O 25 Zeitaufgelöste Spektroskopie II

Zeit: Samstag 15:00–17:00 Raum: TU EB420

O 25.1 Sa 15:00 TU EB420

Anregungs- und Relaxationsdynamik von Elektronen in laserbestrahlten Metallen — •Bärbel Rethfeld[1] und Andreas Kaiser[2] — [1]Institut für Laser- und Plasmaphysik, Universität Duisburg–Essen, D-45117 Essen — [2]Institut fuer Physik, Humboldt-Universität Berlin, 12489 Berlin

Mittels eines ultrakurzen Laserpulses kann das freie Elektronengas in Metallen stark im thermodynamischen Gleichgewicht gestört werden. Durch Elektron–Elektron Stöße thermalisiert das Elektronengas zu einem Gleichgewicht höherer Temperatur; gleichzeitig wird durch Elektron–Phonon Stöße Energie an das Gitter abgeben. Diese elementaren Stoßprozesse werden in einer zeit- und energieaufgelösten Beschreibung durch Boltzmann'sche Stoßintegrale im Detail berücksichtigt, wodurch wir explizit die Verteilungsfunktion der Elektronen und Phononen während und nach der Bestrahlung berechnen können. Die Ergebnisse zeigen, dass durch eine nicht abgeschlossene Thermalisierung des Elektronengases der Energietransfer an das Gitter verlangsamt werden kann. Es werden Relaxations- und Thermalisierungszeiten für das freie Elektronengas in Aluminium ermittelt.

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Time Resolved Nonlinear Magneto-Optical Spectroscopy at Gd(0001) Surface: Ultrafast Lattice and Spin Dynamics — •Ilie Radu, Alexey Melnikov, Uwe Bovensiepen, Kai Starke, Eckart Matthias, and Martin Wolf — Freie Universität Berlin, Fachbereich Physik, Arnimmalle 14, 14195 Berlin

Pump-probe second harmonic generation (SHG) measurements performed on ferromagnetic Gd(0001) surfaces revealed the existence of a coupled coherent phonon-magnon mode at frequency of 3 THz [1]. This is reflected in oscillatory contributions in the transient SHG signal for the electron, phonon and spin subsystems. Here, we present the strong wavelength dependence of incoherent and coherent components of the time-resolved SHG response following the excitation with 35 fs laser pulses within 740-860 nm wavelength range. The SHG process at Gd surfaces evolves resonantly enhanced via the unoccupied surface state component which implies a high spectral sensitivity. With increasing photon energy we observe an increase in the incoherent contribution and a decrease in the coherent part of the excitation. This is ascribed to a population build-up in the unoccupied spin down surface state which increases with hν, while the depopulation of the occupied component, occurring simultaneously, varies just weakly with photon energy.

This project is funded by DFG through SPP 1133.

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

O 25.3 Sa 15:30 TU EB420

Spin-dependent electron dynamics in front of an ultrathin iron film — •Anke Schmidt[1], Martin Pickel[2], Martin Wiemhöfer[2], Markus Donath[2], and Martin Weinelt[3] — [1]Lehrstuhl für Festkörperphysik, Staudtstraße 7, 91058 Erlangen — [2]Physikalisches Institut, Universität Münster, Wilhelm-Klemm-Straße 10, 48149 Münster — [3]Max-Born-Institut, Max-Born-Straße 2A, 12489 Berlin

Ultrafast demagnetisation of ferromagnetic thin films upon laser excitation is a phenomenon not yet fully understood. It is still controversial which processes lead to the loss of total magnetic moment. Two-photon photoemission (2PPE) provides a powerful tool for the investigation of electron dynamics and the identification of scattering processes at surfaces [1].

We have studied the energetics and dynamics of exchange-split image-potential states on ultrathin iron films on Cu(100) with time-, energy-, and spin-resolved bichromatic 2PPE. We are able to observe the exchange splitting of the first and the second image-potential state directly. In time- and spin-resolved measurements, spin-dependent lifetimes were found. A linewidth analysis of the energy-resolved 2PPE-spectra shows spin-dependent dephasing, which indicates a spin-dependent elastic scattering process.

[1] K. Boger, M. Weinelt and Th. Fauster, Phys. Rev. Lett. **92**, 126803 (2004)

O 25.4 Sa 15:45 TU EB420

Electron dynamics in thin Ag-films on Si(100) — •Claudia Kennerknecht[1], Sven Schramm[1], Walter Pfeiffer[1], Olaf Weisse[2], and Eckart Hasselbrink[2] — [1]Physikalisches Institut, Universität Würzburg, Am Hubland, 97070 Würzburg — [2]Fachbereich Chemie, Universität Duisburg-Essen, Universitätstr. 5, 45117 Essen, Germany

The properties of Ag-films of few nanometers thickness differ substantially from bulk materials. So called quantum well states appear because of the confinement in one dimension [1]. In addition, thin films show unexpected catalytic bevior. Using time-resolved multiphoton photoemission spectroscopy we gain information about the transient electron distribution of our sample. The spectra reveal the internal thermalization and cooling of the electron gas.

Measurements on thin Ag-films on n-doped Si(100) show a wavelength dependence which can be explained by different absorption in the Ag-film and the Si substrate. Time-resolved measurements reveal larger relaxation times compared to measurements on thin Ag-films on MgO(100) and single crystals [2]. We attribute this influence of the substrate to carrier injection from the photoexcited Si.

[1] Matsuda et al, Phys. Rev. B 65 (2002)
[2] Aeschlimann et al, Appl. Phys. A 71 (2000)

O 25.5 Sa 16:00 TU EB420

Ultrafast dynamics of the exchange split surface state of Gd(0001)/W(110) — •Martin Lisowski, Panagiotis Loukakos, Uwe Bovensiepen und Martin Wolf — Freie Universität Berlin, Fachbereich Physik, Arnimallee 14, 14195 Berlin

Gadolinium is a model system for ferromagnetic materials where the exchange interaction of localized magnetic moments is mediated via spin-polarization of the conduction band electrons (RKKY interaction). An interesting question is, whether it is possible to demagnetize such a ferromagnet on a femto-second time scale by disturbing the conduction band electrons. We use time resolved photoelectron spectroscopy to investigate the dynamics of the Gd(0001)/W(110) surface upon excitation with an optical pump pulse. The use of a probe photon energy above the work function of Gd allows us to directly measure the transient electron temperature as well as the occupied and unoccupied part of the exchange split surface state, which serves as a probe for magnetism. We observe a sub pico-second reduction of the SS binding energy. Comparison with a two-temperature model simulation shows that the decrease in binding energy is initially faster than the increase in lattice temperature, excluding a simple lattice heating effect as explanation. A damped oscillation of 2.8 THz frequency and 1 ps damping time is superimposed on the binding energy shift and is attributed to a coherent LO phonon-magnon mode.

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Momentum-dependent dynamics of buried interface states in Ar/Cu(100) — •M. Rohleder, W. Berthold, J. Güdde und U. Höfer — Fachbereich Physik und Zentrum für Materialwissenschaften, Philipps-Universität Marburg, D-35032 Marburg

The electronic properties of interfaces play a fundamental role in both basic and applied research. In particular, the dynamics of electrons located at solid-solid interfaces is a key to many technological applications. Only recently, we have demonstrated the existence of buried interface states in the Ar/Cu(100) system and investigated the transient decay of these image-like states by means of time-resolved two-photon photoemission [1]. In this study, we focus on momentum-dependent relaxation processes in the nearly-free-electron bands. The experiments were performed by using a hemispherical analyzer equipped with a 2d detector, allowing for single-shot $E(k)$ measurements. The parabolic dispersion could be mapped for the first $n' = 1$ interface state. Its effective mass is only 0.6 m_e as a consequence of the highly corrugated potential inside the Ar layer. For finite parallel momenta we found an increase of the decay rate proportional to the kinetic energy of parallel motion, $\Gamma = \hbar/\tau = 6.3$ meV $+ 0.012\ E_{\|}$. Our results infer that the situation is similar to the image-potential states of clean Cu(100) [2] where inelastic interactions with metal electrons lead to interband decay into the bulk and intraband scattering inside the bands.

[1] M. Rohleder *et al.*, submitted to Phys. Rev. Lett.
[2] W. Berthold *et al.*, Phys. Rev. Lett. **88**, 056805 (2002).

O 25.7 Sa 16:30 TU EB420

How much does the surface projected band structure influence ultra fast charge transfer at a surface? The case of Ar adsorbed on Cu(111) and Cu(100) — •Alexander Föhlisch, Sethuraman Vijayalakshmi, Franz Hennies, Annette Pietzsch, Mitsuru Nagasono, and Wilfried Wurth — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, D-22761 Hamburg

Surfaces and interfaces determine many properties of matter. Next to the geometric structure of the surface the surface projected bulk band structure and surface states and resonances play an important role. Even the difference of the surface electronic structure of different crystal faces has consequences for the charge transfer dynamics at these surfaces. Charge transfer at the Cu(100) and Cu(111) surfaces has drawn considerable attention from experiment and theory [1,2,3], due to the difference of their surface projected band gap. Using core hole clock spectroscopy we have shown in previous work that ultra fast charge transfer varies significantly for different metal surfaces [4].

In this contribution we show that charge transfer of the 4s electron of core-excited $2p_{3/2}^{-1}4s^1$ Ar adsorbed on the Cu(100) surface is a factor of two faster than on the Cu(111) surface.

This work was supported by the DFG SPP 1093.

[1] M. Bauer et al., Phys. Rev. B **60**, 5016 (1999)
[2] A.G. Borisov et al., Phys. Rev. Lett. **86**, 488 (2001)
[3] J. P. Gauyacq and A. G. Borisov, Phys. Rev. B **69**, 235408 (2004)
[4] A. Föhlisch et al., Chem. Phys. **289**, 107 (2003)

O 25.8 Sa 16:45 TU EB420

Scattering by Co adatoms between image-potential bands on Cu(001) — •Klaus Boger[1], Martin Weinelt[2], and Thomas Fauster[1] — [1]Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen — [2]Max-Born-Institut, Max-Born-Straße 2A, 12489 Berlin

The increasing resolution and sensitivity of photoelectron spectroscopy reveals more and more details about the influence of defects. By means of time- and angle-resolved two-photon photoemission the various scattering processes induced by adsorbate atoms can be studied [1]. We now have examined the dynamics of electrons in image-potential states on the Cu(001) surface covered by statistically distributed Co adatoms. Even at low coverages of about 0.6% of a monolayer strong scattering from higher image-potential bands into the first one is observed. From the measured data the transfer of energy and parallel momentum at these scattering processes can be determined.

[1] K. Boger, M. Weinelt, and Th. Fauster, Phys. Rev. Lett. **92** (2004) 126803