O 50 Time-resolved spectroscopy II

Time: Friday 11:15–13:00 Room: WIL C207

O 50.1 Fri 11:15 WIL C207

Time-resolved two-photon photoemission from the Si(557)Au surface — •Tilman K. Rügheimer[1], Franz J. Himpsel[2], and Thomas Fauster[1] — [1]Lehrstuhl für Festkörperphysik, Institut für Physik der Kondensierten Materie, Universität Erlangen, Staudtstr. 7, D-91058 Erlangen — [2]Department of Physics, University of Wisconsin-Madison, 1150 University Avenue, Madison, Wisconsin 53706, USA

Atomic chains of gold on silicon surfaces have attracted interest as model systems for one-dimensional conductors. For the Si(557)Au surface electronic states at the gold chains and the step edges are predicted by density functional theory [1]. Angle resolved photoemission [2] and scanning tunneling spectroscopy [3] assign the conduction to the gold chains and the step edges, respectively.

We have carried out two-photon photoemission experiments to clarify the electronic structure of the Si(557)Au surface. Pinning of the Fermi level and two strongly dispersing initial states below the Fermi energy have been found. A conduction band feature shows a complex population dynamics in time-resolved measurements. Finally, our results are compared to recent ab initio calculations [1].

[1] D. Sanchez-Portal et al., Phys. Rev. Lett. 93 (2004) 146803
[2] J. N. Crain et al., Phys. Rev. B 69 (2004) 125401
[3] H. W. Yeom et al., Phys. Rev. B 72 (2005) 035323

O 50.2 Fri 11:30 WIL C207

Electronic Structure of Si(100) at high excitation density: A Time-Resolved Photoemission Study with Combined Laser and Synchrotron Radiation. — •H. Prima Garcia[1], T. Giessel[1], R. Schmidt[1], R. Weber[1], W. Widdra[2], and M. Weinelt[1,3] — [1]Max-Born-Institute, Berlin, Germany. — [2]Martin Luther University, Halle, Germany. — [3]Freie university, Berlin, Germany.

We have studied the dynamics of laser-induced plasma-driven processes at the Si(100) surface. At the BESSY low-α hybrid mode we established an overall time-resolution of 10 ps. For 800 nm, 60 fs laser pulses induces an e-h plasma density of 10^{21} cm^{-3} and concomitant band gap narrowing in the bulk. Band gap renormalization occurs in 50 picoseconds and is distinguishable from photovoltage dynamics.

We observe in addition depopulation of the D_{up} surface state by more than 40%, which suggests a sizeable change of the surface electronic structure and a corresponding reduction of the dimer buckling. A recent time-dependent DFT study predicts this to occur on a subpicosecond time-scale [1].

Si 2p core level spectra show a transient increase of the linewidth, with the surface component broadening stronger than the bulk component. This is interpreted in terms of screening induced defect formation due to the high and long-lived transient carrier density at the surface upon IR laser excitation.

[1] Jan van Heys, Michael Lindenblatt, and Eckhard Pehlke, Phase transitions.in.press.00.May.2005)

O 50.3 Fri 11:45 WIL C207

Local Plasmon Excitations in Silver Nanodots: Spatio-temporal evolution and coupling dynamics probed by interferometric time-resolved PEEM — •Jörg Lange, Carsten Wiemann, Daniela Bayer, Oksana Gaier, Martin Rohmer, Christian Schneider, Michael Bauer, and Martin Aeschlimann — University of Kaiserslautern, Department of Physics, Kaiserslautern, Germany

We have studied the temporal and spatial evolution of collective electronic excitations (Mie-plasmons) in silver nanostructures using phase resolved interferometric two-photon photoemission electron microscopy (PR-2PPEEM). The interference of a reference He:Ne laser beam was used to achieve a temporal resolution in the attosecond regime of the piezo driven scanning interferometer, which we used for the two-photon photoemission pump-probe experiment. At the same time, the 2PPE-yield collected by the photoemission electron microscope allows a lateral resolution better than 40 nm. We demonstrate that this setup enables to monitor the temporal response of collective electronic excitations (Mie-plasmons) to an excited femtosecond laser pulse in silver nanodots. Regarding the plasmon induced inhomogeneous spatial distribution of the 2PPE-yield from single nanodots we observe a complex dependence on the temporal phase between the pump and the probe pulse. Furthermore, we were able to resolve spatio-temporal variations in the 2PPE-signal from pairs of close-lying nanodots, thus enabling insight into the dynamics of coupled plasmon excitations.

O 50.4 Fri 12:00 WIL C207

Ultrafast dynamics on the Gd(001) surface studied with time-resolved photoelectron spectroscopy — •Panagiotis Loukakos, Martin Lisowski, Uwe Bovensiepen, and Martin Wolf — Fachbereich Physik, Freie Universität Berlin

The Gd(001) surface is an interesting system to study the recently discovered coherent phonon-magnon mode as observed with magneto-optical experiments.[1] We use time-resolved photoelectron (TRPE) spectroscopy to analyze directly the dynamical evolution of the electron distribution, after excitation with 1.5 eV, 50 fs laser pulses. The dynamics of the excited system is probed by photoemission with a 6 eV, 80 fs laser pulse. Under normal emission we observe at T=30 K an exchange-split $5d_{z^2}$ surface state (SS) whose majority component lies 200 meV below the Fermi level. We present the ultrafast dynamics of the occupied SS and distinguish two different fluence and time regimes. At early times where the electron population is far from equilibrium and for low absorbed fluences (<0.1 mJ/cm^2) the SS shifts away from the vacuum level. At later time delays, as the electron system thermalizes, the SS shifts towards the vacuum level with dynamics governed by electron-lattice energy transfer. At higher fluences (˜1 mJ/cm^2) the SS shifts at all times towards the vacuum level. Also, an oscillatory behavior of the occupied SS with a period of 300 fs and an amplitude of only 1 meV is well resolved and observed for the first time in PE spectroscopy. This oscillation period is in excellent agreement with the one observed in optical experiments thereby corroborating the mechanism suggested in Ref. 1.

[1]. Melnikov et al. Phys. Rev. Lett. **91**, 227403 (2003)

O 50.5 Fri 12:15 WIL C207

Transition of Ar/Cu image-potential states from short-lived scattering resonances to long-lived quasi-bound interface states — •M. Rohleder, W. Berthold, J. Güdde, and U. Höfer — Fachbereich Physik, Philipps-Universität, D-35032

In the presence of thick Ar overlayers the image potential of Cu(100) gives rise to interface electronic states above the vacuum level. In previous experiments [1,2] we have shown that fundamental aspects of the dynamics of electronic decay at buried solid-solid interfaces and fast electron transfer processes through thin insulators can be investigated for this system by means of time-resolved two-photon photoemission (2PPE). Here, we demonstrate that these interface states may also be observed as final-state resonances in conventional one-photon photoemission (1PPE). Spectroscopically, this has advantages in terms of a higher accessible energy range above the vacuum level. With increasing layer thickness the hydrogen-like series shows a transition from broad resonances in the Ar conduction band into more narrow quasi-bound states confined to the Ar/Cu interface. We compare the experimental results with theoretical resonance positions and linewidths derived from a parametrized one-dimensional potential. For electrons with small momenta perpendicular to the surface we find excellent agreement between calculated and measured energies. The calculated widths of the lowest lying resonances agree well with the electron transfers times measured by 2PPE whereas the 1PPE spectra are apparently broadened by other contributions.

[1] M. Rohleder *et al.*, Phys. Rev. Lett. **94**, 017401 (2005).
[2] M. Rohleder *et al.*, New. J. Phys. **7**, 103 (2005).

O 50.6 Fri 12:30 WIL C207

Ultrafast decay dynamics of a photoexcited adsorbate in interaction with a two-dimensional metallic substrate — •M. Bauer[1], M. Wessendorf[1], S. Matthias[1], J. Lange[1], M. Aeschlimann[1], V.M. Silkin[2], A.G. Borisov[3], P.M. Echenique[2,4], J.P. Gauyacq[3], and E.V. Chulkov[2,4] — [1]Department of Physics, University of Kaiserslautern, 67663 Kaiserslautern — [2]Donostia International Physics Center, San Sebastián, 20018, Spain — [3]Laboratoire des Collisions Atomiques et Moléculares, Université Paris-Sud, 91405 Orsay Cedex, France — [4]Departamento de Física de Materiales and Centro Mixto, Facultad de Química, San Sebastián, Spain

The lifetime of adsorbate resonances is known to play a key role in the course of many photoinduced surface reactions. Control of the resonance

lifetime would, therefore, be a means of manipulating surface chemical processes. In this paper we report on the tuning of a resonance lifetime by interaction of an adsorbate with epitaxically grown thin metal films at varying thickness. For the model system Cs/Ag/Cu(111) we observe that the lifetime of the cesium 6s resonance depends critically on silver film thickness and varies by a factor of three in the thickness regime between 1 and 7 ML. Our results are in qualitative good agreement with theoretical predictions. Quantitative discrepancies are related to structural (stress induced) modifications of the silver film and the copper substrate. Our result is a striking example for a fundamental property of adsorbate-surface interaction relevant for surface chemical processes modified by the dimensionality of the substrate.

O 50.7 Fri 12:45 WIL C207

Mapping the electron correlation at surfaces by two-electron photoemission — •Frank O. Schumann, Carsten Winkler, Gwilherm Kerherve, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle

Established theoretical concepts show that the Coulomb and exchange interaction result in a tendency of two electrons to avoid each other leading to an exchange-correlation (xc) hole. We will report on double photoemission (DPE) experiments using a novel time-of-flight set-up consisting of a small central collector surrounded by a resistive anode. The first allows detection only within a narrow solid angle therefore fixing the momentum. The resistive anode covers a solid angle of $\sim$1 sr, the determination of the impact position results in momentum resolution. As pulsed light source we used synchrotron radiation and studied a NaCl(100) surface upon excitation with 34 eV photons. The very existence of coincidences is already a manifestation of the correlation. The onset of pair emission occurs, when energy conservation allows the ejection of two electrons from the highest occupied level. We have made two key observations. If E_1 and E_2 are fixed such that pair emission from the top of the valence band is possible, a zone of reduced intensity with a diameter of $\sim$1.1 $Å^{-1}$ is visible. Recent calculations on DPE from a Cu(100) surface display exactly such a feature due to the xc-hole. Hence we proof experimentally the very existence of the xc-hole in double photoemission.The zone of reduced intensity disappears, whenever emission below the top of the valence band becomes possible indicating the sensitivity of the xc-hole to inelastic scattering.