# HL 39: Ultra fast phenomena

Time: Thursday 11:15–13:00 Location: ER 270

HL 39.1 Thu 11:15 ER 270

**Intensity dependence of charge and spin currents generated by ultrafast two-color photoexcitation*of semiconductor quantum wells** — Bernhard Pasenow[1], Huynh Thanh Duc[2,1], •Torsten Meier[3,1], and Stephan W. Koch[1] — [1]Department of Physics and Material Sciences Center, Philipps University, Renthof 5, D-35032 Marburg, Germany — [2]Ho Chi Minh City Institute of Physics, Viet Nam Center for Natural Science and Technology,*1 Mac Dinh Chi, Ho Chi Minh City, Vietnam — [3]Department Physik, Fakultät für Naturwissenschaften, Universität Paderborn, Warburger Str. 100, D-33098 Paderborn, Germany

Charge and spin currents that are generated on ultrafast time scales by two-color laser excitation of semiconductor quantum wells are computed using Bloch equations that formulated in the basis of $\mathbf{k}\cdot\mathbf{p}$ wave functions [1,2]. The optically induced inter- and intraband excitations are both treated nonperturbatively providing a consistent description of phototransport effects in the high-excitation regime. The analysis shows that the photoexcited charge and spin currents depend on the amplitudes of the incident $\omega$ and $2\omega$ beams in a highly nonlinear fashion. It is predicted that Rabi flopping leads to intensity-dependent changes of the current directions [3].

[1] B. Pasenow, Dissertation, Philipps-University Marburg, 2006.
[2] T. Meier, B. Pasenow, H.T. Duc, Q.T. Vu, H. Haug, and S.W. Koch, Proc. of SPIE **6471**, 647108 (2007).
[3] B. Pasenow, H.T. Duc, T. Meier, and S.W. Koch, Solid State Communications, in press.

HL 39.2 Thu 11:30 ER 270

**Two-color pump-probe spectroscopy of electron dynamics in doped superlattices** — •Martin Wagner[1], Dominik Stehr[1], Harald Schneider[1], Stephan Winnerl[1], Manfred Helm[1], Aaron Andrews[2], Tomas Roch[2] und Gottfried Strasser[2] — [1]Institut für Ionenstrahlphysik und Materialforschung, Forschungszentrum Dresden-Rossendorf, Postfach 51 01 19, 01314 Dresden — [2]Institut für Festkörperelektronik, TU Wien, Floragasse 7, 1040 Wien, Österreich

We report on two-color pump-probe measurements to investigate the intraminiband dynamics of doped GaAs/AlGaAs SLs with different miniband widths smaller or larger than the optical phonon energy. We have analyzed the cooling behavior at low temperature. We employed infrared pulses from a free-electron laser to excite electrons to the upper miniband at the center of the SL mini-Brillouin zone and the interminiband transition was probed at the zone edge with broadband THz pulses. After relaxation to the ground miniband the electronic distribution is heated up which results in more absorption at the zone edge. When the distribution cools down this induced absorption signal decays, leading to decay times of 40-50 ps for a miniband width smaller and 3.5 ps for a width larger than the optical phonon energy. This difference in time constants can be explained by the new relaxation channel through polar optical phonons. Additionally we performed measurements at room temperature where the lower miniband is already occupied at the zone edge. Thus no induced absorption and fast decay times are observed.

HL 39.3 Thu 11:45 ER 270

**Picosecond acoustic pulse altering the emission dynamics of a semiconductor planar microcavity** — •Thorsten Berstermann[1], Dmitri R. Yakovlev[1,2], Manfred Bayer[1], Alexey V. Scherbakov[2], Andrey V. Akimov[2], Jacqueline Bloch[3], and Isabelle Sagnes[3] — [1]Experimentelle Physik 2, Technische Universität Dortmund, D-44227 Dortmund, Deutschland — [2]A.F. Ioffe Physico-Technical Institute, 194021 St. Petersburg, Russia 2 — [3]Laboratoire de Photonique et de Nanostructures, LPN/CNRS, Route de Nozay, 91460 Marcoussis , France

In the present work we report the first experiments where the propagating strain wave packets, which contain GHz frequency components, effect the intensity and the wavelength of the photoluminescence in a semiconductor microcavity strongly coupled to the exciton resonance in a quantum well. The studied microcavity was grown on GaAs substrate and contains a 8nm wide $In_{0.04}Ga_{0.96}As$/GaAs quantum well in a $\lambda$-cavity, surrounded by Bragg mirrors built up from 20 and 24 pairs of GaAs/AlAs layers. The strain pulses are induced via 100fs short laser pulses obtained from a pulsed laser with a regenerative optical amplifier. The strain amplitude is $\sim 10^{-4}$, yielding a shift of the exciton resonance in the quantum well of ~1 meV [1]. This results in the detuning of the coupled microcavity and exciton resonances causing the modulation of the photoluminescence intensity and its wavelength on a picosecond time scale. The observed effects inroduce new methods for ultrafast control of the emission from optical microcavities and photonic crystals. [1] Akimov et al. PRL 97, 037401 (2006)

HL 39.4 Thu 12:00 ER 270

**THz detection with scalable photoconductive antennas** — •Falk Peter[1], Stephan Winnerl[1], Sven Nitsche[1], André Dreyhaupt[1], Harald Schneider[1], Manfred Helm[1], and Klaus Köhler[2] — [1]Forschungszentrum Dresden Rossendorf — [2]Fraunhofer Institut für Angewandte Festkörperphysik

We present studies on nonresonant photoconductive THz detectors and emitters. Our system consists of a large-area terahertz detector based on an interdigitated electrode structure and an emitter with similar electrode geometry [1]. Emitters based on this concept stand out due to their high efficiency for conversion of near-infrared radiation into far-infrared radiation. The main advantage of the scalable antennas as compared to conventional photoconductive antennas is that they do not require tight focusing of the THz and gating beams. While the emitter is fabricated on semi-insulating GaAs, we compare different detection antennas based on ion-implanted and low temperature grown (LT) GaAs, respectively. We discuss which material properties affect the performance and noise level of our system and discuss the role of the carrier lifetime upon the measured THz signal. The best signal-to-noise ratios are found for N+ dual energy implantations (0.4 MeV and 0.9 MeV) with doses in the $10^{13}$ cm$^{-2}$ range and for (LT) GaAs.

[1] F.Peter, S.Winnerl, S. Nitsche, A. Dreyhaupt, H. Schneider, and M.Helm, Appl. Phys. Lett. 91, 081109 (2007)

HL 39.5 Thu 12:15 ER 270

**THz Lyman spectroscopy and coherent THz control of dark excitons in $Cu_2O$** — •Silvan Leinss[1], Tobias Kampfrath[2], Konrad v. Volkmann[2], Martin Wolf[2], Dietmar Fröhlich[3], Alfred Leitenstorfer[1], and Rupert Huber[1] — [1]Department of Physics, University of Konstanz, 78464 Konstanz — [2]Department of Physics, Free University Berlin, Arnimallee 14, 14195 Berlin — [3]Department of Physics, University of Dortmund, 44221 Dortmund

We employ ultrabroadband THz pulses to resonantly couple to the internal exchange-split 1s-2p Lyman doublet of yellow excitons in $Cu_20$ ($T_L$ = 4 K). A line shape analysis provides absolute values of density and temperature of the optically dark exciton gas forming after two-photon photogeneration of unbound electron-hole pairs. At a delay time of 100 ps, 1s-para states are observed with a density of $2 \times 10^{16}$ cm$^{-3}$ and a temperature of 12 K. Intense THz transients with peak electric fields of 0.5 MV/cm allow us to coherently control the internal quantum state of this ensemble via a partial intra-excitonic Rabi flop. Up to 70% of the quasiparticles are promoted from the 1s into the 2p state. Electro-optic sampling directly monitors the Larmor precession of the Bloch vector in real time. The results suggest a promising new route for preparing ultracold and dense exciton gases.

HL 39.6 Thu 12:30 ER 270

**Influence of heavy-hole light-hole band mixing on the strength of optically generated spin-currents in III-V semiconductor quantum wells** — •Bernhard Pasenow[1], Torsten Meier[2], and Stephan W. Koch[1] — [1]Department of Physics and Material Sciences Center, Philipps University, Renthof 5, D-35032 Marburg, Germany — [2]Department Physik, Fakultät für Naturwissenschaften, Universität Paderborn, Warburger Str. 100, D-33098 Paderborn, Germany

The coherent optical injection and temporal decay of spin and charge currents in semiconductor heterostructures has been investigated on a microscopic level including Coulomb and phononic effects up to second Born scattering contributions [1,2].
In this talk the previously used two-band effective mass approach is extended to a realistic bandstructure model using microscopic 8x8 kp matrix elements focussing on heavy-hole light-hole band-mixing effects. It will be shown how this band-mixing influences the strength of the

optically generated spin-currents in different semiconductor quantum wells leading to rules for optimal structure composition [3].

[1] H.T. Duc, T. Meier, and S.W. Koch, PRL 95, 086606 (2005).
[2] H.T. Duc, Q.T. Vu, T. Meier, H. Haug, and S.W. Koch, PRB 74, 165328 (2006)
[3] B. Pasenow, T. Meier, and S.W. Koch, unpublished

HL 39.7 Thu 12:45 ER 270

**Ultrafast dynamics of coherent optical phonons in $\alpha$-quartz** — •Konrad von Volkmann[1], Tobias Kampfrath[1], Marcel Krenz[1], Alexander Grujic[2], Christian Frischkorn[1], and Martin Wolf[1] — [1]Freie Universität Berlin, Berlin, Germany — [2]Femtolasers GmbH, Fernkorngasse 10, 1100 Vienna, Austria

Femtosecond laser excitation of $\alpha$-quartz causes oscillation of the transmitted intensity and polarization of probe light. This is due to coherent phonons modulating the real and imaginary part of the refractive index $\alpha$-quartz $\tilde{n}_{\mathrm{quartz}} = n + i\,k$. Optical phonon modes are found at 3.9, 6.3, 10.5, 12.2, and 13.9 THz. The observed amplitudes significantly depend on the probe method, either transient absorption (yielding $k$) or ellipsometry (leading to $n$).

We present temperature and pump-polarization dependent data for both probe methods. The polarization dependence will be discussed in terms of impulsive stimulated Raman scattering as excitation mechanism and a detailed analysis of the corresponding Raman tensors will be given. Previous measurements have shown a pump-fluence *in*dependent lifetime which indicates that the decay mechanism of the lattice vibrations is phonon-phonon scattering. The temperature dependence of the phonons confirms this finding and enables a discussion of the scattering rates and the involved phonons.