MA 18 Magnetische dünne Schichten III

Zeit: Montag 10:30–13:00 Raum: TU H1028

MA 18.1 Mo 10:30 TU H1028

Quantitative SQUID Magnetometrie im UHV: Einfluss magnetischer Randdomänen — •Th. Kebe, R. Ramchal, F. Ciubotaru, J. Lindner und M. Farle — Fachbereich Physik, Experimentalphysik AG Farle, Universität Duisburg-Essen, Campus Duisburg, Lotharstrasse 1, 47048 Duisburg, Germany.

Aus der Grösse und Richtung des magnetischen Streufeldes kann mit Raster-HTS-SQUID-Magnetometrie die Magnetisierung magnetischer Monolagen *in situ* im UHV quantitativ bestimmt werden [1]. Da man in der Analyse für die Magnetisierungsverteilung einen eindomänigen Magnetisierungszustand annimmt, schätzen wir den Fehler bei der Magnetisierungsbestimmung für den Fall ab, dass Domänen in Remanenz vorliegen. Hierzu wurden Magnetkraftmikroskopie, Kerr-Effekt und Kerr-Mikroskopiemessungen an 15 ML Fe Filmen auf Ga terminierten GaAs(100) Substraten mit Pt Deckschicht *ex situ* durchgeführt. Der Vergleich mit theoretischen Berechnungen gibt eine quantitative Abschätzung des Einflusses auf das dipolare Streufeld.
Unterstützt durch Sonderforschungsbereich 491, TP A9.
[1] A. Ney, P. Poulopoulos, M. Farle and K. Baberschke, *Phys. Rev. B* **62**, 11336 (2000).

MA 18.2 Mo 10:45 TU H1028

Erzeugung ferromagnetischer Schichten durch Oxidation von CoAl (100) — •Klaus Brüggemann, Volker Rose, Stella van Eek, René Franchy und Harald Ibach — Institut für Schichten und Grenzflächen (ISG3), Forschungszentrum Jülich, D-52425 Jülich

Im Rahmen unserer Untersuchungen zum Aufbau eines TMR-Modellsystems wurden mittels MOKE die magnetischen Eigenschaften von Cobalt0.5 Aluminium0.5 (100) gemessen. Gemäß Literaturangaben zeigt die Verbindung erst ab 63 Atomprozent Co Ferromagnetismus. Der reine Kristall zeigte somit zunächst keine Hysterese. Die Probe wurde nun bei Raumtemperatur mit einer Dosis von 400 L Sauerstoff oxidiert, wobei an der Oberfläche eine ca.7 Å dicke Schicht amorphes Al2O3 entstand. Dadurch werden die obersten Schichten des Kristalls an Al verarmt und eine Cobalt angereicherte Schicht, die Ferromagnetismus aufweist, entsteht. Somit konnte eine Hysterese mit 5 Oe Hc gemessen werden. Das Oxid wurde danach durch Ionenätzen mit Ar entfernt und das Substrat schrittweise auf 600K erwärmt. Dabei diffundierte Al in die verarmte Schicht, was sich durch eine abnehmende Magnetisierung und einer zunehmendes Hc äußerte. Dies kann durch Abnahme der Beweglichkeit der Domänenwände und des magnetischen Materials erklärt werden.

MA 18.3 Mo 11:00 TU H1028

Austauschgekoppelte magnetische Schichten: Variation der Kopplung durch externe Magnetfelder — •T. Klein[1], R. Röhlsberger[2], K. Schlage[1] und E. Burkel[1] — [1]Institut für Physik Universität Rostock, August-Bebel-Str. 55, 18051 Rostock — [2]HASYLAB am DESY, Notkestr. 85, 22607 Hamburg

In diesem Beitrag wird die Austauschkopplung zwischen weich- und hartmagnetischen Schichten über nichtmagnetische Zwischenschichten untersucht. Weichmagnetische Fe-Schichten sind über Cu-Zwischenschichten an hartmagnetische FePt-Schichten mit unidirektionaler Anisotropie ferromagnetisch gekoppelt. Durch externe Magnetfelder, die kurzzeitig senkrecht oder antiparallel zur FePt-Magnetisierungsrichtung angelegt werden, können die Kopplungseigenschaften verändert werden. Für bestimmte Cu-Schichtdicken wird der Kopplungswinkel zwischen den Magnetisierungsrichtungen der Schichten remanent verändert. Es können beliebige Kopplungswinkel durch die externen Magnetfelder induziert werden. Diese Kopplungswinkel wurden mit Hilfe der nuklear resonanten Streuung mit einer hohen Genauigkeit (+/- 3°) bestimmt.

Für senkrecht und antiparallel angelegte Magnetfelder ergeben sich signifikante Unterschiede bezüglich der induzierten Kopplungswinkel als Funktion der Cu-Zwischenschichtdicke. Ein Teil der Resultate konnte mit bekannten Modellen [1] beschrieben werden. Es wird ein neues Modell präsentiert, welches weitere magnetfeldinduzierten Kopplungsphänomene beschreibt.

[1] V. K. Vlasko-Vlasov et al., Phys. Rev. Lett. 86, 4386-4389 (2001)

MA 18.4 Mo 11:15 TU H1028

First-principles study of thin magnetic transition-metal alloy films on Si(001) — •Hua Wu, Peter Kratzer, and Matthias Scheffler — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4–6, D-14195 Berlin

Ferromagnetic (FM) metal/semiconductor heterojunctions have promising technological applications in the field of magnetoelectronics (or spintronics). Here we present density-functional theory calculations addressing the thermodynamic stability and magnetism both of the pseudomorphic CsCl-like MSi (M=Mn,Fe,Co,Ni) thin films and of the Heusler alloy M_2MnSi (M=Fe,Co,Ni) films on Si(001). The results show that the MSi films prefer a Si-termination, and that the M-Si bond-strength increases as M varies from Mn to the later transition metals, which is helpful to understand a number of experimental observations. The ultrathin MnSi film is FM; the FeSi and NiSi films are nonmagnetic; while the CoSi film is surprisingly FM due to its peculiar electronic band structure. For the M_2MnSi films, the Si termination has a higher chemical stability due to stronger surface chemical bonds, while the MnSi termination has a higher thermodynamic stability due to a lower formation energy. The calculated strength of the effective intralayer Mn-Mn coupling scales with the measured FM Curie temperatures of the bulk M_2MnSi. In particular, the Co_2MnSi/Si(001) thin film is stable against a phase separation and has a robust FM ground state as in the bulk Co_2MnSi. However, we note that in the Co_2MnSi/Si(001) film, the formation energies of Co/Si and MnSi/Si interfaces are similar, which could lead to interfacial disorder degrading spin injection.

MA 18.5 Mo 11:30 TU H1028

Revealing Antiferromagnetic Order of the Fe Monolayer on W(001) — •André Kubetzka[1], Paolo Ferriani[1], Matthias Bode[1], Stefan Heinze[1], Gustav Bihlmayer[2], Kirsten von Bergmann[1], Oswald Pietzsch[1], Stefan Blügel[2], and Roland Wiesendanger[1] — [1]Institute of Applied Physics, Univerity of Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich, Germany

Although the system of one monolayer Fe on W(001) has been studied extensively in the past, experiments only deduced that the magnetic ground state is not ferromagnetic [1] while theoretical predictions are still controversal [2,3]. Employing spin-polarized scanning tunneling microscopy (SP-STM) we obtained atomic resolution images showing that a c(2×2) antiferromagnetic structure with an out-of-plane magnetization direction is the magnetic ground state. Since, in contrast, the Fe ML is ferromagnetic on W(110), we thereby show that the type of magnetic order can be changed by a proper choice of the substrate orientation alone. These results are explained based on first-principles calculations.
[1] G.A. Mulhollan *et al.*, Phys. Rev. B **43**, 13645 (1991)
[2] R. Wu and A.J. Freeman, Phys. Rev. B **45**, 7532 (1992)
[3] X. Qian and W. Hübner, Phys. Rev. B **67**, 184414 (2003)

MA 18.6 Mo 11:45 TU H1028

Displacement Profile of Domain Walls at Critical Depinning — •Thomas Nattermann and Andreas Glatz — Institut für Theoretische Physik der Universität zu Köln, Zülpicher Str. 77, 50937 Köln

The influence of a strong surface potential on the critical depinning of an elastic system driven in a random medium is considered. If the surface potential prevents depinning completely the elastic system shows a parabolic displacement profile. Its curvature $\mathcal{C}$ exhibits at zero temperature a pronounced rhombic hysteresis curve of width $2f_c$ with the bulk depinning threshold f_c. The hysteresis disappears at non-zero temperatures if the driving force is changed adiabatically. If the surface depins by the applied force or thermal creep, $\mathcal{C}$ is reduced with increasing velocity. The results apply, e.g., to driven magnetic domain walls, flux-line lattices and charge-density waves

MA 18.7 Mo 12:00 TU H1028

Hysteresis mediated by a domain wall motion — •Thomas Nattermann[1] and Valery Pokrovsky[2] — [1]Institut für Theoretische Physik der Universität zu Köln, Zülpicher Str. 77, 50937 Köln — [2]Department of Physics, Texas A&M University, College Station TX, USA

The position of an interface (domain wall) in a medium with random

pinning defects is not determined unambiguously by the instantaneous value of the driving force, even on average. Employing the general theory of the interface motion in a random medium, we study this hysteresis, different possible shapes of the hysteresis loop, and the dynamical phase transitions between them. Several principal characteristics of the hysteresis, including the coercive force and the curves of dynamical phase transitions obey scaling laws and display a critical behavior in the vicinity of the mobility threshold. At finite temperature the threshold is smeared and a new range of thermally activated hysteresis appears. At a finite frequency of the driving force there exists a range of the non-adiabatic regime in which not only the position, but also the average velocity of the domain wall, displays hysteresis.

MA 18.8 Mo 12:15 TU H1028

Permalloy microstructures at high current densities — •Saleh Getlawi, Ivo Knittel, Michael Koblischka, and Uwe Hartmann — Universität des Saarlandes, 66041 Saarbrücken

It is now less than ten years that magnetization reversal by spin transfer and current-induced domain wall movement has been discovered. Now it is discussed more and mor as a possible mechanism for devices, namely as microwave generator and for permanent information storage. However, the current densities involved are without precedent in technology. We have set up a number of experiments to observe the effects of high current densities on permalloy microstructures. We investigate current-induced domain wall movement by magnetic force microscopy, map the local temperature distribution by Near-Infrared Scanning Near Field Microscopy, and study the effects of electromigration by atomic force microscopy and electron microscopy.

MA 18.9 Mo 12:30 TU H1028

Switching behaviour of small FePt grains observed by magnetic force microscopy — •Ulrike Wolff, Stefan Pofahl, Martin Weisheit, Sebastian Fähler, Ludwig Schultz, and Volker Neu — IFW Dresden, P.O. Box 270116, 01171 Dresden

FePt films of small grains with an average grain size of 100-500nm have been prepared by pulsed laser deposition onto MgO(001) substrates at high temperatures of $800^{\circ}C$ in order to form the $L1_0$ hard magnetic phase. The grains are isolated, fully out-of-plane oriented in c-axis, exhibit a coercivity of 3-5.6T, depending on the grain size, and show in the remanent state single domains [1]. The magnetization process is investigated by means of Magnetic Force Microscopy by measuring in an applied magnetic field of up to 7T (Cryogenic SFM, Omicron) or by imaging the magnetic domain structure of different remanent states with a Dimension 3100 (Digital Instruments). This local study allows the evaluation of grain size dependence on the switching behaviour of individual FePt grains.

[1] M. Weisheit, L. Schultz, S. Fähler, J. Appl. Phys. 95 (2004) 7489

MA 18.10 Mo 12:45 TU H1028

Strain and disorder effects on the transport properties of manganite thin films — •Carmine Antonio Perroni, Vittorio Cataudella, Giulio De Filippis, and Vincenzo Marigliano Ramaglia — Dipartimento Scienze Fisiche, Universita' "Federico II", Napoli

Thickness dependence, strain and disorder effects in films of $La_{1-x}A_xMnO_3$ perovskites are analyzed in the colossal magnetoresistance regime. A reduction in the thickness of the film causes a decrease of critical temperature and an increase of resistivity at low temperatures. The strain effects are in good agreement with experimental data only if the dependence of the hopping matrix elements on the Mn-O-Mn bond angle is properly taken into account. In collaboration with experimental groups, the resistivity is investigated in a wide temperature range for films grown by different techniques and on several substrates allowing to analyze samples with different amounts of disorder. In the low-temperature state the prominent contribution to the resistivity scales as T^{α} with $\alpha \simeq 2.5$ supporting the role of single magnon scattering in presence of minority spin states localized by the disorder. In the high temperature insulating paramagnetic phase the resistivity shows the activated behavior characteristic of polaronic carriers. Finally in the whole range of temperatures the experimental data are found to be consistent with a phase separation scenario also in films doped with strontium.