DYNAMICS OF ELECTRON TRANSFER PROCESSES AT SURFACES (SYET)

Jointly organized by
Magnetism (MA)
Metal- and Material Physics (MM)
Surface Physics (O)

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OVERVIEW OF INVITED TALKS AND SESSIONS

(lecture room HSZ 04)

Invited Talks

SYET 1.1	Thu	10:00	(HSZ 04)	**Ultrafast coherent control of Spin- and magnetization dynamics**, Theo Rasing
SYET 1.2	Thu	10:30	(HSZ 04)	**Spin-dependent dynamics of electrons at ferromagnetic surfaces**, Martin Weinelt, Anke B. Schmidt, Martin Pickel, Markus Donath
SYET 1.3	Thu	11:00	(HSZ 04)	**Electronic structure and coupled electron/atom dynamics of alkali atoms on noble metals**, Hrvoje Petek
SYET 1.4	Thu	11:30	(HSZ 04)	**Ab initio calculation of charge transfer at surfaces**, Daniel Sánchez-Portal
SYET 1.5	Thu	12:00	(HSZ 04)	**Damping of the surface plasmon resonance in metal nanoparticles: mechanisms operating on the femtosecond timescale**, F. Hubenthal, C. Hendrich, F. Träger
SYET 1.6	Thu	12:30	(HSZ 04)	**Time-resolved electron injection from the excited state of anchored molecules into semiconductors**, Frank Willig, Lars Gundlach, Ralph Ernstorfer, Volkhard May, Petter Persson, Rainer Eichberger, Silke Felber

Sessions

SYET 1	**Dynamics of electron transfer processes at surfaces**	Thu 10:00–13:00	HSZ 04	SYET 1.1–1.6

Sessions

– Invited Talks –

SYET 1 Dynamics of electron transfer processes at surfaces

Time: Thursday 10:00–13:00 Room: HSZ 04

Invited Talk SYET 1.1 Thu 10:00 HSZ 04

Ultrafast coherent control of Spin- and magnetization dynamics — •Theo Rasing — IMM, Radboud University Nijmegen, Toernooiveld 1, N-6525 ED Nijmegen, The Netherlands

The manipulation of the electron spin is not only relevant for magnetic storage but may also lead to the development of novel electronic devices with new characteristics (so-called spintronics) or to quantum computation. Therefore, the investigations of the physical mechanisms underlying the manipulation of electron spin in ferromagnets, semiconductors and hybrid ferromagnet/semiconductor structures constitute at present an exciting area of research.

Femto-second laser excitation opens the way to excite magnetic systems on a time scale much shorter than fundamental time scales such as spin-lattice relaxation or precession times. This has already lead to surprising and exciting results like changes in magnetization on a subpicoscond time scale.

Recent progress in this area will be discussed, demonstrating in particular the use of time resolved linear and nonlinear optical methods to investigate the static and dynamic properties of magnetically ordered structures and the possibility of direct spin manipulation with optical fields[1,2].

[1] A. Kimel, A. Kirilyuk, P.A. Usachev, R.V. Pisarev, A.M. Balbashov and Th. Rasing, Nature 435, 655 (2005) [2] F. Hansteen, A.V. Kimel, A. Kirilyuk and Th. Rasing, PRL July 15th (2005).

Invited Talk SYET 1.2 Thu 10:30 HSZ 04

Spin-dependent dynamics of electrons at ferromagnetic surfaces — •Martin Weinelt[1,2], Anke B. Schmidt[1,3], Martin Pickel[4], and Markus Donath[4] — [1]Max-Born-Institut, Max-Born-Straße 2A, 12489 Berlin, Germany — [2]Freie Universität Berlin, Fachbereich Physik, Arnimallee 14, 14195 Berlin, Germany — [3]Universität Erlangen, Lehrstuhl für Festkörperphysik, Staudtstr. 7, 91058 Erlangen, Germany — [4]Physikalisches Institut, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany

Recent experiments demonstrated that significant demagnetization of ferromagnetic thin films upon laser excitation can be achieved within a few hundred femtoseconds. Which microscopic processes lead to the loss of magnetization remains, however, controversial.

Our approach is to find possible decay channels for demagnetization processes by studying the electron dynamics in a ferromagnet spin dependently. We combined ultrafast time-resolved spectroscopy with spin-resolved electron detection. Despite the loss of about four orders of magnitude in count rate due to the spin-selective detector, our experiment allows for a time-, energy, and angle-resolved analysis of majority- and minority-electron dynamics.

We could demonstrate that image-potential states in front of ultrathin ferromagnetic films provide a simple model system for a detailed investigation of spin-dependent scattering processes at surfaces.

[1] A.B. Schmidt, M. Pickel, M. Wiemhöfer, M. Donath, and M. Weinelt, Phys. Rev. Lett. 95, 107402 (2005).

Invited Talk SYET 1.3 Thu 11:00 HSZ 04

Electronic structure and coupled electron/atom dynamics of alkali atoms on noble metals — •Hrvoje Petek — Department of Physics and Astronomy

We have investigated the unoccupied electronic structure of alkali atoms (Li-Cs) on noble metal surfaces (Cu(111) and Ag(111)). Contrary to all theoretical predictions, the unoccupied alkali atom resonance at 2.8 - 3.0 eV exhibits universal behavior with the resonance energy being independent of the principle quantum number of the alkali atom or the chemisorption distance. The excited state appears to correlate with the energy of localizing an electron on the alkali atom. We have also investigated the electronic relaxation rates of alkali atoms through the reverse charge transfer into the conduction band of the substrate. The charge transfer is hindered by the presence of the projected band gap at the alkali atom resonance, for a large range of parallel momenta. The effective relaxation rates appear to be slower than predicted by theories that treat accurately the anisotropy of the band structure of noble metals.

Invited Talk SYET 1.4 Thu 11:30 HSZ 04

Ab initio calculation of charge transfer at surfaces — •Daniel Sánchez-Portal — Unidad de Física de Materiales, Centro Mixto CSIC-UPV/EHU, and Donostia International Physics Center (DIPC), Paseo Manuel de Lardizabal 4, 20018 Donostia - San Sebastián, Spain

In this contribution I will present a scheme for the calculation of the transfer rates of electrons from adsorbates to metallic substrates. The electrons initially reside in electronic excited states in the adsorbates. Our calculations are based on first-principles density-functional calculations of the combined adsorbate-substrate system using finite slabs. These results are then combined with bulk calculations of the substrate material to obtain the Green's function of the semi-infinite system. Our results are thus based on a realistic description of the electronic structure of both systems, the substrate and the adsorbate, and the interaction between them. This scheme has also been applied recently to the calculation of the elastic width of quantum well states at alkali overlayers on Cu(111) [1]. We focus here in two cases: i) the c(4x2)-S/Ru(0001) surface [2], and ii) Ar monolayers on Ru(0001) [3]. In the first case we find a charge transfer time well below the femtosecond scale, in very good agreement with the experimental measurements based on core-hole-spectroscopy using Coster-Kronig decay channels. Also for the case of Ar on Ru our calculated values and trends are in good agreement with the experimental observations.

[1] C. Corriol, V. M. Silkin, D. Sánchez-Portal, A. Arnau, E. V. Chulkov, P.M. Echenique, T. von Hofe, J. Kliewer, J. Kröger, and R. Berndt, Role of elastic scattering in electron dynamics at ordered alkali overlayers on Cu(111), to appear in Phys. Rev. Lett.

[2] A. Föhlisch, P. Feulner, F. Hennies, A. Fink, D. Menzel, D, Sánchez-Portal, P. M. Echenique, and W. Wurth, Direct observation of electron dynamics in the attosecond domain, Nature (London) 436, 373 (2005)

[3] D. Sánchez-Portal, D. Menzel and P. M. Echenique, to be published

Invited Talk SYET 1.5 Thu 12:00 HSZ 04

Damping of the surface plasmon resonance in metal nanoparticles: mechanisms operating on the femtosecond timescale — •F. Hubenthal, C. Hendrich, and F. Träger — Universität Kassel, Institut für Physik und Center for Interdisciplinary Nanostructure Science and Technology, Heinrich-Plett-Str. 40, 34132 Kassel, Germany

We present systematic measurements of the ultrafast dephasing time T_2 of surface plasmon excitations in gold and silver nanoparticles (NPs) with the objective to identify the involved damping mechanisms. Au and Ag NPs were produced by applying two laser-based methods [1]. Subsequently, systematic measurements of T_2 in the size range between $R =$ 2 nm and 23 nm were carried out by persistent spectral hole burning [2] as a function of all relevant parameters, i.e. particle size and shape, substrate material and adsorbate coverage. The most essential among the numerous results is the observation of the influence of the reduced dimension on the dephasing time. While $T_2 = 14$ fs has been measured for Au NPs with radii larger than 12 nm which is consistent with the damping contained in the bulk dielectric function, the value of T_2 shrinks to, for example, 5 fs for $R = 3$ nm. This cannot be explained semiclassically by taking only the surface scattering of the oscillating electrons into account. In fact, we observe an increased Landau damping in Au NPs. It is identified by comparing our experimental results for Au and Ag NPs to theoretical predictions of Persson and Yannouleas et al.

[1] T. Wenzel, J. Bosbach, A. Goldmann, F. Stietz, F. Träger, Appl. Phys. B 69, 513 (1999) [2] J. Bosbach, C. Hendrich, F. Stietz, T. Vartanyan, F. Träger, Phys. Rev. Lett. 89, 257404 (2002)

Invited Talk

SYET 1.6 Thu 12:30 HSZ 04

Time-resolved electron injection from the excited state of anchored molecules into semiconductors — •Frank Willig[1], Lars Gundlach[1], Ralph Ernstorfer[1], Volkhard May[2], Petter Persson[3], Rainer Eichberger[1], and Silke Felber[1] — [1]Hahn-Meitner-Institute, SE4, Glienickerstrasse 100, 14109 Berlin, Germany — [2]Humboldt Universität, Institut für Physik, Newtonstrasse 15, 12489 Berlin, Germany — [3]Uppsala University, Quantum Chemistry, Box 518, SE-75120 Uppsala, Sweden

The chromophore perylene was covalently attached to the anchor groups carboxylic acid and phosphonic acid. These molecules were further modified by inserting different spacer groups. The anchor groups formed strong chemical bonds with the semiconductors TiO2 and ZnO. The adsorption geometry was predicted on the basis of DFT calculations and checked with angle and polarization dependent two-photon photoemission (2PPE) signals. The above complex molecules were adsorbed from solution in a dedicated ultra-high-vacuum (UHV) chamber. The characteristic time for transferring the electron from the excited state of the chromophore to empty acceptor states of the semiconductor was measured with 2PPE and with transient absorption. The experimental electron transfer times were compared with line widths obtained from DFT calculations and from fit curves to the linear absorption spectra. The initial energy distribution of the injected electrons represents the heterogeneous electron transfer spectrum. The measured shape of the distribution agreed with the theory for heterogeneous electron transfer in the so called wide band limit.