MA 24 Oberflächenmagnetismus

Zeit: Dienstag 10:30–12:30 Raum: TU A060

MA 24.1 Di 10:30 TU A060

Resonant x-ray emission applied to Mn-based Heusler alloys — •Max Theodor Kuchel[1], Jürgen Braun[1], Markus Donath[1], and Mikhail Yablonskikh[2] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität Münster,Wilhelm-Klemm-Str. 10, 48149 Münster — [2]Department of Physics and Engineering Physics, University of Saskatchewan, Canada

We present resonant x-ray emission spectra calculated for a series of different Mn-based Heusler alloys. The fully relativistic calculations are based on the well known Kramers- Heisenberg formula [1] which describes second order optical excitation processes. The initial, intermediate and final states appearing in this formula were derived by use of the tight-binding linear muffin-tin orbitals method [2]. Comparing our theoretical spectra with corresponding experimental data we found a good agreement.

[1] A. Kotani, Rev. Mod. Phys. **73**, 203 (2001)
[2] O. K. Andersen and O. Jepsen, Phys. Rev. Lett. **53**, 2571 (1984)

MA 24.2 Di 10:45 TU A060

The effect of chemical disorder on the empty electronic states of NiMnSb — •Jürgen Braun[1], Hristo Kolev[1], Georgi Rangelov[1], Markus Donath[1], Sven Borneman[2], Jan Minar[2], and Hubert Ebert[2] — [1]Physikalisches Institut, Westfälische-Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster — [2]Institut für Physikalische Chemie, Ludwig-Maximilians-Universität München, Theresien Str. 37-41, 80333 München

The empty electronic states of the half-metallic semi Heusler alloy NiMnSb have been investigated by spin-resolved Appearance Potential Spectroscopy (SRAPS). Compared to fully relativistic SRAPS calculations our measurements reveal an unexpected low spin-polarization. To understand the physical origin of this discrepancy we performed a quantitative theoretical analysis of the influence of chemical disorder on the unoccupied density of states (DOS). Our theory describes the spectra as the self-convolution of the matrix-element weighted, orbitally-resolved unoccupied DOS, which was calculated by use of the ab-initio Coherent Potential Approximation (CPA) method.

MA 24.3 Di 11:00 TU A060

Ultrathin Ni films grown with O surfactant: Structure and Magnetism — •C. Sorg, N. Ponpandian, A. Scherz, R. Nünthel, T. Gleitsmann, K. Baberschke, and H. Wende — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin-Dahlem, Germany

We have studied ultrathin Ni films grown on Cu(100) and Cu(110) with and without O surfactant using element specific XAS and XMCD at the O K edge as well as at the Ni $L_{2,3}$ edges [1]. The O surfactant improves the growth mode of these films towards a better layer-by-layer growth and leads to a reduced surface roughness [2]. Since the O surfactant reduces also the surface anisotropy energy, the spin reorientation transition is shifted to a lower Ni thickness on Cu(100) [3]. On the more open and anisotropic Cu(110) surface an out-of-plane phase exists only if O is present on the Ni films. By means of XAS, we give final evidence that no bulk-like NiO is formed and that the O stays on top of the Ni films. We observe a charge transfer from Ni to O states. With XMCD we investigate the Ni orbital and spin moments. On the Cu(100) surface the total Ni magnetization of thinner films is reduced compared to the bulk. In contrast, on Cu(110) we observe an enhancement which is mainly carried by the orbital moment. Finally, we determine an induced magnetic orbital moment of the oxygen parallel to the one of Ni by analyzing the XMCD at the O K edge. – Supported by BMBF (05 KS4 KEB 5).

[1] C. Sorg *et al.*, Surf. Sci. **565**, 197 (2004).
[2] R. Nünthel *et al.*, Surf. Sci. **531**, 53 (2003); *ibid.* **566-568**, 100 (2004).
[3] J. Hong *et al.*, Phys. Rev. Lett. **92**, 147202 (2004).

MA 24.4 Di 11:15 TU A060

Tunable Magnetic Properties of Nanocrystalline Pd-Ni Alloy — •Sadhan Ghosh[1], Christian Lemier[1], Jörg Weissmüller[1,2], and Viswanath Raghavan Nadar[1] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, Karlsruhe — [2]Fachrichtung Technische Physik, Universität des Saarlandes, 66041 Saarbrücken

Ferromagnetism is strongly related to the electronic structure density, therefore it is interesting to study how far one can modify the magnetic order of solids by changing their electron density. While this is usually done by alloying, one can also change the charge density reversibly by inducing space−charge regions at surfaces. This is particularly interesting in nanostructured materials, since the high surface to volume ratio maximizes the effect of the local property changes on the macroscopic materials behaviour [1]. It has been demonstrated that the polarized nanoporous metals exhibit large volumetric expansion and contraction in phase with the applied electrode potential [2]. In the present work, we report the variation of the magnetic moment of charged nanocrystalline Pd−Ni alloy, produced by the inert−gas condensation method, by in−situ magnetization experiments. We discuss the relative variation of charge−induced magnetization by changing the alloy composition as well as changing the electrochemical environment. [1] Gleiter H., Weissmüller J., Wollersheim O., Würschum R. Acta mater. 49 (2001), 737; [2] Weissmüller, J., Viswanath, R.N., Kramer, D., Zimmer, P., Würschum, R., Gleiter, H. Science 300 (2003), 312.

MA 24.5 Di 11:30 TU A060

Bias dependence of the spin polarized tunneling current between a ferromagnetic tip and antiferromagnetic surfaces — •U. Schlickum, C. L. Gao, W. Wulfhekel, J. Henk, P. Bruno, and J. Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle

In spin-polarized scanning tunneling microscopy (Sp-STM) measurements the spin dependent tunneling current is used to image magnetic structures on the nanometer scale. Spin sensitivity is achieved by the tunneling magnetoresistance effect, i.e. the tunneling current depends on the relative orientation of the magnetization of the tip and sample spin. Besides the possibility to image magnetic structures, this technique allows the investigation of the spin dependent tunneling through a well defined tunneling barrier (vacuum gap). In our contribution, we present Sp-STM measurements performed on ultra-thin antiferromagnetic Mn and Cr films on Fe(001). Both systems show a layer-wise antiferromagnetic order at the surfaces [1, 2]. We found that the size and the sign of the spin contrast, i.e. the difference in the tunneling current between oppositely spin polarized layers, depends on the bias voltage. For Cr, a strong increase of the spin contrast close to a spin polarized surface state was measured. For Mn, we observed, however, a rather complex dependence which can be explained with model calculations based on ab-initio band structures.

[1] U. Schlickum, N. Janke-Gilman, W. Wulfhekel, and J. Kirschner, Phys. Rev. Lett. 92, 107203 (2004). [2] D. T. Pierce, J. Unguris, R. J. Celotta, and M. D. Stiles, J. Magn. Magn. Mater. 200, 290 (1999).

MA 24.6 Di 11:45 TU A060

Temperature-dependent exchange splitting of image-potential states in front of a magnetic surface — •Martin Pickel[1], Anke Schmidt[2], Martin Wiemhöfer[1], Markus Donath[1], and Martin Weinelt[3] — [1]Physikalisches Institut, Universität Münster, Wilhelm-Klemm Str. 10, 48149 Münster — [2]Lehrstuhl für Festkörperphysik, Staudtstr. 7, 91058 Erlangen — [3]Max-Born-Institut, Max-Born-Str. 2A, 12489 Berlin

Electrons excited to image-potential states can be used as sensors for various surface properties. For example, an exchange-split bulk bandstructure, leads to spin-dependent binding energies of the image-potential states [1]. This allows to study magnetic properties and related electron dynamics at ferromagnetic surfaces. By spin-resolved two-photon photoemission we studied ultrathin iron films on Cu(001). The exchange splitting of the image-potential states is directly resolved for the n=1 and n=2 states. With increasing temperature the splitting is reduced and vanishes at the Curie temperature. The decrease in spin polarization with increasing temperature is found to be proportional to the splitting. The linewidths of the image-potential states are spin dependent and indicate spin-dependent lifetimes. With increasing temperature the difference in linewidth declines in accordance to the lowering of the spin-splitting. This behaviour reflects the change in the electronic structure of the Fe films. The observed collapse of the exchange splitting with temperature and the temperature behaviour of the linewidths are discussed particularly with regard to the simple Stoner picture.

[1] F. Passek and M. Donath, Phys. Rev. Lett. **69**, 1101 (1992)

MA 24.7 Di 12:00 TU A060

Spin-polarized scanning tunneling microscopy of ultrathin Fe/Mo(110) films — •J. Prokop, A. Kukunin, and H.J. Elmers — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz

We report on magnetic contrast observed by low-temperature (5 K) spin-resolved scanning tunnelling microscopy (SP-STM) of Fe nanowires deposited on a Mo(110) single crystal. Magnetic information is obtained from the conductivity map. Magnetic contrast is achieved using tungsten tips covered by Au/Co thin films. The W tips were flashed at $\sim$ 2000 K, and subsequently covered by 10 ML thick Au and Co layers at RT. Due to the spin reorientation transition of Co films on Au an out-of-plane magnetic sensitivity is obtained for thin cobalt films, while for thicker Co coverages an in-plane magnetization component can be probed. The iron nanowires were prepared by step flow growth onto the Mo(110) substrate kept at 700 K during molecular beam epitaxy (MBE) in ultra high vacuum (UHV). We find that the 1 ML thick ferromagnetic Fe nanowires reveal a magnetization perpendicular to the surface [1]. Double layer (DL) nanowires show a perpendicular easy axis, too. Due to the dipolar coupling adjacent nanowires are mostly antiparallely magnetized. The domain wall width observed in DL stripes is $\sim$ 3 nm, similar to the width observed in ML stripes [1]. The reorientation of the tip sensitivity axis was confirmed by SP-STM measurements of thicker Fe/Mo(110) films.

[1] M. Bode et al., Phys. Rev. Lett. 92, 067201 (2004).

MA 24.8 Di 12:15 TU A060

Growth and electronic properties of thick films and pyramidal islands of Dy/W(110) studied by STM/STS — •Luis Berbil-Bautista, Stefan Krause, Torben Hänke, Matthias Bode, and Roland Wiesendanger — Institut of Applied Physics, University of Hamburg, Jungiusstraße 11, Germany

The magnetic structure of bulk Dysprosium (Dy) exhibits two phase transitions with decreasing temperature T: from paramagnetic to helimagnetic at $T_{\mathrm{N}} = 178\,\mathrm{K}$ and from helimagnetic to ferromagnetic at $T_{\mathrm{C}} = 85\,\mathrm{K}$ [1]. The helimagnetic phase is particularly interesting as the turn angle between two adjacent basal (0001) planes Dy varies between 43° at T_{N} and 26° at T_{C} [2].

The magnetic structure of the Dy(0001) surface is basically unknown. Since it is almost impossible to clean Dy bulk crystals we have studied the growth and electronic structure of Dy films on W(110) by STM and STS, respectively. In agreement with Wegner *et al.* [3] our tunneling spectra are dominated by a double-peak structure which originates from an exchange-split d-derived surface state. The exchange splitting amounts to 500 meV at $T = 20\,\mathrm{K}$.

By an appropriate variation of the substrate temperature during growth stepped-pyramidal islands were prepared. These islands may be suitable for an investigation of the surface helimagnetic turn angle as numerous different atomic planes are exposed to the surface.

[1] D.R. Behrendt *et al.*, Phys. Rev. **109**, 1544 (1958).
[2] M.K. Wilkinson *et al.*, J. Appl. Phys. **32**, 48S (1961).
[3] D. Wegner *et al.*, to be published.