O 58: Symposium: Beyond Optical Wavelengths: Time-Resolved Spectroscopy of Surface Dynamics with EUV and XUV Radiation I (Invited Speakers: Reinhard Kienberger, Martin Aeschlimann)

Time: Thursday 9:30–11:00 Location: HE 101

Invited Talk O 58.1 Thu 9:30 HE 101

First steps of attosecond spectroscopy in condensed matter — •Reinhard Kienberger — Max-Planck-Institut für Quantenoptik, Hans Kopfermann Str. 1, 85748 Garching, Deutschland

The generation of ever shorter pulses is a key to exploring the dynamic behavior of matter on ever shorter time scales. Electronic dynamics inside atoms often evolve on an attosecond (1 as = 10-18 s) timescale and require sub-femtosecond pulses for capturing them. Atoms exposed to a few oscillation cycles of intense visible or near-infrared light are able to emit a single electron and XUV photon wavepacket of sub-femtosecond duration. Precise control of these sub-femtosecond wavepackets have been achieved by full control of the electromagnetic field in few-cycle light pulses. These XUV pulses together with the few-cycle (few-femtosecond) laser pulses used for their generation have opened the way to the development of a technique for attosecond sampling of electrons ejected from atoms or molecules. First experiments have been carried out to measure sub-femtosecond behavior of matter like the dynamics of the photoionization process on solids. Not only that attosecond metrology now enables clocking on surface dynamics, but also the individual behaviour of electrons of different type (core electrons vs. conduction band electrons) can be resolved. Here, we measured a time delay of about 100 as on the emission of the aforemention two types of electrons.

Invited Talk O 58.2 Thu 10:00 HE 101

Time- and angle-resolved photoemission spectroscopy using a femtosecond high-harmonic light-source — •Martin Aeschlimann — Department of Physics, TU Kaiserslautern, 67663 Kaiserslautern

To date, femtosecond high-harmonic (HHG) light sources have been used successfully in a number of IR-pump XUV-probe photoemission experiments to study the ultrafast dynamics of surface processes. Examples include electron relaxation in materials, surface adsorbate dynamics, photoacoustic dynamics, and molecular dissociation. All these IR-XUV geometries are accompanied by incident laser fields of $> 10^{11} W/cm^2$ leading to additional interesting laser-assisted strong-field dynamic processes on solid surfaces. For instance, just recently the laser assisted photoelectric effect (LAPE) could be demonstrated for IR-XUV excitation of a Pt(111) surface [1] as well as laser assisted auger decay (LAAD). Recent experimental results in this field will be presented. Furthermore, time resolved IR-XUV photoemission can be extended to the momentum space by the use of state-of-the-art 2D photoelectron spectrometers [2]. First ARPES spectra recorded with HHG light pulses will be presented, showing the potential of this technique for future investigations of surface dynamics.

[1] L. Miaja-Avila et al., Phys. Rev. Lett. 97, 113604 (2006)
[2] S. Mathias et al., Rev. Sci. Instr. 78, 083105 (2007)

O 58.3 Thu 10:30 HE 101

Core-level shifts induced by femtosecond laser excitation — Andrea Melzer, Daniel Kampa, Jinxiong Wang, and •Thomas Fauster — Lehrstuhl für Festkörperphysik, Universität Erlangen

The Si(001)(2x2)-Ga surface was used to investigate time-dependent Ga(3d) core-level shifts by pumping electrons from the valence to the conduction band by femtosecond laser pulses with 1.59 eV photon energy. The Ga(3d) core level was probed with higher harmonics generated in argon from the same laser source (1.4 mJ pulse energy, 30 fs pulse length, 779 nm wavelength, 1 kHz repetition rate). The time resolution for the 25th harmonic (40 eV photon energy) was ∼400 fs after a grating monochromator. The band bending of about 110 meV of the p-doped Si(001)(2x2)-Ga surface is completely lifted by illumination of the surface with 1.59 eV laser pulses. The Ga(3d) core level shows a slow time-dependent shift attributed to the build-up (∼1 ns) and decay (∼100 ns) of the photovoltage. The upper limits for the Ga(3d) core-level shift and broadening on the subpicosecond timescale was determined to be less than 12 meV at the used pump pulse intensity of 20 mJ/cm^2. Experiments with pump pulses of 3.18 eV photon energy showed similar results. Possible reasons for the small core-level shift will be discussed.

O 58.4 Thu 10:45 HE 101

Surface spectroscopy of CO/Pt(111) with High Harmonics in the XUV — •Thorben Haarlammert[1], Sebastian Wegner[1], Grigorius Tsilimis[1], Helmut Zacharias[1], and Alexander Golovin[2] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität, Münster — [2]Institute of Physics, St. Petersburg State University

We report on the generation of High Harmonic radiation in the photon energy range up to 100 eV with up to 10 kHz repetition rate, based on the conversion of femtosecond Ti:sapphire radiation in rare gases. The fundamental laser is based on a single stage, multiple pass amplification of a cavity-dumped oscillator. Output pulse energies of 1 mJ and pulse durations of les than 30 fs at adjustable repetition rates up to 10 kHz are achieved. The generated High Harmonics are separated by a toroidal grating and directed to the surface. A time-of-flight detector with multiple anodes registers the kinetic energies of emitted photoelectrons. The angular distributions of photoelectrons emitted form CO/Pt(111) under s-polarized excitations have been measured for a variety of initial photon energies. Different from gas phase results a significant intensity of photoelectrons are emitted also in the normal direction, i.e., in the direction of the C - O chemical bond. A first theoretical investigation supports qualitatively the observed angular distributions.