O 5: Electron and spin dynamics I

Time: Monday 11:15–13:00 Location: H34

O 5.1 Mon 11:15 H34

Image-potential states on Au(100) measured by Two-Photon Photoemission — •Tobias Bierlein, Daniel Niesner, and Thomas Fauster — Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen

Most metals do not have reconstructions of their clean surfaces at room temperature. But Au(100) and Ir(100) surfaces always reorder to (5x20) respectively (5x1) reconstructions. There are some methods to break this reconstructions and obtain (1x1) surfaces. The resulting surfaces were examined for work function and image-potential states with Two-Photon Photoelectron Spectroscopy (2PPE). 2PPE uses two short laser pulses for the emission of electrons. The first pulse excites the electrons into the image potential states, the second pulse emits them into free electron states. Measurements were performed using a display analyzer, which allows to detect electrons from a large range of emission angles. With this method binding energies and dispersion of image-potential states were determined.

O 5.2 Mon 11:30 H34

Image-Potential Resonances on Al(100) — •Matthias Schult, Manuel Marks, Jens Güdde, and Ulrich Höfer — Fachbereich Physik und Zentrum für Materialwissenschaften, Philipps-Universität, 35032 Marburg, Germany

The Hydrogen-like image-potential (IP) states provide a well understood model system to study electron dynamics at metal surfaces. The energy of these states is usually located within the projected bulk band gap, which limits the penetration of the excited electrons into the bulk. In many surface phenomena that are connected to electron transfer, however, electronic resonances, i.e. electronic states at the surface that are resonant with bulk states, play an important role.

At Al(100) the vacuum energy lies 6 eV above the projected bulk band gap and the whole series of IP states form surface resonances with strong coupling to bulk states. Excited electrons in these resonances can not only decay by electron-hole pair excitation, but can also scatter elastically into the bulk. Therefore, much shorter lifetimes and broader linewidths compared to noble metal surfaces can be expected.

In this talk we present experimental results on the energies and lifetimes of IP resonances on the Al(100) surface obtained by time-resolved two-photon photoemission. In the photoelectron spectra the first members of the IP resonance series up to $n = 3$ could be resolved. For $n \geq 3$ lifetimes that are longer than the experimental time-resolution of 60 fs could be observed. We will compare the experimental results to calculations using a one-dimensional model potential, which predict binding energies and the elastic contribution to the lifetimes.

O 5.3 Mon 11:45 H34

Time and angle-resolved photoelectron spectroscopy of solids using femtosecond high-harmonic-generation pulses — •Timm Rohwer, Martin Wiesenmayer, Stefan Hellmann, Kai Rossnagel, Lutz Kipp, and Michael Bauer — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

Angle-resolved photoelectron spectroscopy (ARPES) has emerged as a leading technique in identifying static key properties of complex electron systems. In a pump-probe scheme using femtosecond XUV pulses this technique can be extended to monitor ultrafast changes in the electronic valence and core-level structure in response to an intense optical excitation. In this contribution we present first time-resolved ARPES data from Pt(111) recorded with a 3 kHz high-harmonic-generation source. A multilayer mirror monochromator guarantees a LAPE (laser-assisted photoemission) cross-correlation trace shorter than 35 fs, mainly governed by the width of the 800 nm excitation pulses. We furthermore proof the capability of this technique to monitor ultrafast band structure phenomena over the whole Brillouinzone.

O 5.4 Mon 12:00 H34

One- and two-photon photoemission from Si(100) — •Thomas Fauster[1], Shin'ichiro Tanaka[2], and Katsumi Tanimura[2] — [1]Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen, Germany — [2]The Institute of Scientific and Industrial Research, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan

One- and two-photon photoelectron spectra with the same total photon energy should give information on the same initial and final states. Differences show the influence of intermediate states in two-photon photoemission (2PPE). Of particular interest are bulk bands where the conservation of perpendicular momentum leads to peak shifts, resonances and peak narrowing [1,2].

We have measured one- and two-photon photoemission from Si(100)(2×1) in normal emission using frequency-quadrupled and -doubled femtosecond laser radiation with a total photon energy around 6 eV for s- and p-polarized light incident at 45°. Differences and common features in the various spectra are analyzed and discussed.

[1] Schattke *et al.*, Phys. Rev. B **78**, 155314 (2008).
[2] Pontius *et al.*, Phys. Rev. B **72**, 115105 (2005).

O 5.5 Mon 12:15 H34

Ultrafast Electron Transfer Dynamics at Phosphorus-Metal Interfaces — •Florian Blobner, Stefan Neppl, and Peter Feulner — Physik-Department E20, TU-München, Germany

Ultrafast electron transfer reactions in heterogeneous systems are of paramount interest in both fundamental research and technology.

To obtain a better understanding of the underlying mechanisms of ultrafast charge transfer, we investigated the simplest model system, a reactive atom adsorbed on a surface. Using the core hole clock spectroscopy, we studied the influence of the electronic and structural properties of different adsorbate-substrate systems on the charge transfer dynamics. We investigated the following three systems: P/Ru(0001) with two different adsorbate superstructures and P/Cu(111).

Our analysis shows that the charge transfer of the excited phosphorus P2s electron to the conduction band of the Ru(0001) occurs on a timescale of a few femtoseconds down to several hundred attoseconds and is not affected by the symmetry of the adsorbate superstructure nor by the polarization of the electric field. In contrast to that, no evidence for an electron localization could be found for Phosphorus adsorbed on the Cu(111) surface. Our investigations also proved that both P/Ru(0001) systems are well suited for further analysis with the attosecond streaking technique which allows insight into the real time dynamics of the system.

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O 5.6 Mon 12:30 H34

Attosecond photoelectron spectroscopy of solids — •Elisabeth Magerl[1], Adrian L. Cavalieri[1], Ralph Ernstorfer[2], Stefan Neppl[2], Nicholas Karpowicz[1], Michael Stanislawski[1], Elisabeth Bothschafter[1], Dietrich Menzel[2], Johannes V. Barth[2], Peter Feulner[2], Ferenc Krausz[1,3], and Reinhard Kienberger[1,2] — [1]Max Planck Institute of Quantum Optics, Garching, Germany — [2]Technical University of Munich - E20, E11, Garching, Germany — [3]Ludwig Maximilians University, Munich, Germany

The dynamics of the photoelectric effect in single-crystals are investigated on the attosecond time scale. An isolated attosecond XUV-pulse is used to excite photoelectrons, while a few-cycle waveform-controlled NIR-pulse modulates the kinetic energy of the emitted photoelectrons. Recently, applying this streaking technique a relative time delay in emission on the order of 100 attoseconds between electrons originating from different electronic levels in tungsten was already revealed [1].

In order to further study the delay and its possible dependence on material properties and on laser parameters, several streaking measurements on different systems were carried out: We present results obtained on single-crystalline tungsten and rhenium, measured with XUV photon energies of 90 and 130 eV. We also show measurements on a combined system of a single crystal substrate with an adsorbed monolayer of a rare gas.

[1] A. L. Cavalieri et al., Nature **449**, 1029 (2007)

O 5.7 Mon 12:45 H34

1*T*-$TiSe_2$: Ultrafast Dynamics in the CDW Phase — •Stephan Hilgenfeldt, Martin Wiesenmayer, and Michael

Bauer — Institut für Experimentelle und Angewandte Physik, Universität Kiel, 24098 Kiel, Germany

At $T \approx 200$ K the transition metal dichalcogenide $1T$-$TiSe_2$ undergoes a phase transition into a charge density wave (CDW) phase which is accompanied by the formation of a (2×2×2) superlattice. The origin of this CDW phase has been under discussion for a long time and recent photoemission experiments give evidence for an excitonic insulator phase to play a key role in the understanding of this system. In this talk we present pump-probe photoemission results of $1T$-$TiSe_2$ in the CDW state in the weak excitation regime. We are able to monitor an optically induced weakening of the CDW phase taking place within 250 fs and we follow the subsequent dynamics of this perturbation further into the picosecond time regime. Our results will be discussed under consideration of the excitonic insulator model for $TiSe_2$.