HL 35: THz and MIR

Time: Wednesday 15:00–16:15 Location: EW 203

HL 35.1 Wed 15:00 EW 203

Observation of picosecond Polaron Stabilization in FA-lead-halide pervoskites via infrared modes — •Daniel Sandner[1], Matthias Nuber[1], Qi Ying Tan[2], Reinhard Kienberger[1], Cesare Soci[2], and Hristo Iglev[1] — [1]Chair for Laser- and X-ray physics E11, Technische Universität München, Garching, Germany — [2]Centre for Disruptive Photonic Technologies, NTU, Singapore

The optoelectronic properties of lead-halide perovskites are greatly influenced by the polarons. In our experiments, we use time-resolved mid-infrared spectroscopy with sub-ps and single wavenumber resolution to study the vibrational properties of the FA cation via a CN stretching mode. It has been shown in polymers and perovskites that localized charge carriers can lead to infrared active (IRAV) modes. After exciting Cs0.2FA0.8PbBr3 films with visible light pulses, we observe an IRAV mode that increases up to 100 ps after excitation in intensity, while the broad background by free carrier absorption shows a decline by carrier recombination. We interpret this finding as Polaron stabilization, meaning the rearrangement of the polar lattice around the charge carrier. (doi.org/10.1039/D2TC04519B)

We further studied the role of the halide, temperature, and confinement. At low temperatures, the IRAV mode, which we associate with a polaron, is weaker and shows shorter distinct dynamics, which is in good agreement with reported transport data. We find that the effect is absent in quasi-2D perovskites, which adds more experimental evidence to the recent debate about the nature of photoexcitations in those materials.

HL 35.2 Wed 15:15 EW 203

Nonlinear terahertz responses of optically excited Cu_2O — •Changqing Zhu, Anneke Reinold, Patrick Pilch, Marc Assmann, and Zhe Wang — TU Dortmund University, Germany

Excitons in Cu_2O have attracted significant attention due to their peculiar properties, such as the remarkable Rydberg series with the principal quantum number extending up to 30 and the realization of Bose-Einstein condensation. We report on time-resolved nonlinear terahertz spectroscopic study of optically excited nonequilibrium states in Cu_2O. Terahertz harmonic generation is observed and investigated as a function of the fluence of the optical excitation and by varying the delay between the optical excitation and the terahertz driving pulse. Our time-resolved spectroscopic techniques allow us to associate the observed nonlinear terahertz responses with different processes of exciton-related dynamics.

HL 35.3 Wed 15:30 EW 203

Mid-infrared photocurrents in topological insulator thin film — •Filippo Romano[1,2], Holger Mirkes[1,2], Nina Pettinger[1,2], Alexander Holleitner[1,2], and Christoph Kastl[1,2] — [1]Walter Schottky Institute and Physik-Department, Technical University of Munich, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Munich, Germany

Clearly discriminating the transport of trivial bulk and non-trivial surface states remains often challenging in topological insulators because of their rather large residual bulk conductivity. Photogalvanic currents can serve as a tool to selectively address the surface states based on simple symmetry principles (Nanophotonics 2020, 9, 2693 - 2708). However, most experiments so far used a near-infrared excitation far above the fundamental bulk gap of the prototypical 3D topological insulators mixing surface and bulk states in the optical excitation process (Nat. Commun. 2015, 6, 6617). Here, we extend optoelectronic measurements of topological insulator thin films from near-infrared (from 0.8 μm) to mid-infrared wavelengths (up to 20 μm). The latter may allow a selective excitation of surface state photocurrents without contribution from bulk bands. The research is supported through the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No 101076915 (2DTopS).

HL 35.4 Wed 15:45 EW 203

Cyclotron and spin resonances in AlAs quantum wells — •Daniiar Khudaiberdiev — Institute of Solid State Physics, Vienna University of Technology, Vienna, 1040, Austria

Magneto-optical spectroscopy in THz range is a very useful technique for studying two-dimensional electron systems (2DESs). The main effect that is usually measured is the cyclotron resonance (CR), which gives the information on the cyclotron mass of the charged carriers, and thus, can be used to reconstruct the band structure in some cases [1]. Recently, a different method of measuring the effective mass was introduced [2]. This interferometric method gives the conductivity mass that, in contrast to the cyclotron mass, can be renormalized by the electron-electron interaction and also can be anisotropic. In this work we are using both methods to probe the AlAs quantum well system, which is well known for it*s anisotropic and heavy effective mass, and therefore, for it*s strong electron-electron interaction [3]. *In addition to the cyclotron resonance, the electron spin resonance (ESR) have also been observed in the system. Both of them are present in both photoresistance and transmission data. Direct observation of the ESR in the optical response provides an opportunity to study its polarization dependencies, that can give new information on its nature. [1] J. Gospodarič et al., Phys. Rev. B 104, 115307 (2021). [2] V. M. Muravev et al., Phys. Rev. Applied 19, 024039 (2023) [3] A. V. Shchepetilnikov et al., Phys. Rev. B 92, 161301(R) (2015).

HL 35.5 Wed 16:00 EW 203

Simulation and measurement of silicon resistivity characterization with terahertz TDS — •Joshua Hennig[1,2], Jens Klier[1], Stefan Duran[1], Christian Röder[3], Kuei-Shen Hsu[4], Jan Beyer[4], Nadine Schüler[5], Georg von Freymann[1,2], and Daniel Molter[1] — [1]Department of Materials Characterization and Testing, Fraunhofer ITWM, Kaiserslautern — [2]Department of Physics and Research Center OPTIMAS, RPTU Kaiserslautern-Landau — [3]Fraunhofer Institute for Integrated Systems and Device Technology IISB, Department Energy Materials and Test Devices, Erlangen — [4]Institute of Applied Physics, Technische Universität Bergakademie Freiberg — [5]Freiberg Instruments GmbH, Freiberg

Silicon is one of the most important semiconductors used in many applications that are essential to modern electronics. One of its main characteristics is the resistivity which is usually measured by the four-point probe method requiring to contact the sample with the measuring tip. This, however, always contains the danger of affecting the material under test. A fast and non-contact measurement technique is terahertz time-domain spectroscopy (TDS). This technique is already well established in the characterization of dielectrics, but its potential to characterize semiconductors is not fully utilized, yet. Therefore, this potential is investigated by simulations as well as measurements of single-layer silicon wafers as well as two-layer silicon samples with TDS. As will be shown, the resistivity characterization is possible over a wide range for single-layer samples, while it is more complicated and restricted to specific cases for two-layer samples.