O 22: Surface dynamics – Poster

Time: Monday 18:00–20:00 Location: P2

O 22.1 Mon 18:00 P2

Tracing light-induced dynamics of correlated charge order at the atomic scale — •Luis Enrique Parra Lopez[1], Alkisti Vaitsi[1], Vivien Sleziona[1], Fabian Schulz[2], Martin Wolf[1], and Melanie Müller[1] — [1]Fritz Haber Institute, Berlin, Germany — [2]CIC nanoGUNE, Donostia-San Sebastian, Spain

Terahertz-driven scanning tunneling microscopy (THz-STM) is a versatile technique that enables the study of ultrafast dynamics in quantum materials with simultaneous nanometer spatial and femtosecond temporal resolution. Here, we use THz-STM to investigate the local ultrafast response of the charge density wave (CDW) phase in 1T-TaS2. Optical-pump THz-probe measurements reveal coherent oscillations of the THz-driven tunneling current at 2.5 THz, consistent with the amplitude mode of the CDW. In addition, we observe a previously unreported 1.3 THz mode in the vicinity of a structural defect, consistent with predictions for interlayer phonons. Beyond these ultrafast collective dynamics, our measurements uncover an additional slower effect: THz-induced long-lived changes of the local density of states (LDOS). These metastable modifications appear as LDOS peak shifts indicative of local stacking changes. They do not arise from the coherent CDW response, but from a local THz-induced perturbation of the CDW lattice. We demonstrate that these changes appear predominantly near lattice inhomogeneities and are consistent with local misalignments of the stacking configuration. Together these findings highlight THz-STM as a platform for imaging and controlling nonequilibrium quantum phases at their intrinsic spatial and temporal scales.

O 22.2 Mon 18:00 P2

Photonic Structures for Purcell-Enhanced Driving of a Structural Phase Transition — •Nandana Veena Uday[1], Florian Spickmann[1,2], Sebastian Zafra Koch[1,2], Felix Kurtz[1], Claus Ropers[1,2], and Hannes Böckmann[1] — [1]Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — [2]University of Göttingen, 4th Physical Institute, Göttingen, Germany

Direct integration of silicon photonics with low-dimensional materials connects tailored light-matter interaction with surface-sensitive probing. Here, we explore the remote optical driving of a prototypical Peierls insulator, adsorbed on the surface of a silicon photonic waveguide. Optical gratings couple infrared light to guided modes of a silicon slab, while ultrafast low-energy electron diffraction probes the waveguide-mediated optical quench of the periodic lattice distortion in adsorbed atomic indium chains. These experiments constitute first steps towards engineering photonic environments for surface phase control using tailored lithographic fabrication techniques. Potential avenues range from Purcell-enhanced photoinduced phase transitions to driven states of matter obtained by interfacing surface structures with integrated micro-resonator cavities. [1] Böckmann, Hannes, et al. Structural Dynamics 9.4 (2022)

O 22.3 Mon 18:00 P2

Non-equilibrium phonon dynamics of the kagome metal CsV_3Sb_5 — •Felix Kurtz[1,2], Lukas Jehn[1,2], Alp Akbiyik[1,2], Matthieu Le Tacon[3], Amir-Abbas Haghighirad[3], and Claus Ropers[1,2] — [1]Department of Ultrafast Dynamics, Max Planck Institute for Multidisciplinary Sciences, D-37077 Göttingen — [2]4th Physical Institute, University of Göttingen, D-37077 Göttingen — [3]Institute for Quantum Materials and Technologies, Karlsruhe Institute of Technology, D-76021 Karlsruhe

Tracking the equilibration processes that follow photoexcitation in materials can reveal couplings between and among electrons and lattice degrees of freedom. Thus, a variety of femtosecond electron or X-ray diffraction techniques are used to follow non-equilibrium structural dynamics. Recently, we have introduced ultrafast low-energy electron diffuse scattering (ULEEDS), a surface-sensitive method capable of tracing momentum-dependent phonon populations with out-of-plane polarization [1]. Here, we employ ULEEDS to a second material, the kagome metal CsV_3Sb_5, and reveal non-thermal phonon occupations whose subsequent equilibration is driven by phonon-phonon scattering. Comparing these results to our previous study of $TiSe_2$, we find that while a rapid buildup near the Brillouin-zone boundary still precedes a slower emergence of zone-center acoustic modes, the relaxation times in CsV_3Sb_5 are confined to a much narrower distribution.

[1] F. Kurtz *et al.*, Nat. Mater. **23**, 890-897 (2024)

O 22.4 Mon 18:00 P2

Extending Surface Phase Diagrams to Non-Equilibrium Plasmas — •Maximilian Wünschek, Alper T. Celebi, and Markus Valtiner — Institute of Applied Physics, Vienna University of Technology, Wiedner Hauptstrasse 8-10/E134, Vienna 1040, Austria

Surface phase diagrams are widely used to visualize the stability of surface reconstructions under equilibrium gas conditions. However, many growth and treatment processes use plasmas that operate far from equilibrium, where activated and ionized species are present in substantial concentrations. Examples such as ZnO have shown that unique reconstructions can be found outside the stability range defined by conventional chemical potential axes, highlighting the need to extend surface phase diagrams to non-equilibrium regimes.

Using GaN as a model system, we compile a large dataset of reconstructions for polar GaN surfaces under hydrogen, nitrogen, and oxygen environments. Building on these results, we introduce a framework for applying surface phase diagrams to plasma conditions by incorporating non-thermal species into the chemical potential landscape. A minimal kinetic model estimates plasma composition, and thermochemical properties of the constituent species are combined into an effective plasma chemical potential.

The resulting extended diagrams show how radicals and ions shift phase boundaries and stabilize surface structures inaccessible under equilibrium. This approach provides a basis for understanding and predicting surface configurations formed during plasma-assisted processing.

O 22.5 Mon 18:00 P2

Atomic vibrations in the icosahedral quasicrystal AlPdMn studied with femtosecond electron diffraction — •Moritz Schlechtriem[1,2], Victoria C. A. Taylor[2], Hyein Jung[1,2], Ralph Ernstorfer[1,2], and Yoav William Windsor[1,2] — [1]Technische Universität Berlin — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin

Quasicrystals (QCs) are materials in which the atomic arrangement lacks periodicity but exhibits perfect spatial order. QCs therefore produce sharp diffraction patterns with unconventional features such as 5-fold rotational symmetry. Due to the aperiodic nature of QCs, phonons are insufficient to fully describe atomic vibrations. Phasons are quasiparticles related to atomic motion in the presence of aperiodicity, and their group velocity can exceed the speed of sound. The resulting enhanced thermal conductivity gives rise to potential applications of QCs, e.g. in nanoelectronics.

Here we use pump-probe femtosecond electron diffraction (FED) to study ultrafast atomic vibrations in QCs. This enables us to study the femtosecond evolution of photoinduced atomic motion, shedding light on the coupling mechanisms between electrons, phonons and phasons.

In this presentation we focus on the icosahedral QC alloy AlPdMn. FED results, in which different high-symmetry directions (e.g. the 5-fold rotation axis) are probed, will be presented.

O 22.6 Mon 18:00 P2

Thermo-osmotic flows at the Chemically Patterned Surfaces — •Neerdhi Goswami and Frank Cichos — Universität Leipzig Linnestr. 5 04103 Leipzig Germany

The boundary flows at a solid-liquid interface are governed by the interaction of the solid and liquid, specifically by the excess enthalpy of these interactions. Consequently, chemical modification of surfaces alters boundary flow fields. By generating spatially dependent patterns of solid-liquid interactions, we can not only shape various flow fields but also directly compare excess interaction enthalpies between modified and unmodified regions.

This study analyzes opto-thermo-osmotic flow fields at a thiol-patterned gold-water interface to provide a quantitative microscopic picture of dynamic interfacial interactions through comparative analysis. Thiol stripes were generated through micro-contact printing, creating alternating patterns of modified and unmodified gold regions. Surface plasmon resonance (SPR) imaging confirmed thiol addition by detecting the characteristic frequency shift upon adsorption.

This quantitative characterization of interfacial interactions provides fundamental insights into how surface chemistry modulates boundary flows, with implications for designing responsive microfluidic systems and optimizing interfacial processes in precision separation and manipulation applications.