HL 33: 2D Materials and Heterostructures: Optoelectronics

Time: Wednesday 15:00–16:15 Location: EW 201

HL 33.1 Wed 15:00 EW 201

Surface acoustic wave-controlled photocurrent in few-layer WSe2 — •Benjamin Mayer, Clemens Strobl, Matthias Weiss, Hubert Krenner, Ursula Wurstbauer, and Emeline Nysten — Institute of Physics, University of Münster, Germany

The unique combination of piezo-electric surface acoustic waves (SAWs), high-resolution optical spectroscopy and electrical transport provides a versatile testbed to sense and manipulate the optical properties and carrier transport processes in novel nanoscale materials and opens pathways to novel acousto-optoelectronic devices [1]. Here, we present the fabrication and validation of a hybrid platform comprising strong SAW-devices on piezoelectric LiNbO3 and mechanically exfoliated transition metal dichalcogenide (TMDC) 2D materials. In our experiments, we employ the SAWs dynamic electric field with a frequency of 150-250MHz to induce a SAW power dependent Acousto-Electric Current (AEC) in few-layer WSe2 placed on top of two gold electrodes. The SAW directional dependence of this fundamental effect enables a detailed investigation of the Au-TMDC interface. Furthermore, the TMDC can be photodoped via excitation with a green laser (532nm) to deeply study the underlying charge carrier dynamics. In the low SAW-Power regime photogating leads to an enhanced AEC by two orders of magnitude, whereas bipolar charge carrier transport sets in for higher SAW powers. [1] J. Phys. D:Appl. Phys. 52(35):353001 (2019)

HL 33.2 Wed 15:15 EW 201

Strong field valleytronics in bulk MoS2 — •Igor Tyulnev[1], Álvaro Jiménez-Galán[2], Julita Poborska[1], Lenard Vamos[1], Rui F. Silva[3], Philip St. J. Russell[4,5], Francesco Tani[4], Olga Smirnova[2,6], Misha Ivanov[2,7,8], and Jens Biegert[1,9] — [1]ICFO, Barcelona, Spain — [2]MBI, Berlin, Germany — [3]ICMM, Madrid, Spain — [4]MPL, Erlangen, Germany — [5]FAU, Erlangen, Germany — [6]TU, Berlin, Germany — [7]HU, Berlin, Germany — [8]Imperial College, United Kingdom — [9]ICREA, Barcelona, Spain

Light field control over condensed matter allows the tailoring of material properties and exploits topology with which classical and quantum operations can be realized in next-generation devices. At this forefront are valleytronics which exploit the valley degree of freedom to provide an optical switch between extrema in the band structure. Resonant excitation distinguishes these valleys through selection rules derived from symmetry breaking of time inversion by circular polarized light fields and of space inversion in monolayer materials. Thus, requiring not only specific excitation wavelengths but also limiting possible material platforms. In this work, we, for the first time, validate a novel, off-resonant approach to valley control based on the synthesis of a bi-circular field which by symmetry matching 2H-MoS2 controls the band structure. We demonstrate that strong-field valley control is possible, universal and, at optical speeds, unlocks a path towards engineering efficient, multilayer devices operating on sub-optical cycle timescales.

HL 33.3 Wed 15:30 EW 201

Near field photocurrent nanoscopy at a biased graphene interface junction — •Francesca Falorsi[1], Marco Dembecki[2], Christian Eckel[1], Monica Kolek Martinez de Azagra[1], and R. Thomas Weitz[1] — [1]1st Institute of Physics, Faculty of Physics, Georg-August-University Göttingen, Göttingen — [2]Physics of Nanosystems, Faculty of Physics, LMU Munich, Germany; current address. WSI, TUM, Garching, Germany

The nanoscale analysis of photocurrent is a versatile tool to gain information about electronic states, quantum processes, and device characteristics of quantum materials. When photocurrent is studied with a near-field scattering microscope (s-SNOM), it is possible to overcome the diffraction limit. Thus one can image the local characteristic of the devices with a 20 nm resolution. In this work, the analysis of s-SNOM images of the local photocurrent generated at mono-bi layer graphene interfaces is performed to gain a more profound knowledge of the specific mechanisms governing electronic flow and resistivity at a nanoscopic level. In particular, by analyzing the polarity of the photocurrent concerning the source-drain voltage applied across the device, it was possible to indirectly image the charge carrier accumulation around a defect during electronic charge flow, predicted by Landauer in 1957. It was found that for values of the Fermi energies in proximity to the charge neutrality point (i.e. at low hole or electron doping) the photocurrent has the same polarity as the applied source-drain voltage, as it would be expected for changes in carrier concentration induced by the LRD.

HL 33.4 Wed 15:45 EW 201

Energy- and Temperature-dependent Photoconductivity Studies for $MoSe_2$ — •Konstantin Neureither[1,2], Johannes Groebmeyer[1,2], Rao Peng[2], Johannes Knolle[2], and Alexander Holleitner[1,2] — [1]Walter Schottky Institut, TU Munich, Germany — [2]Physics Department, TU Munich

We study the photoconductivity of $MoSe_2$ for different excitations energies and lattice temperatures. Using circular polarized CW lasers, we focus on the effects of spin-orbit coupling on longitudinal and transversal photocurrents. Furthermore, we investigate a novel measurement technique that enables us to resolve long-time charge carrier decay dynamics by performing photocurrent spectroscopy in the frequency-domain.

HL 33.5 Wed 16:00 EW 201

Persistent Photoconductivity in Thin Films of ZrS_3 — •Lars Thole[1], Asem Ben Kalefa[1], Christopher Belke[1], Sonja Locmelis[2], Lina Bockhorn[1], Peter Behrens[2], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Institut für Anorganische Chemie, Leibniz Universität Hannover, 30167 Hannover, Germany

The field of two dimensional materials includes a large variety of materials. Among these, the group of transition metal trichalcogenides (TMTCs) has so far been lesser researched. Here, we have prepared transistor structures from thin films of the TMTC ZrS_3. In our samples, we found a particularly long persistent photoconductivity (PPC) which lasts over several hours, similar to what was seen in MoS_2 [2]. Looking at the temperature dependence gives information about the scattering times involved. In addition to using a stretched exponential function to fit the data, we can use a combination of three exponential functions. This shows that there are three processes involved in the origin of the PPC in our samples. These processes can be characterized by looking at samples with different thicknesses.

[1] L. Thole et al., ACS Appl. Electron. Mater., 5, 11, 6286 (2023)
[2] Y. Wu et al., Sci. Rep., 5, 11472 (2015)