O 7: Spin-Orbit Interaction at Surfaces I

Time: Monday 11:15–12:45 Location: H38

O 7.1 Mon 11:15 H38

Spin filtering by Self-Assembled Organic Monolayers on gold — •Benjamin Göhler[1], Volker Hamelbeck[1], Matthias Kettner[1], Georg F. Hanne[1], Helmut Zacharias[1], and Ron Naaman[2] — [1]Physikalisches Institut, Universität Münster — [2]Department of Chemical Physics, The Weizmann Institute, Israel

Electron dichroism has been reported for vapours of chiral molecules [1]. Because of different interactions of spin-polarized electrons with chiral molecules the attenuation of polarized electron beams depends on the helicity of the electrons. Similarly the photoelectron yield of gold covered with organized organic thin films of chiral molecules shows a dependence on the circular polarization of the incident light, because the spin polarized photoelectrons of the gold substrate interact differently with the thin film [2]. In this presentation we show that these photoelectrons are in fact spin-polarized. Photoelectrons are emitted by 210 nm (5.9 eV) laser radiation which is sufficient to emit photoelectrons of the gold substrate but not to ionize the molecules of the organic layer. The self assembled layer of chiral molecules (ds-DNA) filters the electrons with a spin polarization of about 20%. The spin polarization is measured by a calibrated mini Mott analyzer.

[1] J.Phys.B. 30, 5491, 1997. [2] Science 283, 814, 1999.

O 7.2 Mon 11:30 H38

Spin spirals with unique rotational sense in magnetic thin films: Cr on W(110) — •Bernd Zimmermann[1], Marcus Heide[1,2], Gustav Bihlmayer[1], and Stefan Blügel[1] — [1]Institut für Festkörperforschung (IFF) und Institute for Advanced Simulation (IAS), Forschungszentrum Jülich — [2]Department of Precision Engineering, Osaka University, Japan

Recently [1] for a Mn monolayer on W(110) a new and unexpected magnetic phase was discovered which exhibits a left rotational sense of the magnetization. The origin was explained by the presence of Dzyaloshinskii-Moriya Interaction (DMI) caused by the spin orbit coupling in a symmetry-broken environment of the surface. In this work we present investigations on the magnetic structure of a single Cr layer on W(110) by means of density functional theory (DFT). We perform spin-spiral calculations including SOC and find that the DMI is strong enough to compete with the symmetric exchange interaction to create a spiraling magnetic structure with unique rotational sense. A layer-resolved analysis shows, that the main contribution to the DMI comes from the W interface atoms. Using a micromagnetic model, we determine how far the spin spiral deviates from a perfectly homogeneous solution. We compare our results to the systems Mn/W(110) and Fe/W(110), where the direction of the spin spiral and the period length are different. Our results are confirmed by SP-STM experiments [2].

[1] Bode *et al.*, Nature **447**, 190 (2007)
[2] Santos *et al.*, New J. of Phys. **10**, 013005 (2008)

O 7.3 Mon 11:45 H38

Spin-orbit and exchange interaction of the surface state on Au/Ni(111) — •Andreas Nuber[1], Frank Forster[1], Hendrik Bentmann[1], Jürgen Braun[2], and Friedrich Reinert[1,3] — [1]Experimentelle Physik VII, Universität Würzburg, Germany — [2]Dep. Chemie und Biochemie, LMU München, Germany — [3]Forschungszentrum Karlsruhe, Gemeinschaftslabor für Nanoanalytik, Germany

The surface state of Au(111) is a standard model of spin-orbit Rashba-type splitting, visible in ARUPS as two parabolas shifted in $k_{||}$-direction. On Ni(111), the surface state is split in energy due to exchange interaction. Both interactions are expected to be present on the surface of thin Au films grown on Ni(111). We used high resolution ARUPS to investigate the system Au/Ni(111) for different Au layer thicknesses and compared our experimental data with photoemission calculations based on LSDA and DMFT. Due to the integrating properties of photoemission we could not resolve a combination of spin-orbit and exchange splitting on unmagnetized samples. But magnetizing the Ni(111) substrate in-plane can change this in principle.

O 7.4 Mon 12:00 H38

Spin-polarized topological surface states of topological insulators Bi_2Te_3 and Bi_2Se_3 — •Markus R. Scholz[1], Dmitry Marchenko[1], Andrei Varykhalov[1], Oliver Rader[1], Andrey Volykhov[2], and Lada V. Yashina[2] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie — [2]Department of Chemistry, Moscow State University

The topological insulator has been proposed as new state of quantum matter in 2005 [1]. A gap in the two-dimensional bulk is crossed by one-dimensional states which occur as pairs in which the spin of each partner is connected to its propagation direction. A generalization towards three-dimensional solids predicted topological insulator properties for Bi10%Sb and Bi_2Te_3 [2]. Spin resolution is crucial for distinguishing the topological from ordinary surface states in experiment as was shown for Bi10%Sb [3]. For Bi_2Te_3 only spin-averaged data exists [4]. We grew Bi_2Te_3 and Bi_2Se_3 single crystals by the Bridgeman method and conducted spin- and angle-resolved photoemission. For both systems, the spin-resolved spectra show that the surface state forms a single non-degenerate Dirac cone with the Kramers degeneracy point at $\overline{\Gamma}$. Spin- and angle-resolved spectra above and below the Kramers point and for positive and negative $\mathbf{k}_{||}$ clearly show the spin-momentum relation expected for the surface of a topological insulator.

[1] C. L. Kane and E. J. Mele, Phys. Rev. Lett. 95, 146802 (2005); 226801 (2005) [2] L. Fu and C. L. Kane, Phys. Rev. 76, 045302 (2007) [3] D. Hsieh et al., Science 323, 920 (2009) [4] Y. Xia et al., Nature Phys. 5, 398 (2009)

O 7.5 Mon 12:15 H38

Tight-binding treatment of Dzyaloshinskii-Moriya interaction on surfaces — •Timo Schena[1], Yuriy Mokrousov[1], Phivos Mavropoulos[1], Cyrille Barreteau[2], and Stefan Blügel[1] — [1]Institut für Festkörperforschung and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]CEA Saclay, IRAMIS, SPCSI Bat. 462, F-91191 Gif sur Yvette, France

The Dzyaloshinskii-Moriya interaction (DMI) was recently discovered to be important in determining the magnetic properties of thin films and nanostructures. Little is known about the strength and the sign of DMI as function of the chemical composition. We report the development of a self-consistent, parametrized tight-binding code able to treat bulk-systems, films, one-dimensional structures and clusters of high magnetic complexity. It is optimally designed to study the effects arising due to interplay of non-collinear magnetic order, spin-orbit coupling and broken symmetries at surfaces. The self-consistency is based on a simple Stoner model and consideration of the Mulliken-charges of each atom for charge neutrality. To demonstrate the applicability of the developed method we investigate the occurrence of DMI in 3d transition-metal overlayers on substrates of heavy elements.

O 7.6 Mon 12:30 H38

In-situ UPS studies into hydrogen terminated surface of amorphous carbon films and its direct effects on electron emission — •Daniel Chua — National University of Singapore, Singapore

The effects of hydrogen terminated surface of single crystal diamond are well known. This imparts unique properties such as p-type transfer doping and enhanced surface conductivity to the diamond films. In this work, the effects of surface hydrogenation on non-hydrogenated tetrahedral amorphous carbon (ta-C) films are systematically studied and for the first time, we report that the hydrogen termination directly leads to a lowering of the turn-on field for ta-C films, resulting in electron emission from an ultra-smooth thin film without any pre-conditioning process. Prior, HREELS confirmed the presence of C-H bonds on the surface after microwave plasma CVD system was used to hydrogenate the surface of the ta-C films. In-situ UPS shows the hydrogen terminated surface reduces the work function by > 1 eV and is highly stable up to 600oC. Surface roughness from an AFM shows minimal changes to the morphology during the various process. Enhancement effects are distinctly observed when the surface hydrogenated ta-C films are directly tip-coated on vertically aligned carbon nanotubes. These hybrid core-shell structures have potential applications as cold cathode source due to the very low turn-on field.