MA 23 Spinabhängiger Transport III

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

MA 23.1 Di 10:30 TU H1028

Direct observation of current induced domain wall motion and wall spin structure modification — •Mathias Kläui[1], Ulrich Rüdiger[1], Pierre-Olivier Jubert[2], Rolf Allenspach[2], Laurent Vila[3], Giancarlo Faini[3], C.A.F. Vaz[4] und J.A.C. Bland[4] — [1]FB Physik, Universität Konstanz — [2]IBM Zürich Laboratory, Rüschlikon, Switzerland — [3]LPN-CNRS, Marcoussis, France — [4]Cavendish Laboratory, University of Cambridge, UK

Novel approaches to the switching of magnetic nanostructures are currently heavily investigated. A promising approach is switching by current-induced domain wall propagation (CIDP), where due to a spin torque effect, electrons transfer angular momentum to a head-to-head domain wall and thereby push it in the direction of the electron flow [1,2]. Here we use Spin-SEM to directly observe domain wall propagation in-situ in permalloy nanostructures induced by current pulses. We determine the propagation distances as a function of pulse height and pulse length for different types of domain walls (vortex, transverse). High resolution imaging allows us to image the nanoscale spin structure of the walls after and during the injection of currents and we observe that the current modifies the spin structure dramatically. Theoretically there are different competing approaches for incorporating spin torque effects into micromagnetic calculations [3,4] and direct comparison with our results allow us to discriminate between these theories. [1] M. Kläui et al., Appl. Phys. Lett. 83, 105 (2003) [2] A. Yamaguchi et al., Phys. Rev. Lett. 92, 77205 (2004) [3] A. Thiaville et al., J. Appl. Phys. 95, 7049 (2004) [4] S. Zhang and Z. Li, cond-mat/0407174 (2004)

MA 23.2 Di 10:45 TU H1028

Magnetowiderstandsverhalten nanostrukturierter magnetischer Leiterbahnen mit einer gepinnten Domänenwand — •Christoph Hassel, Mario Brands und Günter Dumpich — Experimentalphysik, AG Farle, Universität Duisburg-Essen (Standort Duisburg), Lotharstr. 1, 47048 Duisburg

Mittels Elektronenstrahllithographie werden nanostrukturierte Co/Pt-Leiterbahnen hergestellt, die abschnittsweise aus schmalen und breiten Leiterbahnelementen bestehen. Da die Koerzitivfeldstärke von der Leiterbahnbreite abhängig ist, führt die verwendete Leiterbahngeometrie dazu, dass sich am Übergang zwischen den beiden Leiterbahnstücken eine einzelne Domänenwand bildet, wie magnetkraftmikroskopische Aufnahmen belegen. Magnetowiderstandsmessungen, die an diesen Strukturen vorgenommen wurden, spiegeln das Ummagnetisierungsverhalten der einzelnen Leiterbahnelemente wider und gestatten, den Widerstand eines einzelnen Domänenwandbereiches zu bestimmen. Es wird diskutiert, inwieweit es möglich ist, für diese Struktur Widerstandsbeiträge, die auf dem anisotropen Magnetowiderstand (AMR) beruhen, von Beiträgen des Domänenwandwiderstandes (DWR) zu trennen.

Diese Arbeit wird im Rahmen des SFB 491 gefördert.

MA 23.3 Di 11:00 TU H1028

Magnetisches Schaltverhalten von einzelnen, nanostrukturierten Kobalt-Leiterbahnen — •O. Posth, M. Brands und G. Dumpich — Experimentalphysik, AG Farle,
Universität Duisburg-Essen (Standort Duisburg), Lotharstr. 1, 47048 Duisburg

Es wurde der Magnetowiderstand von dünnen Co-Leiterbahnen bei tiefen Temperaturen untersucht. Die Co-Leiterbahnen sind mittels eines 3-Schritt Elektronenstrahllithographieprozesses (EBL) mit nichtmagnetischen Kontakten versehen worden. Die Leiterbahnen oxidieren unter Atmosphäreneinfluss oder wurden zum Schutz vor der Oxidation in-situ mit Kohlenstoff oder Platin abgedeckt.

Die Magnetowiderstandmessungen zeigen in transversaler und vertikaler Geometrie einen negativen Magnetowiderstand, der auf dem anisotropen Magnetowiderstand (AMR) beruht. Mit Hilfe der longitudinalen Magnetowiderstandsmessung lassen sich in Abhängigkeit von Schichtdicke und Abdeckschicht verschiedene Umschaltprozesse unterscheiden. Das bei nicht abgedeckten Co-Leiterbahnen beobachtete Domänenwandpinning kann durch die verwendeten Abdeckschichten verhindert werden.

Diese Arbeit wird von der DFG im Rahmen des SFB 491 gefördert.

MA 23.4 Di 11:15 TU H1028

Disorder-induced resistive anomaly near ferromagnetic phase transitions — •Carsten Timm[1], M.E. Raikh[2], and Felix von Oppen[1] — [1]Institut für Theoretische Physik, Freie Universität Berlin — [2]Department of Physics, University of Utah, Salt Lake City, U.S.A.

The resistive anomaly in disordered itinerant ferromagnets has a long history, dating back to the first observation by Gerlach in 1932. In 1968, Fisher and Langer proposed a theory for this anomaly based on anomalous scaling. We show that the resistivity $\rho(T)$ can exhibit a *stronger* singularity than predicted in that work. Close to the Curie temperature T_c the correlation length becomes large compared to the mean free path. Then, the quenched disorder is probed by *diffusive* carriers, which requires one to go beyond the Boltzmann description used in all previous works. Our approach combines ideas from the theory of random media and from mesoscopic physics. Specifically, we find that $d\rho/dT$ scales as $|T-T_c|^{-1/2}$ assuming Gaussian magnetic fluctuations. Our results are relevant for ferromagnets with low T_c, such as $SrRuO_3$ or diluted magnetic semiconductors, whose mobility near T_c is limited by disorder.

MA 23.5 Di 11:30 TU H1028

Grain-boundary transport in polycrystalline ferromagnetic manganites with varied T_C — •R. B. Gangineni, K. Dörr, K. Nenkov, K. -H. Müller, and L. Schultz — IFW Dresden, PB 270116, 01171 Dresden

The grain-boundary magnetoresistance of several (non-textured) polycrystalline half-metallic manganites $La_{0.7}A_{0.3}(Mn,B)O_3$ (A = Sr, Pb, Ca; B = Ti, Ta, W)due to spin-polarized second-order tunneling was systematically investigated.The dependence of electrical conductance G(H) on larger applied magnetic fields(μ_0H > 1 T, above technical saturation of magnetization) can be described by a quadratic polynomial for all samples. $La_{0.7}Sr_{0.3}MnO_3$and $La_{0.6}Pb_{0.4}MnO_3$ with high Curie temperatures T_C werefound to show nearly linear field dependence of magnetoconductance, while other samples exhibit a more or less pronounced quadratic magnetoconductance term. Linear magnetoconductance in large magnetic fields up to 50 T indicates second-order tunneling and proves strong antiferromagnetic interactions of grain boundary magnetic moments [1].Interestingly, the linear magnetoconductance term decreases systematically with increasing T_C for 150 K $<T_C<$ 365 K.

[1] N. Kozlova et al., Physica B 346, 74 (2004)

MA 23.6 Di 11:45 TU H1028

Scanning laser microscopy studies of tunneling magnetoresistance in artificial $La_{2/3}Ca_{1/3}MnO_3$ grain boundaries — •T. Nachtrab[1], M. Wagenknecht[1], H. Eitel[1], M. Zaiser[1], R. Kleiner[1], D. Koelle[1], J.-B. Philipp[2], and R. Gross[2] — [1]Physikalisches Institut - Experimentalphysik II, Universität Tübingen, 72076 Tübingen — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching

It is widely believed that an artificial grain boundary (GB) in a manganite film, made e.g. by growing the film on a bicrystal substrate, can act as a tunneling barrier for the spin polarized current below T_{Curie}. However, the TMR effect in these devices can be strongly influenced by the formation of magnetic microdomains along the GB.

By means of low temperature scanning laser microscopy (LTSLM), we imaged the tunneling conductance distribution along the GB in a $La_{2/3}Ca_{1/3}MnO_3$ film grown on a 24° bicrystal $SrTiO_3$ substrate. Our images can be interpreted as a map of the relative orientations of adjacent microdomains at both sides of the GB. Careful ramping of the applied magnetic field enables us to directly observe the growth of the magnetic microdomains at low temperature ($T \approx 10\,\text{K}$). In addition, due to the spatial resolution of the LTSLM ($\approx 2\,\mu$m), we are able to reconstruct the T dependence of the GB resistance, R_{GB}. It increases with T up to $T_{max} \approx 130\,\text{K}$ and then decreases. However, it remains at a relatively high level even above T_{Curie} ($\approx 220\,\text{K}$). This gives strong evidence that the GB behaves as a barrier also in the paramagnetic phase of the manganite film suggesting a tunneling transport mechanism.

MA 23.7 Di 12:00 TU H1028

Magnetoresistance in CoFeHfO oxide films — •Yuansu Luo, Markus Esseling und Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich- Hund Platz 1, 37077 Göttingen

Oxide films $[Co_{55}Fe_{25}Hf_{20}]_{1-x}O_x$ were prepared by reactive sputtering and characterized by XRD, magnetic and electrical measurements, including XPS analysis to determine the oxygen amount x. For $x < 0.1$, the films are homogeneous and amorphous, showing excellent soft magnetic properties. These films were used as magnetic electrode layers in magnetotunneling junctions to simplify the oxidation process for the barrier fabrication. For large x, a chemical phase separation occurs. The films consist of two interconnected amorphous phases with dominated atomic correlation Hf-O and Co-Co(Fe) and become paramagnetic-like and insulating at low temperatures. A large magnetoresistance (MR) effect which increases with x has been observed in these films. For x=0.4, the MR value is 12 % at RT and 22 % at 10 K (7 T). The effect is similar to that observed in granular systems and related to spin dependent scattering. The large MR effect at low temperatures could be attributed to spin dependent tunneling effect across the HfO_x phase.

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MA 23.8 Di 12:15 TU H1028

Local Anisotropic Magnetoresistance Simulations and Measurements — •Markus Bolte, Marcus Steiner, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

Understanding magnetoresistance effects in ferromagnetic nanostructures is prerequisite for the development of magnetoelectronic devices such as read–heads for magnetic storage media, magnetic random access memory cells, and prospective semiconductor/ferromagnet hybrid devices. A spatially resolved picture of magnetoresistance effects allows an accurate prediction and control of the behavior of such devices. We have extended the code of one of the standard micromagnetic simulation frameworks, OOMMF, to simulate the influence of the local anisotropic magnetoresistance (AMR) on the total resistance of micrometer sized permalloy rectangles of varying thicknesses [1]. We compared the results with AMR-measurements done on permalloy ($Ni_{83}Fe_{17}$) samples with similar geometry. The simulated magnetization configurations and the concomitant magnetoresistances are in good agreement with the magnetic states observed in magnetic-force microscopy and resistance measurements. Finite–element calculations yield the local current density resulting from changes in resistance due to AMR [2].

[1] M. Steiner, C. Pels, M. Barthelmess, M. Bolte, U. Merkt, and G. Meier, to be published.

[2] M. Holz, O. Kronenwerth, and D. Grundler, Phys. Rev. B **67**, 195312 (2003).

MA 23.9 Di 12:30 TU H1028

Field dependence of colossal magnetoresistance in magnetic fields up to 50 T — •N. Kozlova, K. Dörr, K.-H. Müller, P. Reutler, R. Klingeler, B. Büchner, and L. Schultz — IFW Dresden, Postfach 270116, 01171 Dresden

The magnetoresistance of $La_{0.7}Sr_{0.3}MnO_3$ and $La_{0.7}Ca_{0.3}MnO_3$ epitaxial films and of a $La_{0.75}Ca_{0.25}MnO_3$ single crystal were investigated in pulsed magnetic fields up to 50 T over a wide temperature range. The Brillouin scaling model of Refs. [1] and [2] based on Mott hopping of electrons between magnetic clusters has been applied to analyze the magnetoresistance data. It has been shown that this model works well a) in the paramagnetic state above T_C and b) in a low temperature window ($0.2 < T/T_C < 0.9$). Near the ferromagnetic transition temperature T_C systematic deviations, in particular in larger fields, indicate that the model fails there, since neither the field dependence of magnetization nor resistance follows a Brillouin function. The temperature-dependent average magnetic moment of clusters is similar for all of our samples, but differs essentially from that obtained earlier for half-doped manganites.

[1] P. Wagner et. al., Phys. Rev. B 55 (1997) 3699.

[2] P. Wagner et. al., Phys. Rev. Lett. 81 (1998) 3980.

MA 23.10 Di 12:45 TU H1028

Transport properties of PCMO in magnetic and electrical fields — •Wilko Westhäuser und Christian Jooss — Institut für Materialphysik, Universität Göttingen

$Pr_{0,68}Ca_{0,32}MnO_3$ (PCMO) is very sensitive to certain external perturbations inducing a phase transition from a charge-ordered antiferromagnetic state to a charge-delocated ferromagnetic state. We investigate the electric field driven phase transition in comparison to the well-known colossal drop in resistance caused by an applied magnetic field (CMR) in several samples: poly-crystalline sintered pellets and epitaxial, laser-deposited thin films on single-crystalline SrTiO3- and MgO-substrates. In These samples we find significant differences in the metal-insulator (MI) transition which are due to strain and lattice defects. Evidences that the MI transition driven by electric fields is localized in a filamentary path are presented.