HL 47: 2D Materials VIII – Quantum emitters and defects

Time: Thursday 15:00–16:00 Location: POT/0081

HL 47.1 Thu 15:00 POT/0081

Tunable phonon sidebands of defect emitters in monolayer WSe_2 heterostructures — •Felix Schaumburg[1], Cornelius Diedrich[2], Alberto Rodriguez[2], Jeniffer König[2], Corinne Steiner[3], Patricia Pesch[3], Axel Lorke[1], Michael Lorke[1], Günther Prinz[1], Martin Geller[1], and Annika Kurzmann[2] — [1]Faculty of Physics, University of Duisburg-Essen and CENIDE, Germany — [2]II. Physikalisches Institut Fachgruppe Physik, Universität zu Köln, Germany — [3]Fachgruppe Physik, RWTH Aachen, Germany

Van der Waals heterostructures hosting single-photon emitters have emerged as a versatile platform for exploring material properties, like phonon interactions. We investigate single-photon emission from a heterostructure composed of a graphite back gate, hBN dielectric layers, and a monolayer of WSe_2. A 10 nm metallic top gate enables electrical tuning of the WSe_2 layer. The entire stack is strained using lithographically defined SiO_2 nanopillars. Optically active defect centers are introduced into the WSe_2 monolayer by electron-beam irradiation. These defect centers in the strained regions exhibit clear single-photon emission, confirmed by second-order correlation function values below 0.5. Voltage-dependent measurements reveal a pronounced Stark shift of the emission lines as well as electrically tunable phonon sidebands. The intensity evolution of these sidebands can be described within the framework of a Franck-Condon model. Our results demonstrate deterministic position control, electrical control, and phonon-sideband engineering of quantum emitters in WSe_2. This paves the way towards bright, electrically tunable emission in two-dimensional materials.

HL 47.2 Thu 15:15 POT/0081

Room Temperature Visualization of Exciton Confinement in Single Photon Emitters samples — •Lucas Liberal[1], Rafael Nadas[2], Frederico B. Sousa[1], Maria Clara Godinho[3], Gabriel Jacobsen[1], Takashi Taniguchi[4], Kenji Watanabe[4], Marcio Teodoro[1], Ado Jorio[3], and Leonardo Campos[3] — [1]Departamento de Física, Universidade Federal de São Carlos, São Carlos, Brasil — [2]Institut fur Physik, Humboldt-Universitat zu Berlin, Newtonstraße 15, Berlin, Germany — [3]Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brasil — [4]Research Center for Materials Nanoarchitectonics, NIMS, Tsukuba, Japan

Two-dimensional semiconductors such as monolayer WSe2 have attracted significant interest due to their remarkable quantum properties and their potential as scalable single-photon emitters. However, conventional micro-photoluminescence (μ-PL) techniques are fundamentally limited by optical diffraction, preventing direct access to critical nanoscale features such as strain gradients and highly localized quantum confinement. In this study, we employ tip-enhanced photoluminescence with a spatial resolution of 10 nm to image, at room temperature, the emission landscape of monolayer WSe2 suspended over nanopillars. Our measurements reveal two distinct localization regimes consistent with leading theoretical models for single-photon activation: one arising from intervalley defect exciton hybridization and another driven purely by strain-induced confinement. These results provide practical guidelines for the deterministic nanoengineering of quantum light sources.

HL 47.3 Thu 15:30 POT/0081

Beyond static defects: temporal evolution of defect-driven reliability in WSe2 — •Madhuri Chennur[1,2], Ulrich Kentsch[1], Jens Zscharschuch[1,2], and Artur Erbe[1,2] — [1]Helmholtz-Zentrum Dresden Rossendorf, Institute of Ion Beam Physics and Materials Research, 01328 Dresden, Germany — [2]TUD Dresden University of Technology, 01062 Dresden, Germany

Two-dimensional (2D) semiconductors are emerging as promising candidates for CMOS-compatible nanoscale electronics, where defects increasingly dictate electron transport. In WSe2 transistors, chalcogen vacancies commonly degrade hole mobility, yet defect-rich surfaces or interfacial contact layers have enabled ultra-low-barrier p-type contacts. However, the electrical role of these defects is almost exclusively interpreted through static pre- and post-irradiation comparisons, leaving the time-dependent evolution of engineered defect and irradiation-induced trap dynamics essentially unexplored.

Here, we present a weeks-to-months time-resolved optical-electrical study of WSe2 FETs irradiated with a single-dose broad-beam irradiation, followed by temporal tracking of threshold voltage, subthreshold swing, and hysteresis under constant bias and ambient conditions. Raman and PL spectroscopy performed in parallel reveal lattice disorder, oxidation, and adsorbate uptake. We observe a reproducible transition with shifts in electrical parameters, demonstrating that defect is intrinsically dynamic, not static. This coupled temporal mapping provides missing insight into defect-aware reliability for realistic ambient and radiation-relevant 2D electronics.

HL 47.4 Thu 15:45 POT/0081

Physical Drivers of Metal Adsorption at 2D Interfaces for Memristive Applications — •Manoj Dey[1], Hamid Mehdipour[1,2], Peter Kratzer[2], and Matthias Scheffler[1] — [1]The NOMAD Laboratory at the FHI of the Max Planck Society, Berlin — [2]Faculty of Physics, University of Duisburg-Essen, Duisburg

Two-dimensional (2D) materials with engineered defects are emerging as promising candidates for next-generation memristors. In these "atomristors," resistive switching (RS) arises from atomic-scale processes at the electrode-2D interface. Experiments show that adsorption and desorption of electrode metal atoms at vacancies play a key role in RS [1]. Here, we combine hybrid density functional theory with many-body dispersion corrections and the Sure Independence Screening and Sparsifying Operator (SISSO) method [2] to study metal adsorption on transition-metal dichalcogenides at gold interfaces. SISSO provides a predictive model for adsorption energies and uncovers the fundamental physical factors driving RS. Our sensitivity analysis shows how orbital hybridization and bonding interactions dominate the behavior, offering simple heuristics for understanding the atomic processes. We also build a materials-property map that highlights promising candidates and connects our predictions with experimentally demonstrated devices. Together, these results link fundamental material descriptors to RS behavior and offer clear guidance for designing future 2D atomristors.

[1] Ruijing Ge *et al.*, *Adv. Mater.*, **33**, 2007792 (2021).
[2] R. Ouyang *et al.*, *Phys. Rev. Materials*, **16**, 2, 083802 (2018).