

08-04 Structural and magnetic correlations in nanoscale ferromagnetic systems

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For studying spin dynamics, well defined magnetic thin film systems are needed [1-3]. Furthermore, a full characterization of magnetic properties on the systems is essential. We grow magnetic thin films by molecular beam epitaxy (MBE) and perform magnetic characterization *in situ* by means of ferromagnetic resonance (FMR). For this, we use an ultra-high vacuum (UHV) chamber with a base pressure of 10^{-10} mbar equipped with a low-energy electron diffraction (LEED) unit and an Auger electron spectrometer (AES) and two MBE evaporators allowing for successive and simultaneous evaporation of different materials. Furthermore, a unique *in situ* FMR apparatus for angle-dependent measurements using an X-band resonator is attached to the chamber. A cryostat and a heater system offer a broad accessible temperature range for the samples. As an example we present here some results obtained on Fe/GaAs(110) thin films. Besides the thickness-dependent reorientation transition, this system shows – in contrast to the Fe/GaAs(100)-systems – a uniaxial anisotropy which persists for remarkably high Fe-coverage [4]. We provide a thickness-

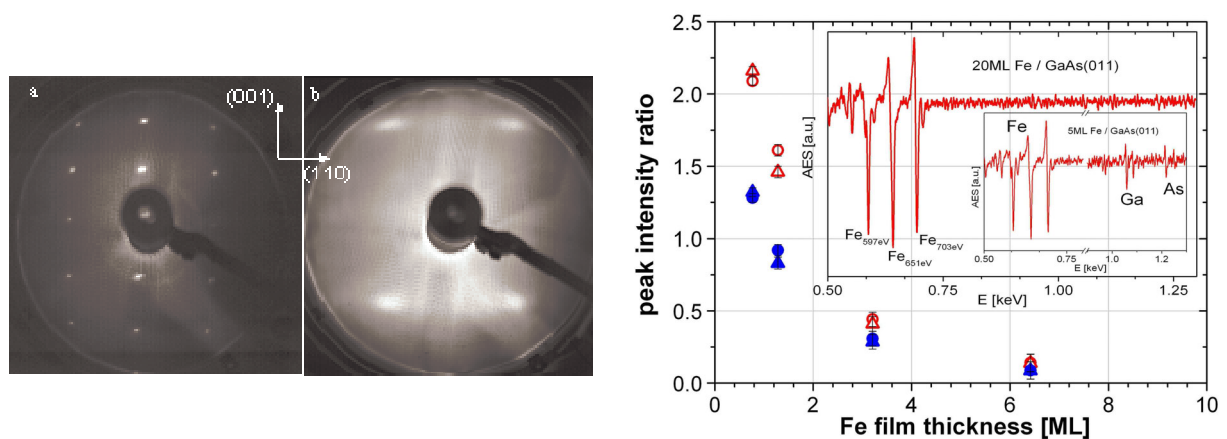


Fig. 1: *left*: LEED images from (a) the clean GaAs(110) substrate and (b) 10 nm Fe film revealing the symmetry of the surface. *right*: (insets) AES spectra of contamination-free surfaces with different Fe-coverage. The plot shows a thickness dependent decrease of AES-Fe-peaks intensity relative to those of the substrate.

dependent study of magnetic anisotropies and structural investigations revealing the mechanism of these magnetic transitions.

Figure 1 shows LEED images of the clean GaAs(110) substrate and a 10 nm Fe-film revealing the symmetry of the surface. The Fe/substrate peak intensity ratio suggests a 3D-island-growth. Additionally, *in situ* STM investigations confirm this assumption – the behaviour of the thickness dependent surface roughness suggests an underlying Fe film [4].

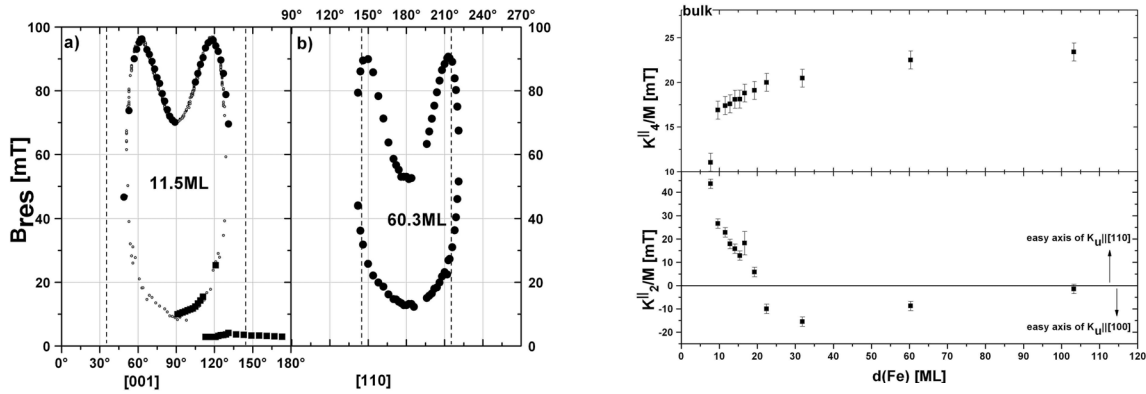


Fig. 2: *left*: in-situ FMR at 9.3 GHz: angle dependent resonance fields of 11.5 ML and 60.3 ML films. The FMR signature is shifted by 90°. Dashed lines denote the $\langle 111 \rangle$ directions. *right*: Crystalline and uniaxial anisotropy.

From the angle-dependent FMR measurements (Fig. 2 *left* a, b) a full set of magnetic anisotropies can be extracted. The separated contributions of crystalline and uniaxial anisotropies are shown. While the crystalline anisotropy does not reach the bulk value even for relatively high coverage, the uniaxial anisotropy crosses zero once at about 20 ML and disappears then at about 100 ML indicating a relaxation of the film. We could show that oxidizing or covering the films with Ag leads to an increase of more than 200 % in the uniaxial anisotropy pointing out the importance of using the UHV technique for such investigations.

References

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