MA 9: Anisotropy/Magnetoelasticity

Time: Monday 17:15–18:30 Location: H22

MA 9.1 Mon 17:15 H22

A novel approach to induce biaxial stress on magnetic thin films and its influence on the Magnetic anisotropy — •Jorge Enrique Hamann, Senthilnathan Mohanan, and Ulrich Herr — Institute for Micro and Nanomaterials, University of Ulm, Ulm-89081, Germany

Magnetic thin films and multilayers exhibiting perpendicular anisotropy (PA) are the promising candidates for the perpendicular magnetic recording media and solid state magnetic memory. Stress induced magnetic anisotropy plays a major role for PA in magnetic-noble metal multilayer systems. The main aim of this study is to investigate the influence of biaxial stress on the magnetic anisotropy of thin films with positive and negative magnetostriction constants, namely CoFe alloy and Ni. In this study, we introduce a novel way to induce biaxial in-plane stress on to the thin films. We deposited magnetic thin films on Ta substrate and an isotropic biaxial stress is introduced in the magnetic thin films by loading the Ta substrate with H2. Films with varying biaxial tensile stress are produced by changing the H2 loading time. We measured the influence of biaxial tensile stress with the corresponding change in the out of plane hysteresis loop measurement. We observed a gradual change in the slope of M(H) curve in case of CoFe, and of saturation field in case of Ni, which correlates well with varying stresses induced in the film. We made a quantitative analysis of the data using a micromagnetic model with which we estimated the values for corresponding magnetostriction constant and crystalline anisotropy.

MA 9.2 Mon 17:30 H22

Effects of uniaxial stress on the properties of giant magnetoresistive sensors on polyimide substrates — •Berkem Özkaya, Srinivasa Rao Saranu, Senthilnathan Mohanan, and Ulrich Herr — Institute for Micro and Nanomaterials, University of Ulm, D-89081, Germany.

The change in the sensitivity of giant magnetoresistive (GMR) sensors on polyimide substrate was demonstrated. Applying uniaxial stress on magnetic layers leads to stress induced anisotropy. Initially, we investigated stress effects on single Co thin film prepared by DC magnetron sputtering, which exhibits macroscopic in-plane easy axis induced by the preparation process. In-situ magnetisation curves in the stressed state were obtained by using MOKE magnetometer. When stress is applied perpendicular to induced in-plane easy axis, coercivity field (Hc) and remanent magnetisation (Mr) are decreasing, and saturation field (Hs) is increasing. For [Cu/Co]15 multilayer exhibiting ˜20% GMR value, it is observed that when the stress is applied parallel to the external magnetic field (Hext), Hs is increasing and the GMR remains constant, resulting in a reduced sensitivity. On the other hand, when the stress is applied perpendicular to Hext, we observed that Hs is decreasing and the GMR remains constant, resulting in a increased sensitivity. For trilayer system of Co/Cu/Ni in which Co is positive and Ni is negative magnetostrictive layer, applying stress leads to reverse rotation of magnetisation in both magnetic layers. When the stress is applied parallel to Hext, the GMR is decreasing, and Hs is increasing, resulting in a reduced sensitivity.

MA 9.3 Mon 17:45 H22

Magnetische Anisotropie von epitaktischen Fe_3Si-Filmen auf MgO(001) — •Florian Römer, Khalil Zakeri, Jürgen Lindner, Michael Farle, Natalia Utochkina und Werner Keune — Fachbereich Physik und Centre for Nanointegration (CeNIDE), Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany

Epitaktische Fe_3Si-Filme mit Dicken zwischen 5 und 50 nm wurden mittels Ferromagnetischer Resonanz und Magnetooptischen Kerreffekt bei Raumtemperatur untersucht. Die Beiträge zur magnetischen Anisotropie wurden separiert und quantitativ bestimmt.

Neben einer dickenunabhängigen dominierenden kubischen Anisotropie $K_4 = 27,5 \cdot 10^2$ J/m^3 im Volumen, wurde eine schwache uniaxiale Anisotropie in der Filmebene $K_{2\parallel}$ gefunden, die auf Grenzflächeneffekte zurückzuführen ist. Bei 5 nm Filmdicke ist $K_{2\parallel} \approx K_4/10$. Das effektive Entmagetisierungsfeld M_{eff} wird neben der Magnetisierung, die gegenüber dem Volumenwert von Fe_3Si um etwa 30% reduziert ist, von einem uniaxialen Anisotropiebeitrag senkrecht zur Filmebene beeinflusst. Letzterer kann auf die tetragonale Verzerrung des Filmes aufgrund des epitaktischen Wachstums zurückgeführt werden.

Unterstützt durch DFG, Sfb 491.

MA 9.4 Mon 18:00 H22

Nonlinear magnetoelastic coupling coefficients in strained Fe, Co and Ni monolayers — •Zhen Tian, Dirk Sander, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik,

Magnetoelastic (ME) coupling in magnetic thin films has an essential influence on the magnetic anisotropy. The experimental results[1] in recent years indicate a second-order ME coupling effect in thin films with large epitaxial strain. It is the goal of this study to extend the experiments to compressive strain. We deposited Fe, Co and Ni films on Ir(100) in the thickness range 0.1 to 10 nm. Film stress and ME stress were measured by the optical beam bending method[1]. The magnetic films show large film stress of the order GPa due to the mismatch between the film and the substrate, and we deduce a large epitaxial strain of the order percent in the films. We investigate the correlation between film stress, strain and the ME coupling. Our results indicate that ME coupling coefficients B_1 of Fe films and B_2 of Co and Ni deviate from the bulk value and depend on the film strain ϵ. The experimental results can be fitted with an effective strain-dependent ME coupling coefficient B_i^{eff} with $B_i^{eff} = B_i + D^{eff}\epsilon$. Our analysis shows that the nonlinear coefficient D^{eff} is much larger than the first order coupling term B_i. For Co we obtain $B_2 = 5.8\frac{MJ}{m^3}$ and $D^{eff} = 275\frac{MJ}{m^3}$, while the bulk value is $7.7\frac{MJ}{m^3}$. Our results are discussed in view of recent theoretical predictions[2].

[1] D. Sander: Rep. Prog. Phys. **62**, 809(1999).
[2] M. Fähnle, M. Komelj: Phys. Rev. B, **65**, 212410 (2002); M. Fähnle, M. Komelj: Phys. Rev. B, **73**, 012404 (2006).

MA 9.5 Mon 18:15 H22

The Magnetoelastic Paradox — •Manuel Zschintzsch[1], Dirk C. Meyer[1], Günter Behr[2], Jan Prokleska[3], Herwig Michor[4], Mathias Doerr[5], Michael Loewenhaupt[5], and Martin Rotter[6] — [1]ISP, TU Dresden, Germany — [2]IFW, Dresden, Germany — [3]Charles University, Prague, Czech Republic — [4]TU-Wien, Austria — [5]IFP TU-Dresden, Germany — [6]IPC, Universität Wien, Austria

The Magnetoelastic Paradox [1] describes the difference between the low temperature magnetoelastic behavior of antiferromagnetic compounds and the theoretical predictions due to the spin interactions. While studying the behavior at an atomic scale it's important to separate the different kinds of interactions, in our case domain effects, single ion contributions and spin interactions.

Accordingly our measurements were performed on antiferromagnetic Gd based compounds: Due to antiferromagnetism domains don't have to be considered. Additionally Gd exhibits no magnetic orbital momentum. Thus, single-ion contributions to the magnetoelastic behaviour don't occur. The alloying partners were chosen in a way that they have no, or only weak magnetic moments. All magnetoelastic effects which can be seen from our X-ray diffraction experiments can be attributed to spin interaction of Gd exclusively. We measured the temperature dependend lattice parameters and peakwidths in the temperature range of 15 to 300K. The experimentally determined absence of symmetry breaking distortions (no changes of peakwidth detected) at the Neel-temperature leads to the existence of the magnetoelastic paradoxon.

[1] M. Rotter et al. *Europhys. Lett.* 75, 160-166 (2006)