O 19: Vacuum Science & Technology: Theory and Applications – Poster

Time: Monday 18:00–20:00 Location: P2

O 19.1 Mon 18:00 P2

Contact-Separation phenomenon at the Silica-Gold interface: AFM and ToF-SIMS insights — •Nisha Ranjan, Tolga Acartürk, Kathrin Küster, and Ulrich Starke — Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany

Contact-Separation (CS) electrification at solid interfaces constitutes a fundamental phenomenon. However, it often exhibits uncertainties and irreproducibility [1,2]. The silica-gold contact pair is a model example of a dielectric-metal system with a similar elastic modulus that shows a significant variation in charging properties such as polarity reversal among CS surfaces [3]. We aim to understand the phenomenon with interfacial interactions and chemical composition using direct microscale measurements under ultra-high vacuum conditions at the silica-gold interface. We use Atomic Force Microscope/Force Spectroscopy (AFM/FS) to quantify interfacial interactions, such as electrostatic force, van der Waals interaction, contact area, contact pressure, and deformation. Repeated approach-retraction cycles enabled the correlation of mechanical response with charge accumulation and compositional change. We use Time-of-Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) for surface composition mapping to assess mechanochemistry. Our finding demonstrates that the magnitude of the force is significantly influenced by the charge accumulation. Concurrently, a change in surface composition was also observed. [1] I. Jimidar and J. Méndez Harper, Physics Today 78(8), 54 (2025). [2] D.J. Lacks, Angew. Chem. Int. Ed. 51, 6822 (2012). [3] G. Fatti et al., PRL 131, 166201 (2023).

O 19.2 Mon 18:00 P2

Simulation-Guided GIXPS: Planning faster (HA)XPS measurements while enabling depth-sensitivity — •David Capalbo[1], Oliver Rehm[1], Endrit Kusari[1], Andrei Gloskovskii[2], Christoph Schlueter[2], Lutz Baumgarten[3], and Martina Müller[1] — [1]Fachbereich Physik, Universität Konstanz, Konstanz, Germany — [2]DESY, Hamburg, Germany — [3]FZ Jülich GmbH, PGI-6, Jülich, Germany

(Hard) X-Ray Photoelectron Spectroscopy ((HA)XPS) is an established method for characterizing surfaces, interfaces, and the bulk material properties of thin films, multilayers, and devices. Such measurements, when performed at a synchrotron-based setup, can produce faster and better resolved data compared to a laboratory setup, but beamtime is limited and highly competed for. We present a simulation-based approach that enables faster and more efficient measurements by exploiting grazing-incidence (GI) angle geometries (0.3°-2°). At these GI angles, tunable depth-selective photoelectron emission becomes possible while increasing the signal by up to two orders of magnitude at characteristic angles. In our approach, an additional damping term is added to an already existing simulation model, which enables the user to simulate an accurate GI(HA)XPS response before the beamtime. This enables them to identify and prioritise configurations of interest, reduce the required aquisition time, all while keeping the expected advantages of standard (HA)XPS measurements. O.Rehm *et al.*

O 19.3 Mon 18:00 P2

Electrospray Ion Beam Deposition for Atomic Resolution Native Protein Structure Investigation at Surfaces — •Stephan Rauschenbach — University of Oxford, Kavli Institute for Nanoscience Discovery, Department of Chemistry, Sherringdon Road, Oxford

Electrospray ion beam deposition (ESIBD) enables controlled deposition of intact biomolecules from solution onto surfaces under ultra-high vacuum conditions. We present ESIBD as a sample preparation method for cryo-EM, scanning probe, and holography applications, bridging native electrospray ionisation mass spectrometry with surface-based structural characterisation techniques.

The method combines mass-selective soft landing with controlled ice growth embedding protocols. Proteins maintain their native conformations during the gentle electrospray process and deposition. For cryoEM Ice matrix formation occurs post-deposition minimising mechanical stress and denaturation.

Here we discuss the state of the art implementation of this method on commercial and self-built platforms and demonstrate atomic resolution imaging of soluble and membrane proteins deposited on surfaces in vacuum.

O 19.4 Mon 18:00 P2

Analysis of the charge distribution of an insulating sphere in contact electrification processes — •Andre Mölleken, Hermann Nienhaus, and Rolf Möller — Experimental Physics, University of Duisburg-Essen and Center for Nanointegration Duisburg-Essen (CENIDE)

While the mechanisms of contact electrification between metals are well established, non-conductive materials present a more complex scenario due to the emergence of nonuniform surface charge distributions. This study investigates how such charge inhomogeneities on an insulating sphere like Al2O3 or quartz influence the subsequent charge transfer during contact with a planar metal or insulator electrode. We employ a redesigned experimental setup based on an established parallel-plate capacitor concept [1], enabling high-temporal-resolution measurements of induced and transferred charges as the sphere bounces on the lower electrode. By decomposing the measured signal into monopole and dipole components, we extract the net charge, quantify the dipole moment of the surface charge distribution, and determine the rotational frequency of the bouncing sphere. This approach reveals how initial charge patterns evolve dynamically and modulate the efficiency and direction of charge transfer upon impact. The new setup allows controlled manipulation of the sphere's initial surface charge distribution prior to each experiment. The results offer a novel way to study how the charge distribution on the surface influences the contact electrification process. [1] M. Kaponig, A. Mölleken, H. Nienhaus, R. Möller, Dynamics of contact electrification, Sci. Adv. 2021, 7 (22), eabg7595.

O 19.5 Mon 18:00 P2

Contact electrification between Au and hydrogen-passivated Si(111) surfaces — •Christian Gruber, Andre Mölleken, Tobias Prost, Hermann Nienhaus, and Rolf Möller — Experimental Physics, University of Duisburg-Essen and Center for Nanointegration Duisburg-Essen (CENIDE)

The charge of 1mm Au spheres bouncing on a hydrogen-passivated Si(111) surface under vacuum conditions is measured in a parallel-plate capacitor setup with fC charge sensitivity and microsecond time resolution [1]. The transferred charge between metal and semiconductor is determined as a function of impact velocity ranging from 1 to 0 m/s, of doping and of surface condition after preparation. Light exposure to the semiconductor surfaces during experiments shows no significant influence on the results. On p-doped samples the Au spheres collect a charge of typical a few 100fC with each contact. The dependence on the preparation is not as clear as on n-doped samples, on which the quality of the surface preparation clearly causes a polarity change. On n-doped samples the Au spheres collect a typical charge of a few 100 fC to over 1000 fC. However, in the limit of zero impact velocity the variations between the different samples become negligible and Au is found to be charged negative. The results are compared with predicted charge transfer between Au and Si in static Schottky diode models.

[1] M. Kaponig, A. Mölleken, H. Nienhaus, R. Möller, Dynamics of contact electrification, Sci. Adv. 2021, 7 (22), eabg7595.

O 19.6 Mon 18:00 P2

Towards nanoscale EUV spectroscopy of 2D heterostructures using interferometric coherent diffractive imaging — •Hannah Strauch, Jan Mädrich, Daniel Steil, Stefan Mathias, and G. S. Matthijs Jansen — University of Göttingen, 1st Institute of Physics, Göttingen, Germany

Time-resolved spectroscopy in the extreme ultraviolet (EUV) energy range provides element-specific insight into electronic and structural dynamics. Particularly, EUV spectroscopy of nanoscale 2D material heterostructures enables to identify the individual layer contributions due to its element-specificity. For such systems, however, a spatially resolved probe is essential: 2D material heterostructures are both intrinsically micro-scale and highly susceptible to spatial inhomogeneities. The comprehensive understanding of ultrafast dynamics in those systems therefore requires simultaneous spatial, spectral, and temporal resolution, which is a combination that remains experimentally demanding even with state-of-the-art techniques.

We will present our progress towards such a comprehensive measurement approach with our table-top EUV interferometry-based setup, which enables time-resolved spectroscopy with spatial resolution through the combination of Fourier transform holography (FTH) with interferometric Fourier transform spectroscopy (FTS). The surface sensitivity required for few-layer systems is provided through measurements in reflection geometry.

O 19.7 Mon 18:00 P2

Development of a Low Temperature Two-Level System Microscope for Superconducting Quantum Circuits — •David Mazibrada[1], Johannes Schwenk[1], Jürgen Liesenfeld[1], Hannes Rotzinger[1,2], Philip Willke[1], and Alexey V. Ustinov[1,2] — [1]Physikalisches Institut (PHI) — [2]Institut for Quantum Materials and Technologies (IQMT), Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany

Superconducting quantum circuits are among the most advanced platforms for solid-state qubits. Their performance is perturbed, however, by parasitic two-level systems (TLS). The electric fields of the qubit interact with the electrical dipole moment of the TLS, leading to an exchange of photons between the two quantum systems. TLS are mostly of an unknown nature and position, and identifying them locally would help to improve future qubits. Since TLS couple not only to the qubit's microwave field but also to externally applied electric fields, this interaction enables us to probe and localize individual TLS.
We present a microscope combining a cryogenic atomic force microscope (AFM) and a superconducting quantum circuit. By applying a local electric field with the AFM tip and performing microwave spectroscopy, we aim to identify, characterize, and map the position of individual TLS on superconducting quantum circuits.

O 19.8 Mon 18:00 P2

Prospects of ARPES measurements in an external static magnetic field — Dmitry Usanov and •Daniil Yevtushynsky — Laboratory for Quantum Magnetism, EPFL, 1015 Lausanne, Switzeralnd

Angle-resolved photoemission spectroscopy (ARPES) has traditionally been performed in magnetically shielded environments, as external magnetic fields distort electron trajectories and worsen the momentum resolution. This limitation has prevented direct observation of many field-dependent electronic phenomena. Recent studies, however, have demonstrated that applying a strongly localized static magnetic field enables ARPES measurements under external field conditions. We propose to test a newly developed compact magnetic circuit, integrated into a standard flag-type sample holder, capable of generating a high magnetic flux density at the sample position while minimizing its effect on photoelectron trajectories. In the presentation we will discuss the optical action of the designed magnetic field and subsequent aberration corrections for different types of samples. In addition, we will provide estimations of the maximum magnetic field for ARPES in the soft X-ray and VUV ranges. At the end, we will propose different test systems, where moderate magnetic fields can tune the spin order and induce pronounced modifications of the band structure near the Fermi level. Successful implementation will establish a new experimental capability - ARPES in controlled static magnetic fields - opening pathways to study field-dependent band topology and spin-charge coupling across a broad class of quantum materials and heterostructures.

O 19.9 Mon 18:00 P2

New Electrospray Ion Beam Deposition source for well-controlled STM sample preparation — •Niclas Przibylla[1], Markus Etzkorn[1], Stephan Rauschenbach[2], and Uta Schlickum[1] — [1]Institute of Applied Physics, TU Braunschweig, Braunschweig — [2]Kavli Institute for Nanoscience Discovery, University of Oxford, United Kingdom

High resolution imaging of complex biomolecules such as peptides, glycans, and photosynthesis building blocks are crucial for advancing their fundamental functionalities and exploring them for quantum technologies, Scanning probe microscopy techniques together with mass-selected electrospray ion beam deposition enable atomic-level structural characterization of these molecules. This project deploys a novel electrospray ion beam deposition (ESIBD) system with Python-based programmable control for depositing non-volatile molecules onto clean surfaces under ultra-high vacuum conditions. The process involves electrospray ionization, mass-to-charge filtering via quadrupole ion guides, and electrostatic focusing onto nitrogen-cooled samples. Key innovations include a modular chamber architecture allowing future expansion, alongside RF-operation using rectangular voltage waves for enhanced mass filtering precision. Frequency-asymmetric and amplitude-asymmetric waveforms will enable systematic investigation of ion stability diagram effects, advancing deposition control capabilities.

O 19.10 Mon 18:00 P2

Electronoptical Concept of ARPES and RIXS Combined in a Novel Photoelectron Microscope — O. Tkach[1], Y. Lytvynenko[1], C. Fawaz[2], T. Lacmann[3], S. Chernov[4], O. Fedchenko[1,5], H. Agarwal[1], M. Hoesch[4], J. K. Dey[4], J. Dilling[4,6], L. Bruckmeier[4,6], M. Scholz[4], J. Schunck[4,7], S. Roth[2], K. Rossnagel[4,6], M. Beye[8], M. Le Tacon[2], •G. Schönhense[1], and H.-J. Elmers[1] — [1]Univ., Mainz — [2]IQMT, KIT — [3]EPFL, Switzerland — [4]DESY, Hamburg — [5]Goethe Univ. Frankfurt — [6]CAU Kiel — [7]Univ. Hamburg — [8]AlbaNova, Sweden

The instrumentation required for ARPES and Resonant Inelastic X-ray Spectroscopy (RIXS) is usually completely different. ARPES uses electron spectrometers, primarily hemispherical ones, whereas RIXS requires high-resolution X-ray spectrometers with long optical paths to achieve the desired resolution. In a special time-of-flight photoelectron microscope, we combined photoelectron momentum microscopy (MM) - imaging of the backfocal plane of the objective lens, a powerful ARPES approach - with the concept of PAXRIXS [1]. Here, the RIXS photons are converted into photoelectrons using an ultrathin foil. The position at which a RIXS photon hit the converter is a measure for the momentum transfer. For RIXS, the converter foil is moved between the sample and the extractor with fields-of-view of >4 mm. This is facilitated by a novel type of front lens which enables various operating modes. Ultrathin Au, Ag, and Pt converter foils provide energy resolutions between 20 meV and 400 meV.

[1] Dakovski et al., J. Synchrotron Radiat. 24 (2017) 1180.