O 74: Ultrafast Electron and Spin Dynamics at Interfaces

Time: Wednesday 18:15–20:30 Location: Poster A

O 74.1 Wed 18:15 Poster A

Electron dynamics at an azobenzene-functionalized metal surface — Wibke Bronsch, Larissa Boie, •Cornelius Gahl, and Martin Weinelt — Fachbereich Physik, Freie Universität Berlin, Germany

Self-assembled monolayers (SAMs) of azobenzene-decorated alkanethiols represent a versatile class of systems for the functionalization of a metal surface with molecular switches. The alkyl-linker chains serve as a buffer layer to efficiently decouple the chromophores from the metal substrate. In this contribution we investigate the electron dynamics in SAMs of azobenzene-decorated undecane thiol diluted with dodecanethiol on Au(111) by means of two-photon photoemission spectroscopy. For a pure dodecanethiolate SAM a lifetime of ∼50 ps has been reported for an image potential state [1]. We found that the presence of azobenzene shortens its lifetime considerably. Furthermore, photoisomerization causes a change of the work function depending on the density of the photochromic moieties.

[1] M. Shibuta, N. Hirata, R. Matsui, T. Eguchi, and A. Nakajima, J. Phys. Chem. Lett. 3, 981 (2012).

O 74.2 Wed 18:15 Poster A

Exciton Dynamics in Thin Sexithiophene Films on Au(111) — Wibke Bronsch[1], •Sebastian Baum[1], Malte Wansleben[1,2], Kristof Zielke[1], Cornelius Gahl[1], and Martin Weinelt[1] — [1]Freie Universität, Berlin, Deutschland — [2]Physikalisch-Technische Bundesanstalt, Berlin, Deutschland

Sexithiophene (6T)/Gold is a model system for an organic semiconductor/metal interface. Exciton formation and relaxation as well as charge transfer processes across those interfaces are of high relevance in molecular electronics. Starting from the optical properties of thin 6T films on Au(111) investigated by differential reflectance spectroscopy, we performed time-resolved two-photon photoelectron spectroscopy using different excitation energies below and within the vibrational progression of the S1 absorption band. As a result we can draw a detailed picture of the exciton dynamics.

O 74.3 Wed 18:15 Poster A

High harmonic generation at 500 kHz: an XUV light source for solid state spectroscopy — •Johannes Feldl, Michele Puppin, Yunpei Deng, Martin Wolf, and Ralph Ernstorfer — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin

We present a table-top ultrafast extreme ultraviolet (XUV) light source operating at a repetition rate of 500 kHz. The frequency-doubled output of an optical parametric chirped pulse laser amplifier drives high harmonic generation (HHG) in noble gas jets with high backing pressure. A single harmonic with photon energy near 22 eV and a bandwidth of 100 meV is spectrally isolated. The best photon flux, exceeding 10^{11} photon/s from HHG, was obtained with an argon gas jet. This high-repetition rate XUV light source permits time- and angle-resolved photoemission spectroscopy with high counting statistics and provides access to electron dynamics in the full Brillouin zone.

O 74.4 Wed 18:15 Poster A

Resonant excitation and circular dichroism of the second Dirac cone of the topological insulator Bi_2Se_3 — •Sophia Ketterl[1], Sebastian Otto[2], Martin Bastian[1], Cornelius Gahl[1], Thomas Fauster[2], and Martin Weinelt[1] — [1]Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany

Topological insulators (TIs) host metallic topological surface states (TSS) with helical spin structure. This makes them promising materials for the generation of spin-polarized currents. The TI Bi_2Se_3 is intrinsically n-doped and thus the TSS at the Γ point with a Dirac cone dispersion is occupied. Two-photon photoemission (2PPE) experiments have shown that Bi_2Se_3 exhibits a second Dirac cone in the band gap between the second and third conduction band [1].

We studied the properties of the second Dirac cone of Bi_2Se_3 by 2PPE with both linearly and circularly polarized light. We show that the second Dirac cone can be populated directly from the first Dirac cone by photoexcitation with 1.7 eV photon energy. We observe dichroic photoemission for both circularly polarized probe and pump pulses. This hints at a helical spin structure of the second Dirac cone [1] and its asymmetric population, respectively. Both are necessary to create photocurrents with a definite spin polarization.
We studied the temporal evolution of the transient population of the second Dirac cone in order to understand how inter- and intraband scattering influences photocurrents within the TSS.

[1] D. Niesner *et. al.*, *Phys. Rev. B* **86**, 205403 (2012).

O 74.5 Wed 18:15 Poster A

Investigation of charge dynamics by optical Pump-Probe Scanning Tunneling Microscopy — •Terence Thias, Philipp Kloth, Katharina Kaiser, and Martin Wenderoth — IV. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The combination of optical Pump-Probe techniques with Scanning Tunneling Microscopy (STM) enables us to merge atomic resolution of an STM with time resolution on the ns time scale. As it is beyond the bandwidth of the current amplifier we use Shaken-Pulse-Pair-Excitation technique [1]. By illuminating the n-doped GaAs(110) surface we generate electron hole pairs, which will be separated in the tip-induced Space Charge Region (SCR). This results in a hole accumulation layer at the surface. As recent results have shown [2] these holes can serve as an additional tunnel channel into the valence band. Studying the time evolution of the photo-induced tunnel current gives access to the charge dynamics .Surprisingly, we have found a dependency on the pulse duration of excitation as well as on the tunnel current. We discuss two main processes determining the relaxation characteristic of the excited system. One process is the filling of the photo-generated holes trapped at the surface, the other is the charging/discharging of dopants changing the local SCR beneath the STM tip.

[1] Terada et al., Nature Photonics, 4(12), 2010
[2] Kloth et al., Nat. Comm. (2015)

O 74.6 Wed 18:15 Poster A

A setup for time-resolved SHG microscopy of 2D heterostructures — •Jonas Zimmermann, Gerson Mette, and Ulrich Höfer — Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany

Van-der-Waals coupled 2D materials span the whole range from metallic over semiconducting up to isolating materials and their combination leads to fascinating opportunities for designing stacked heterostructures. The huge variety of possibilities calls for experimental methods which can effectively probe the structure as well as the electron dynamics of these heterostructures.

Here, we present an experimental setup for time-resolved studies on interfaces of 2D heterostructures by means of SHG microscopy. This technique allows us to quantify the crystal structure via polarization dependent measurements and will give access to the electron dynamics via time-resolved pump-probe measurements. We demonstrate the capabilities of our setup with measurements done on CVD grown polycrystalline WS_2 monolayer flakes. The resolution of the experiment is diffraction limited to about 2μm. The relative orientation of several crystal domains can be determined with an error of a few degrees. Because the setup is designed to exclude any dispersion afflicted components, high temporal resolution by the use of ultra-short laser pulses in a pump-probe measurement is feasible. This combination of high temporal and spatial resolution can be applied to 2D heterostructures to study the effects of relative crystal orientation on time-dependent charge transfer processes between different materials.

O 74.7 Wed 18:15 Poster A

Mutual influence of relaxation processes in laser-irradiated metals — •Kai Klein, Sebastian Weber, and Baerbel Rethfeld — Fachbereich Physik und Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany

When an ultrashort laser pulse irradiates a metal, energy is absorbed by the electron system which is driven out of thermal equilibrium on a femtosecond time scale. Due to electron-electron collisions a new thermodynamical equilibrium state within the electron system is established in a characteristic time, the so-called thermalization time. At the same time, electron-phonon collisions transfer energy to the phononic system until both temperatures equilibrate.

We study the dynamics of the nonequilibrium systems by applying complete Boltzmann collision integrals to describe the transient electron distribution due to excitation, thermalization and relaxation. Specific material properties enter the calculation through the density of states.

The results show the mutual influence of both collision processes. We see that the coupling to the phonons affects the electron thermalization. Moreover, the electron-phonon coupling strength differs from the equilibrium coupling, when the electron system is not thermalized.