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In situ Kerr magnetometry study of thin films of Fe_xCo_{1-x}/Pd(100)

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Abstract – Ultra-thin magnetic films of Fe_xCo_{1-x} on Pd(100) were investigated by Kerr magnetometry. We demonstrate how to extract the three components of the magnetization from the Kerr (MOKE) measurements. This calculation was successfully tested for a Fe_xCo_{1-x} /Pd(100) system. The ultra-thin films were prepared by co-evaporation in an UHV-system and characterized by XPS, LEED, RHEED, MOKE and CEMS (Conversion Electron Mössbauer Spectroscopy).

Fe_xCo_{1-x} alloy films exhibit magnetic uniaxial anisotropy depending on the alloy composition (x) or lattice distortion. Since Pd has lattice parameters larger than Fe and Co, growing Fe_xCo_{1-x} on Pd(100) expands the film laterally and contracts it perpendicularly to the surface. This can lead to perpendicular spontaneous magnetization (e. g. for x=50), which is of great technological interest [1].

Three samples of approximately 12 monolayers have been prepared by co-evaporation of Fe^{57} and Co under ultra high vacuum conditions (base pressure 10^{-10} mbar), controlled by RHEED oscillations and characterized by XPS before and after annealing at 200^0C for 15 minutes. Some samples were additionally annealed at 300^0C for 15 minutes. To characterize the magnetic properties the Magneto-optic Kerr Effect (MOKE) and Mössbauer spectroscopy were used. Determination of the stoichiometry was mainly afforded by XPS. All measurements were performed at room temperature.

In situ MOKE measurements were realized with 635nm laser light incident at 45^0 to the sample normal. Glan-Thomson polarizer/analyzers, a photoelastic modulator (f=50kHz) and Si-photodiode detectors have been used in longitudinal and polar geometries. The signal at f and 2f was registered with Lock-In technique and the dc-signals have been measured. An externally generated magnetic field up to 300mT can be applied at a continuously varying angle in a plane perpendicular to the optical incidence plane and perpendicular (polar geometry) or parallel (longitudinal/transversal geometry) to the sample surface.

The magnetization of an anisotropic thin film can be oriented towards an arbitrary direction. Through Kerr magnetometry it is possible to determine the three components of the magnetization relative to a coordinate system anchored to the sample. This problem was studied by several authors in the literature [2,3,4]. In the present work we developed two new methods for separation of the magnetization components and tested them for a Fe_xCo_{1-x} system grown on Pd(100). We demonstrate that a linear combination of measurements at (at least) two different settings (polarization of analyzer/polarizer) of the Kerr magnetometer allows the separation of the components. We applied the developed methods to the Fe_xCo_{1-x} /Pd(100) system in order to calculate the magnetization perpendicular to the surface for different stoichiometries (x = 30; 50) and with thermal annealing of the films.

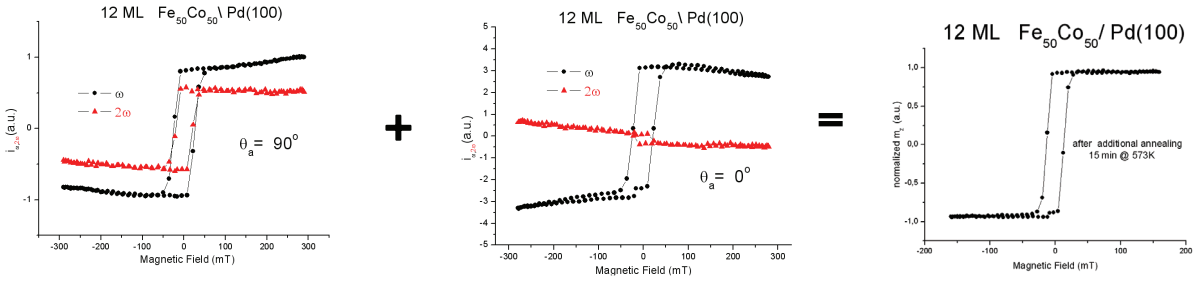

Figure 1: Normalized m_z magnetization got by different Kerr measurements combination for $Fe_{50}Co_{50}$ ultra thin film.

References

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