O 32: Electronic structure of surfaces: Spectroscopy, surface states I

Time: Tuesday 14:00–15:30 Location: MA 004

O 32.1 Tue 14:00 MA 004

Soft x-ray spectroscopy of the plasma interface — •Florian Diekmann, Sebastian Rohlf, Felix Georg, Mathis Klette, Lisa Bauer, Matthias Kalläne, Thomas Trottenberg, and Kai Rossnagel — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität Kiel, 24098 Kiel, Germany

A better microscopic understanding of the fundamental electronic interactions between low-pressure plasmas and solid surfaces is presently hindered by the lack of experimental techniques that can probe both sides of the plasma interface on the relevant length and time scales: the electron- and ion-depleted space-charge region in front of the surface, i.e., the plasma sheath, as well as the electron accumulation layer in the surface region of the solid. Here, we show how to fill this void by combining synchrotron-based gas-phase and surface x-ray absorption spectroscopy into a novel experimental technique that provides direct spectroscopic information on the complete interface between low-pressure plasmas and solid surfaces. First *in situ* and *in operando* near edge x-ray absorption fine structure (NEXAFS) spectroscopy results on the plasma interface are presented for an Al_2O_3 substrate in contact with argon and neon plasmas.

O 32.2 Tue 14:15 MA 004

Photoelectron Momentum Microscopy with Large k-Field of View using Soft X-Rays — •Sergey Babenkov[1], Arndt Quer[2], Katerina Medjanik[1], Dmitry Vasilyev[1], Martin Ellguth[1], Florian Diekmann[2], Sebastian Rolf[2], Matthias Kalläne[2], Kai Rossnagel[2], Jens Viefhaus[3], Hans-Joachim Elmers[1], and Gerd Schönhense[1] — [1]JGU, Inst. für Physik, Mainz — [2]CAU, Inst. für Exp. und Angew. Physik, Kiel — [3]DESY, Hamburg, Germany

Time-of-flight k-microscopy at the high-brilliance soft X-ray beamline P04 (PETRA III) was employed for studying the electronic structure of several transition-metal dichalcogenides. Main emphasis was to maximize the field-of-view in k-space allowing to observe the k-patterns and circular dichroism (CDAD) texture in several repeated Brillouin zones (BZs) along $k_{x,y}$ (parallel) and k_z (perpendicular to the surface). CDAD patterns exhibit a rich texture, varying with k-vector in all directions and with photon energy. The dichalcogenides constitute an interesting intermediate case between true 2D systems as discussed in early CDAD work [1] and bulk systems as studied recently [2]. Varying k_z in small steps via the photon energy (from 290 to 370 eV, with ca. 5 eV increment) reveals strong redistributions of spectral weight of the Fermi-surface pockets at Γ, *M*, *M'* between the first and the repeated BZs along $k_{x,y}$. This is accompanied by pronounced changes in the CDAD texture. The variation with k_z allows to quantify the size of the quasi-3D Fermi surface via tomographic k-space mapping.

[1] G. Schönhense, Phys. Scripta **T31**, 255 (1990); [2] O. Fedchenko et al., submitted (2017)

O 32.3 Tue 14:30 MA 004

Probing the electronic structure of atomically-thin carbon nitride nanosheets photocatalytsts by soft X-ray spectroscopies — •Jian Ren[1,2], Nannan Meng[3], Iver Lauermann[4], Bin Zhang[3], and Tristan Petit[1] — [1]Institute of Methods for Material Development, Helmholtz-Zentrum Berlin für Materialen und Energie GmbH, Germany — [2]Department of Physics, Freie Universität Berlin, Germany — [3]Department of Chemistry, Tianjin University, China — [4]PVcomB, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Germany

Polymeric carbon nitride (PCN) is a promising earth-abundant 2D material for solar energy conversion. Optical, electronic, and chemical properties of PCN materials can be manipulated by changing the size, composition, dimension and shape of their reactive (nano)domains. Exfoliation is a promising strategy to enhance PCN photocatalytic performance via preparation of ultrathin nanosheets. In this work, the electronic structures and surface chemistry of the oxygen- and amino group decorated atomically-thin PCN nanosheets, as determined from infrared, soft X-ray absorption and ultraviolet photoemission spectroscopies, will be detailed. A special attention will be given to determine the structure-performance relationship of PCN photocatalysts by comparing the photocatalytic activity of these different materials with their electronic and surface chemical properties. These measurements were performed at the BESSY II synchrotron in Berlin. Synchrotron radiation-based soft X-ray spectroscopies have become powerful techniques to investigate the electronic structure of 2D materials.

O 32.4 Tue 14:45 MA 004

Layer thickness dependence of the Kondo temperature in the surface alloy $CePt_5$ on Pt(111) — •Katharina Treiber, Philipp Eirich, Chul Hee Min, and Friedrich Reinert — Experimentelle Physik VII, Universität Würzburg

At low temperatures local interactions between Ce *4f*-and conduction electrons in thin films of $CePt_5$ on Pt(111) lead to a spectral feature at the Fermi surface - the Kondo resonance [1]. This inelastic scattering process leads to a reduction of the f-level occupancy to $n_f < 1$. This is reflected in the Ce *3d* core levels. The spectral weight of their spin orbit split *3d 3/2*- and *5/2* peaks is redistributed on six peaks mirroring the f-level occupation [2]. Previous studies have shown that the $CePt_5$ surface alloy appears in a variety of different phases depending on Ce coverage and post annealing procedure [3]. XAS and XMCD studies recently suggested a change of the correlation strength throughout those different phases [4].

In this contribution we examine the electronic structure of the different phases regarding their various structural changes, by XPS and ARPES. We explore the hybridization strength and effective occupancy of the *4f*-electrons as a function of temperature, probing depth and $CePt_5$ layer thickness. This provides us with an opportunity to tune the strength of the electronic correlation in $CePt_5$ on Pt(111). [1] M. Garnier *et al.*, Phys. Rev. B **56**, R11399(R), (1997) [2] O.Gunnarsson, K. Schönhammer, Phys. Rev. B **28**, 8, (1983) [3] J. Kemmer *et al.*, Phys. Rev. B **90**, 195401 (2014) [4] C. Praetorius *et al.*, Phys. Rev. B **92**, 045116, (2015)

O 32.5 Tue 15:00 MA 004

Electronic structure of V- and Cr-doped $(BiSb)_2Te_3$ thin films. — •Sonja Schatz[1], Can Raphael Crespo Vidal[1], Thiago R. F. Peixoto[1], Hendrik Bentmann[1], Martin Winnerlein[2], Steffen Schreyeck[2], Charles Gould[2], Karl Brunner[2], Laurens W. Molenkamp[2], and Friedrich Reinert[1] — [1]Experimentelle Physik VII, Universität Würzburg, D-97074 Würzburg — [2]Experimentelle Physik III, Universität Würzburg, D-97074 Würzburg

Magnetic topological insulators have received large interest in recent years, as they realize the long-sought-after quantum anomalous Hall effect. In particular, V- anc Cr-doped $(Bi_xSb_{1-x})_2Te_3$ thin films have been reported to exhibit an insulating ferromagnetic ground state and a quantum anomalous Hall phase at low temperatures. The macroscopic magnetic properties of these films vary depending on doping-type (V vs. Cr) [1] and on the host stoichiometry parameter x. Here, we present our investigations on the electronic structure in dependence of these parameters by resonant photoelectron spectroscopy at the $2p$ absorption edges. We find that V $3d$ states are located at the Fermi level E_F, while for Cr the $3d$ states shift towards higher binding energies and show a vanishing density of states at E_F. We discuss possible implications on the nature of the ferromagnetic interactions in this material class.

[1] C. Z. Chang *et al., Nature Materials* **14**, 473 (2015).
[2] T. Peixoto *et al., Physical Review B* **94**, 195140 (2016).

O 32.6 Tue 15:15 MA 004

Systematics of electronic and magnetic properties in the transition metal-doped quantum anomalous Hall platform Sb_2Te_3 — •Johannes Jung[1], M. Bode[1], P. Sessi[1], S. Schatz[1], T.R.F. Peixoto[1], H. Bentmann[1], F. Reinert[1], A. Barla[2], M.F. Islam[3], A. Pertsova[4], A. Balastky[4], and C. M. Canali[3] — [1]Physikalisches Institut, Universität Würzburg, Am Hubland, Würzburg, Germany — [2]Istituto di Struttura della Materia, Trieste, Italy — [3]Department of Physics,Linnaeus University, Kalmar, Sweden — [4]Nordita, Stockholm University, Sweden

The quantum anomalous Hall effect has been reported to emerge in magnetically doped topological insulators. While its phenomenological description is quite clear, its microscopic origins are far from being completely understood and controlled. Here, we provide a systematic characterization of the most prominent QAHE platform: transition metal-doped Sb_2Te_3. By combing complementary experimental tech-

niques (STM/STS/resPES/XMCD) with ab-initio theory, we analyze how 3*d* dopants (V, Cr, Mn, Fe) impact the electronic and magnetic properties. Our results reveal that the fate of the topological surface state strongly depends on the specific character of the 3*d* impurity. In particular, (i) the single-ion magnetic anisotropy, which controls the magnetic gap opening and its stability, can vary from in-plane to out-of-plane depending on the dopant; (ii) the emergence of impurity resonances close to the Dirac point can give rise to new bands, significantly altering the Sb_2Te_3 electronic structure. Overall, our results provide general guidelines for the realization of a robust QAHE.