HL 109: Ultra-fast phenomena I

Time: Friday 9:30–10:45 Location: POT 006

HL 109.1 Fri 9:30 POT 006

Visualization of ultrafast currents in nanowires by imaging with femtosecond low-energy electron pulses — •Melanie Müller, Alexander Paarmann, and Ralph Ernstorfer — Fritz-Haber-Institut der MPG, Berlin, Germany

We use a nanotip as laser-triggered low-energy electron point source (LEEPS) delivering coherent ultrashort electron pulses for time-resolved projection imaging of photoexcited nanostructures. Due to their high sensitivity to weak fields, low-energy electron pulses are particularly suited for mapping transient electric fields and charge distributions in nanostructures. Specifically, charge carrier separation upon above-bandgap excitation in doped nanowires (NWs) transiently induces local variations of the vacuum level, deflecting the electrons from their original trajectories. Operating our LEEPS microscope in a pump-probe scheme, we are able to probe ultrafast photocurrents in axially doped InP NWs with several 10 nm spatial and femtosecond temporal resolution.

HL 109.2 Fri 9:45 POT 006

Ultrafast charge carrier and exciton dynamics at the SP6/ZnO(10-10) interface — •Laura Foglia[1], Mino Kris Sparenberg[2], Fritz Henneberger[2], Julia Stähler[1], and Martin Wolf[1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Deutschland — [2]Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Germany

The efficiency of hybrid organic inorganic devices depends strongly on the timescale of competing electronic processes, such as interfacial charge transfer and bulk exciton decay. These typically ultrafast timescales can be accessed by pump-probe techniques, where a pump laser pulse initially excites the system and the change of electronic or optical properties is probed by a second laser pulse, as a function of time delay. We apply broadband transient transmission spectroscopy to investigate the carrier dynamics at the interface between ZnO and a spirobifluorene derivative, SP6. The system is first excited at 3.6 eV (across the SP6 HOMO-LUMO and ZnO band gap) and subsequently the transmission in the visible range (1.7-2.9 eV) is monitored. In this manner the excited state absorption is probed by changes in the polarization due to the evolution of the electronic population in both the SP6 LUMO and ZnO conduction band. First results show subpicosecond dynamics, much shorter than the exciton dynamics previously observed by time-resolved photoluminescence.

HL 109.3 Fri 10:00 POT 006

Long-Lived Electronic Coherence in the Metal-Organic-Hybrid Cobalt/Alq3 — Martin Aeschlimann[1], Tobias Brixner[2], Mirko Cinchetti[1], Norman Haag[1], Matthias Hensen[3], Bernhard Huber[2], Christian Kramer[2], Walter Pfeiffer[3], •Martin Piecuch[1], Christian Strüber[3], and Philip Thielen[1] — [1]Fachbereich Physik and Research Center OPTIMAS, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern, Germany — [2]Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [3]Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany

The coherent electron dynamics in optically pumped (400 nm excitation) molecular states of the metalorganic complex tris(8-hydroxyquinolinato)aluminium (Alq3) deposited on cobalt is investigated by coherent two-dimensional nanoscopy [1]. Upon excitation with sequences of ultrashort pulses at 800 nm quantum beats appear in the time-resolved photoemission signal. In two-dimensional nanoscopy spectra two excited electronic states are identified with an energy spacing of about 77 meV. Their linewidth are 11 meV and 48 meV, respectively, corresponding to coherence lifetimes of about 370 fs and 87 fs. The appearance of such narrow spectral features indicates that electronic excitations in an individual adsorbate state can be surprisingly long and thus can play an important role in determining charge transfer efficiencies at the metal-hybrid interface.

[1] Aeschlimann et al. Science 333, 1723-1726, (2011)

HL 109.4 Fri 10:15 POT 006

Atomistic Modeling of Excitation Energy Transfer in a Semiconductor Nanocrystal Molecule Hybrid System — •Dirk Ziemann and Volkhard May — Institut für Physik, Newtonstr. 15, Humboldt Universität zu Berlin, D-12489 Berlin, Germany

Inorganic organic hybrid systems can show completely new properties that are not achievable by each material alone. Especially photovoltaic devices like solar cells and light emitting diodes are able to benefit from these properties. Corresponding to these devices semiconductor nanocrystals interacting with organic molecules have aroused great interest. Despite the variety of experimental investigations there is a lack of theoretical studies.

In this talk an efficient model for describing energy transfer on an atomistic level between a CdSe semiconductor nanocrystal and a molecular system consisting of Pheophorbide-a molecules is presented. Despite the modeling of nanocrystals consisting of thousands of atoms also the coupling to a supramolecular complex is shown. For the nanocrystal also surface effects are taken into account and the formation of exciton states is considered.

HL 109.5 Fri 10:30 POT 006

Passively carrier-envelope phase stabilised few-cycle laser pulses in the near-infrared — •Jörg Robin, Jan Vogelsang, Kristina Strahlendorff, Petra Gross, and Christoph Lienau — Institut für Physik, Carl von Ossietzky Universität, Carl-von-Ossietzky-Straße 9-11, 26129 Oldenburg

The acceleration dynamics of strong-field-emitted electrons from sharp metallic nano-tips sensitively depend on the carrier-envelope phase (CEP) of the incident few-cycle laser pulses [1]. Stabilising the CEP [2] thus is a step towards controlling the coherent electron motion on ultrashort time and length scales. Focussing 120-fs pulses centred at 800 nm from a regenerative titanium:sapphire chirped pulse amplification system operating at a repetition rate of 5 kHz into a sapphire crystal generates a white light continuum, which inherits the CEP of the driving pulses. Out of this spectrum both a broadband proportion in the visible and a narrowband proportion in the infrared are parametrically amplified in a non-collinear setup using the second harmonic of the driving pulses as pumping radiation. By recombining the output of these two stages via type II difference frequency generation shot-to-shot CEP fluctuations cancel out and passively CEP-stabilised pulses tunable in a range from 1400 nm to 1800 nm with a pulse duration of 10 fs and a pulse energy of 200 nJ are produced. Here, we demonstrate the CEP stability of our system and show its importance for the electron motion around metallic nanostructures.

[1] Piglosiewicz, B. et al. Nature Photonics (2013). doi:10.1038/nphoton.2013.288

[2] Manzoni, C. et al. Opt. Lett. 29, 2668 (2004)