O 42: Electronic structure of surfaces: Spectroscopy, surface states – Poster

Time: Tuesday 14:00–16:00 Location: P2

O 42.1 Tue 14:00 P2

Plasmonic lenses for nano-spectroscopy of Van der Waals materials — •Natalie Lehmann[1], David Huber[2], Daiyu Geng[1], Jiabao Yang[1], Stuart Parkin[1], Wolf Widdra[2], and Niels Schröter[1] — [1]Max Planck Institute of Microstructure Physics, Halle (Saale), DE — [2]Martin-Luther-University Halle-Wittenberg, Halle (Saale), DE

Surface plasmon polaritons excited at the edge of Archimedean spirals carved into a gold (111) surface can be focused to a sub-micrometer spot at the spiral center [1, 2]. We aim to use this nano-focused electric field to spectroscopically investigate 2D materials, which are often only a few micrometers in size. Here we present our measurements on gold/graphene samples. Notably, the plasmonic focus remains intact, and the gold surface is effectively cleaned by the graphene; even without sputtering the gold, its characteristic surface state is observed. Furthermore, the measured k-space spectrum shows replicas of the sp orbitals above the Fermi edge, reflecting the dynamics of an excited electron system. We propose that the laser pulse is pumping the system while the plasmon is probing the excited states. These findings demonstrate the feasibility of ultrafast pumped, nano-focused spectroscopy using a single micrometer-sized laser beam.

O 42.2 Tue 14:00 P2

Hydrogen Plasma Cleaning of Fe_3Sn_2 single crystals for surface-sensitive measurements — •Felix Müller[1], Lu Lyu[1], Lilian Prodan[1], Jannis Lessmeister[2], Tobias Eul[1], Martin Aeschlimann[2], István Kézsmárki[1], and Benjamin Stadtmüller[1] — [1]University of Augsburg — [2]RPTU University Kaiserslautern-Landau

Preparing clean and well-defined surfaces is essential for high-resolution photoemission spectroscopy (PES) and other similarly surface-sensitive studies. Typical preparation methods to realize high-quality surfaces include in situ cleaving under ultrahigh vacuum (UHV) conditions. However, this method cannot be universally applied to all crystal structures. Alternative approaches can rely, for instance, on H_2-based plasma cleaning using H_2 sources integrated into a UHV system. Here, we investigate the effectiveness of this method in preparing Fe_3Sn_2 surfaces for spectroscopy and discuss its potential as a general cleaning technique for other topological bulk materials.

We show that the hydrogen plasma efficiently removes common surface contaminants, particularly oxygen and carbon, while preserving the intrinsic surface structure. This enables the observation of sharp spectroscopic features over the whole energy range and significantly enhances the signal quality of subsequent PES measurements. Our results show that plasma can be a simple and reproducible method for achieving contamination-free surfaces of topological bulk materials for surface-sensitive spectroscopy applications.

O 42.3 Tue 14:00 P2

WTe2: a Cool Look at 330 mK — •Rian A.M. Ligthart, Kevin Hauser, Alexander LaFleur, Gleb Neplyakh, and Fabian D. Natterer — Department of Physics, University of Zurich, Winterthurerstrasse 190, CH-8057 Zurich, Switzerland

As silicon-based electronics reach their size limit, two-dimensional (2D) materials, particularly Transition Metal Dichalcogenides (TMDs), emerge as promising alternatives to enhance efficiency at the same length scale. Among them, WTe2 stands out due to its unique properties including topological states, Weyl semimetal character and graphene-like high electron mobility.

We investigate cleaved bulk WTe2 using a Scanning Tunneling Microscope at 330 mK. With scanning tunneling spectroscopy, the electronic properties and their dependence on vector magnetic fields are studied on the surface of bulk WTe*, as well as at step edges and twin domain boundaries. We scrutinize the topological nature of the edge states and observe a reduced density of states around zero bias in bulk WTe2.

O 42.4 Tue 14:00 P2

Chiral-Induced Spin Selectivity in Thia-Bridged Triarylamine Hetero[4]helicenes SAMs: Structural Insights from XPS and NEXAFS — •Yichen Jin[1], Jan Böhnke[1], Lapo Querci[2], Niccolò Giaconi[2], Cornelius Gahl[1], Dominik Stemer[3], Roberta Sessoli[2], Matteo Mannini[2], and Martin Weinelt[1] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]University of Florence, Via della Lastruccia 3-13, Sesto Fiorentino 50019, Italy — [3]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Helicene enantiomers act as efficient spin filters when assembled on metallic surfaces, making them promising candidates for organic spintronic applications. Previous magnetic conductive AFM studies reported spin polarizations of up to ~60% through the respective chiral enantiomers of Thia-Bridged Triarylamine Hetero[4]helicenes (HelSAc) self-assembled monolayers (SAMs) ascribed to the chirality-induced spin selectivity (CISS) effect. To understand the structural origins underlying this behavior, we investigated HelSAc SAMs on Au(111) using XPS and NEXAFS. Angle-dependent XP spectra of sulphur 2p reveal three chemically distinct components assigned to S*C, S*Au, and atomic sulfur. NEXAFS shows pronounced polarization dependences of the σ^* and π^* resonances, demonstrating the parallel alignment of the HelSAc to the Au surface. Together, these results establish a well-defined chemical and structural picture of HelSAc SAMs, providing the essential foundation for interpreting spin-dependent photoelectron spectroscopy and understanding the CISS effect in this chiral system.

O 42.5 Tue 14:00 P2

Structure and Electronic Properties of (Bi, Pb) Atom Layer Structures studied by ARPES and STM — •Lars Konermann[1], Wen Si[2], Hiroko Abe[1], Masaki Imamura[3], Masahiro Haze[2], Kazutoshi Takahashi[3], Yukio Hasegawa[2], and Akari Takayama[1,4] — [1]Waseda Univ., Shinjuku, Japan — [2]ISSP, Univ. of Tokyo, Kashiwa, Japan — [3]SL Center, Saga Univ., Tosu, Japan — [4]IMRAM, Tohoku Univ., Sendai, Japan

In Single-atom layer (SAL) structures comprised of heavy elements on semiconductor substrates, spin-split electronic states occur due to strong spin-orbit interactions and the breaking of the spatial inversion symmetry, known as the Rashba effect. For (Bi, Pb) on Si or Ge, spin-splitting electronic bands have been demonstrated both theoretically and experimentally. Furthermore, the possibility of a superconducting transition is anticipated suggesting spin-triplet superconductivity. Albeit, experimental confirmation has not yet been obtained.

We investigated the atomic and electronic structures of (Bi, Pb)/Si(111) and Ge(111) structures using cryogenic scanning tunneling microscopy (STM) and spectroscopy (STS), as well as angle-resolved photoemission spectroscopy (ARPES) with synchrotron radiation. A series of experiments was conducted to evaluate the sample: observation of the periodic atomic arrangement, determination of the Pb/Bi composition ratio, detailed band dispersion, and investigation of the electronic states at ultra-low temperatures.

In this presentation, we will present these experimental results and discuss the potential for superconductivity with the Rashba effect.

O 42.6 Tue 14:00 P2

Line-Moiré Phases of an Epitaxial Honeycomb Monolayer AgTe/Ag(111) — •Romana Ganser — Exp. Physik VII and Würzburg-Dresden Cluster of Excellence ctd.qmat, Universität Würzburg

Moiré heterostructures offer a versatile platform for engineering electronic band structures by precise control over long-range superlattice potentials that particularly give rise to emergent phenomena [1]. Here, we present angle-resolved photoemission spectroscopy (ARPES) measurements on a highly tunable one-dimensional (1D) epitaxial moiré heterostructure. We show that the electronic structure is strongly altered by the moiré superlattice hosting replica bands and sizable hybridization gaps. From our experimental data, we can trace back to the local, spatially-varying interlayer coupling, shaping the moiré potential. The latter leads to a 1D confinement of the electrons and, interestingly, also gives rise to Dirac nodal lines, which are robustly protected by the superlattice symmetry.

[1] Balents, L. et al. Nat. Phys. 16, 725-733 (2020).

O 42.7 Tue 14:00 P2

Realization of an Acoustic Kagome lattice — •Louis Müller[1,3], Noah Endres[1,3], Begmuhammet Geldiev[1,3], Simon Widmann[2,3], Maximilian Ünzelmann[1,3], and Friedrich

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Hosting Dirac cones, flat bands, and saddle points in their band structure, Kagome materials have recently attracted great attention. We realize an acoustic Kagome lattice using 3D-printed resonators, enabling direct measurement of amplitude and phase to reconstruct wave functions and extract the band structure. Our experiment resolves the flat band, identifies the sublattice character of the van-Hove singularities, and clearly reproduces the Dirac cones in good agreement with tight-binding calculations. This platform provides a highly flexible and intuitive way to investigate lattice-driven effects that are difficult to isolate in electronic Kagome systems. Finally, we compare this data to angle-resolved photoemission spectroscopy measurements on a prototypical Kagome superconductor.

O 42.8 Tue 14:00 P2

Excitation of spin-polarized electrons by Deep-UV Pulses with Orbital Angular Momentum from Au(111) and Cu(111) — •Ruwen Quenter, Paul valerian Möllers, and Helmut Zacharias — Center for Soft Nanoscience (SoN), University of Münster, Busso-Peus-Str. 10, 48149 Münster, Germany

Photoemission can, depending on the substrate and the circularly polarization of the light, result in a longitudinal spin polarisation of the excited electrons. The angular momentum of the light influences the final state determined by the selection rules in a way that corresponds to a specific total angular momentum. Spin-orbit interactions cause an energetical separation of states with different total angular momenta, resulting in a spin imbalance of the excited electrons. This can be measured by e.g. Mott scattering. Orbital angular momentum light has a helical wavefront that carries its orbital angular momentum as a degree of freedom wich may have an influence on the electron orbital angular momentum in the electron excitation process. Spin-resolved photoemission measurements could determine if this influence could result in a changed photoelectron spin polarization. We present preliminary results from measurements on Au(111) and Cu(111).

O 42.9 Tue 14:00 P2

Wavefunction confinement of deeply buried As δ-layers in Si(001) measured with hard and soft X-ray angle-resolved photoemission spectroscopy — •Emily C. McFarlane[1], Enrico G. Della Valle[2], Procopios C. Constantinou[2], Taylor J. Z. Stock[3], Kieran Spruce[3], Christoph Schlueter[4], Sergii Chernov[4], Thiago R. F. Peixoto[4], Moritz Hoesch[4], Gerd Schönhense[5], Hans-Joachim Elmers[5], Vladimir N. Strocov[2], Neil J. Curson[3], Steven R. Schofield[3], and Niels B. M. Schröter[1] — [1]Max Planck Institute of Microstructure Physics, Halle (Saale), DE — [2]Paul Scherrer Institute, Villigen PSI, CH — [3]London Centre for Nanotechnology, University College London, London, UK — [4]Deutsches Elektronen-Synchrotron (DESY), Hamburg, DE — [5]Johannes Gutenberg University, Mainz, DE

Vertically confined regions of high concentration dopants in silicon, so-called "δ-layers", are potential building blocks of future quantum devices. A momentum-resolved understanding of the wavefunction confinement of the electrons in such systems is required for their future development, which so far has been limited to shallow samples. Here we present both hard and soft X-ray photoelectron spectroscopy studies of shallow ($\sim$3nm) and deeper ($\sim$7nm) buried As δ-layers measured with a momentum microscope and hemisphere at PETRA-III and the SLS. We find that the deeper buried sample has smaller electron confinement than the shallower δ-layer, and different quantum well states are located at different depths of the sample. In contrast, in shallow δ-layers all quantum well states are located near the surface.