IEEE Trans. Mag. 11, 1018 (1975).
2. C. Hassel, F. M. Römer, R. Meckenstock, G. Dumpich, J. Lindner, Phys. Rev. B 77, 224439 (2008).