MA 22 Magnetische dünne Schichten IV

Zeit: Dienstag 10:30–13:00 Raum: TU H1012

MA 22.1 Di 10:30 TU H1012

Element-specific characterization of Co_2MnGe/Au interfaces by XRMS — •Andre Bergmann, Johannes Grabis, Alexei Nefedov, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik IV, Ruhr-Universität Bochum

Sputtered superlattices of the Heusler compound Co_2MnGe with Au as spacer layer are studied by x-ray resonant magnetic reflectivity and diffuse scattering. Reflected intensities for both magnetic field directions in the longitudinal magneto-optical Kerr geometry were measured as a function of the photon energy at the first three superlattice reflections in the Co and Mn $L_{2,3}$ absorption edge regions. Both, intensities and the corresponding asymmetries are simulated within a magneto-optical approach in order to determine an element-specific magnetization depth profile. Magnetically dead layers of up to 1 nm thickness are found at the Co_2MnGe/Au interface explaining the relatively low magnetic moment observed in these systems. Resonant diffuse scattering yields information on the chemical and magnetic interface morphology. The in-plane correlation lengths of chemical and magnetic roughness are almost identical and correspond to the Co_2MnGe crystallite size.

MA 22.2 Di 10:45 TU H1012

Morphology, structure and magnetic properties of Ni_xMn_{1-x} and Ni_xMn_{1-x}/Co bilayers grown on Cu(001) — •C. Tieg[1], S. Wang[1], W. Kuch[1,2], and J. Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle — [2]present address: Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin

Thin films of Ni_xMn_{1-x} were epitaxially grown by thermal evaporation on Cu(001) and studied with respect to their morphology, structure, and magnetic properties by means of electron diffraction techniques and magneto-optic Kerr effect measurements. A 2-dimensional growth mode has been verified for coverages up to 15 monolayers (ML) by the presence of MEED oscillations within the composition range of $0.4 < x < 1.0$. While chemically disordered Ni-rich and Mn-rich films exhibit a p(1×1) structure, films in the equiatomic region display a characteristic c(2×2) superstructure for thicknesses within the studied range of up to 18 ML that might be attributed to an ordered $L1_0$ phase as it is present in bulk NiMn. Furthermore, the interlayer spacing d was deduced from a kinematic analysis of LEED I(V) curves taken at thick Ni_xMn_{1-x} films (>10 ML). We obtain a continuously decreasing d from 1.92 ± 0.02 Å for highly Mn-rich films to 1.73 ± 0.02 Å for tetragonally distorted pure Ni films. The lattice constants of Ni_xMn_{1-x} and Cu(001) coincide at $x \approx 0.6$. Magnetic properties were studied for Ni_xMn_{1-x} films in contact with a ferromagnetic layer. The presence of antiferromagnetic order in equiatomic NiMn films at T=300 K above a certain thickness is indicated by a pronounced coercivity enhancement in Co/NiMn bilayers.

MA 22.3 Di 11:00 TU H1012

Electrical and magnetic effects in multi-ferroic (La,A)MnO_3 / PZT bilayers — •C. Thiele[1], K. Dörr[1], J.-W. Kim[1], W.-M. Lin[2], and L. Schultz[1] — [1]IFW Dresden, PB 270116, 01171 Dresden — [2]IFE, TU Dresden, Mommsenstr. 13, 01062 Dresden

Magnetic and electrical properties of conducting ferromagnetic manganites $La_{1-x}A_xMnO_3$ (A= Sr, Ca, Ce) crucially depend on the charge carrier density usually controlled by doping level x. Earlier it was suggested to control epitaxial strain of thin manganite films using the piezoelectric effect of a ferroelectric $Pb(Zr,Ti)O_3$ (PZT) toplayer [1], however, an electrical field effect seems to be dominant in this type of bilayer structure. Off-axis pulsed laser deposition has been applied to epitaxially grow manganite/PZT bilayers. An electrical voltage applied to the PZT layer in bilayer structures leads to hysteretic modulation of the manganite layer resistance which has been studied in dependence on magnetic field, temperature and manganite layer thickness. The phenomenon is discussed in the framework of a field effect modulating the carrier density of the manganite. Further, magnetization, ferroelectrical polarization and piezoresponse measurements are shown.

This work is supported by DFG, FOR 520.

[1] H. Tabata et al., IEICE Trans. Electron. E80-C (1997) 918

MA 22.4 Di 11:15 TU H1012

Correlation of ferromagnetic resonance modes and domain structure in patterned ferromagnetic films — •ute queitsch[1], Jeffrey McCord[1], Rudolf Schäfer[1], Ludwig Schultz[1], Karsten Rott[2], and Hubert Brückl[2] — [1]Leibniz Institut für Festkörper- und Werkstoffforschung (IFW), Helmholtzstraße 20, 1069 Dresden — [2]Universität Bielefeld, Lehrstuhl für Dünne Schichten und Nanostrukturen,Universitätsstrasse 25,33615 Bielefeld

Understanding the high frequency (hf) magnetic response of patterned soft magnetic thin films is crucial for hf applications, e.g. integrated micro-inductors. Arrays of single and bi-layer $Ni_{81}Fe_{19}$ and CoZrTa thin film elements (100 μm x 50 μm x 80 nm) were fabricated. The hf response was characterized by pulsed inductive microwave magnetometry (PIMM) and directly compared to the magnetic domain structure, analyzed by magneto-optical Kerr microscopy in the longitudinal mode. By varying the magnetic field history different ‚virgin' domain states were adjusted. Depending on the micromagnetic structure, characteristic changes in the hf response were observed. It was found that the presence of domains causes a drastic increase in the dominating ferromagnetic resonance frequency of the films due to an accompanied stiffening of its magnetization. With increasing domain density, a decrease in hf permeability for the same sample is observed. Domain wall effects during the dynamic remagnetization process lead to additional frequency modes in the sub-GHz range.

MA 22.5 Di 11:30 TU H1012

Ultrathin antiferromagnetic films on a ferromagnetic substrate: A first-principles study of Mn on Fe(001) — A. Ernst[1], •J. Henk[1], P. Bruno[1], and R. K. Thapa[2] — [1]MPI für Mikrostrukturphysik, Halle/S., Germany — [2]Pachhunga University College, Mizoram University, India

The electronic and magnetic structures of Mn films with thicknesses of up to 12 monolayer on Fe(001) is investigated by means of first-principles calculations, with a focus on the thicker films. The Mn films show a layer-by-layer antiferromagnetic structure and couple antiferromagnetically to the Fe substrate. The magnetic moments at the Mn surface and at the Mn-Fe interface are significantly enhanced, as compared to the respective bulk values. Several surface states are found at the center of the two-dimensional Brillouin zone, some of which might explain recent experimental scanning-tunneling-spectroscopy results [1].

[1] T. K. Yamada, M. M. J. Bischoff, G. M. M. Heijnen, T. Mizoguchi, and H. van Kempen, Phys. Rev. Lett. (2003) **90** 056803.

MA 22.6 Di 11:45 TU H1012

Ferromagnetic Cr and antiferromagnetic Co: Unexpected magnetism of 3d transition-metal monolayers on W(001) — •Paolo Ferriani[1], Stefan Heinze[1], Gustav Bihlmayer[2], and Stefan Blügel[2] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 9a, 20355 Hamburg — [2]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

In the past, first-principles calculations of 3d transition-metal monolayers on (001) surfaces of non-magnetic metals have led to the conclusion that the early 3d metals V, Cr, and Mn possess a c(2 × 2) antiferromagnetic (AFM) ground state while Fe, Co, and Ni are ferromagnetic. For Fe on W(001), however, first-principles calculations so far remained non-conclusive while experiments could not find any magnetic order. Here, we present density-functional theory based calculations of 3d transition-metal monolayers on W(001) using the full-potential linearized augmented plane wave (FLAPW) method. Surprisingly, the normal trend is inverted, i.e. V, Cr and Mn are ferromagnetic while Fe and Co are c(2 × 2) antiferromagnetic on W(001). Ni is non-magnetic. Recently, the AFM ground state of Fe has been confirmed experimentally by spin-polarized scanning tunneling microscopy [1].

[1] A. Kubetzka, P. Ferriani, *et al.*, submitted for publication.

See also talk by A. Kubetzka *et al.* at this DPG meeting.

MA 22.7 Di 12:00 TU H1012

Reorientation of spin-density waves in Cr films induced by proximity effects of vanadium — •H. Zabel[1], E. Kravtsov[1], A. Nefedov[1], A. Remhof[1], F. Radu[1], B. Hjörvarsson[2], A. Hoser[3], and G.J. McIntyre[4] — [1]Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]Department of Physics, Uppsala University, Box 530, S-75121 Uppsala, Sweden — [3]Institut für Kristallographie, RWTH-Aachen, D-52056 Aachen, Germany — [4]Institut Laue-Langevin, F-38042 Grenoble Cedex 9, France

The spin density wave (SDW) magnetism in Cr implies a periodic and usually incommensurate modulation of the magnetization vector in real space. In thin films, the SDW is confined and therefore the spontaneous formation of the SDW due to the Fermi surface nesting competes with hybridization effects of adjacent ferro- or paramagnetic layers, with interfacial structures (order and disorder), and with dimensionality effects (film thickness). We report on neutron scattering studies from proximity effects of neighbouring vanadium layers on the SDW in epitaxial Cr(001) films. We provide direct evidence for long-range effects from the V/Cr interface, leading to changes in the polarization and propagation direction of the SDW in rather thick Cr films. The Néel temperature is found to be affected by boundary conditions for the spin-density waves at V/Cr interfaces. - This work is supported by DFG-SFB 491: Magnetic Heterostructures.

MA 22.8 Di 12:15 TU H1012

MODIFICATION OF THE SPIN DENSITY WAVE OF CR IN FE/CR MULTILAYERS BY INSERTION OF SN — •Dieter Lott[1], Danica Solina[1], Mohamed Almokhtar[2], Ko Mibu[3], Jörg Dudek[4], Wolfgang Schmidt[5] und Andreas Schreyer[1] — [1]GKSS Research Center, Max Planck Str.1, D-21502 Geesthacht, Germany — [2]Physics Department, Assiut University, Assiut, Egypt — [3]Research Center for Low Temperature and Materials Sciences, Kyoto University, Uji, Kyoto, 611-011, Japan — [4]Institut für Experimentalphysik/Festkörperphysik, University Bochum, D-44780 Bochum, Germany — [5]Institut Laue Langevin, 38042 Grenoble, France

Recently, the SDW behavior of Cr in Fe/Cr/Sn/Cr multilayers was studied by Moessbauer spectroscopy [1]. The monolayer (ML) of Sn inserted into the Cr layers serves as a Moessbauer probe permitting the study of the magnetic local environment around Sn providing details about of the magnetic stucture of Cr. In this work, complimentary neutron diffraction studies were carried out on a set of Fe/Cr(t) and Fe/Cr(t/2)/Sn(2Å)/Cr(t/2) multilayers with t=80Åand t=160Å. Here, the magnetic order of the Cr layers was examined, systematically comparing the systems with and without Sn inserted in the Cr layers. The multilayers with Sn show drastic changes in the diffraction pattern for both Cr thicknesses. Using polarized neutron diffraction and reflectivity combined with the information obtained by SQUID measurements enable us to connect the spin orientation of the Cr and Fe moments to the changes in the SDW behavior. [1] M. Almokhtar et al., Phys. Rev. B 66, 134401 (2002)

MA 22.9 Di 12:30 TU H1012

Strukturrechnungen zur Spindichtewelle von Cr in Fe/Cr/Sn/Cr — •Alexander Grünwald, Dieter Lott und Andreas Schreyer — GKSS-Forschungszentrum Geesthacht, D-21502 Geesthacht

Das Verhalten der Spindichtewelle von Cr in Fe/Cr-Multilayern ist ein Gebiet intensiver Forschung. Kürzlich wurde gezeigt, dass das Einfügen einer zusätzlichen Monolage Zinn inmitten der Cr-Schicht zu deutlichen Modifikationen des SDW Verhaltens führt. Um diese Veränderungen qualitativ und quantitativ beschreiben zu können, wurden die durch unpolarisierte Neutronenbeugung gewonnenen Streubilder der Systeme Fe/Cr und Fe/Cr/Sn/Cr mittels kinetischer Streutheorie simuliert. Anhand dieser Strukturberechnungen lassen sich klare Aussagen über die Periode und die Phase der SDW sowie über die magnetische Korrelation machen. Dabei zeigt sich, dass die Erhöhung des Cr-Momentes an der Cr/Sn-Grenzfläche für die Phase der SDW von großer Bedeutung ist.

MA 22.10 Di 12:45 TU H1012

Charakterisierung der dynamischen Spinstruktur von Anisotropie-induzierten antiferromagnetisch gekoppelten Fe/Cr-Multilayern mit Hilfe von Kernresonanzstreuung in streifendem Einfall — •Kai Schlage[1], Ralf Röhlsberger[2], Torsten Klein[1] und Olaf Leupold[2] — [1]Universität Rostock, August-Bebel-Strasse 55, 18055 Rostock — [2]HASYLAB bei DESY, Notkestrasse 85, 22607 Hamburg

In diesem Experiment untersuchen wir die Austauschkopplung eines antiferromagnetisch gekoppelten Fe/Cr-Multilayers mit einer hartmagnetischen FePt-Schicht, die eine uniaxiale Anisotropie aufweist. Die Untersuchungsmethode ist die Kernresonanzstreuung in streifendem Einfall an dem Mössbauerisotop ^{57}Fe [1]. Die hartmagnetische Schicht induziert in den gesputterten, polykristallinen ^{57}Fe/Cr-Vielfachschichten eine magnetische Anisotropie. Diese ist Voraussetzung für das Auftreten von magnetischen Reorientierungsphänomenen wie dem bulk spin-flop [2,3]. Wir verwenden spekulare und off-spekulare Reflektometrie zur Detektierung des bulk spin-flops sowie zur Bestimmung der magnetischen Domänenstruktur in diesem neuartigen System. Zusätzlich ermöglicht die Kernresonanzstreuung an Probensystemen mit nur einer ^{57}Fe-Sensorschicht die direkte Bestimmung der dynamischen Magnetisierung von einzelnen Eisenschichten.

[1] R. Röhlsberger, J. Bansmann, V. Senz, K. L. Jonas, A. Bettac, K. H. Meiwes-Broer und O. Leupold, Phys. Rev. B 67, 245412 (2003) [2] V. Lauter-Pasyuk et al., Phys. Rev. Lett. 89, 127203 (2002) [3] U. K. Rößler und A. N. Bogdanov, Phys. Rev. B 69, 094405 (2004)