HL 20: Poster I

Time: Tuesday 18:00–20:00 Location: P1

HL 20.1 Tue 18:00 P1

Defect-Mediated Electronic Reconstruction in Li-TFSI-Passivated Layered InI Crystals — •Abdulsalam Aji Suleiman[1,2], Ali Karatutlu[1,3], and Aydan Yeltik[4] — [1]Department of Engineering Fundamental Sciences, Sivas University of Science and Technology, Sivas 58000, Türkiye — [2]Sivas Cumhuriyet University Nanophotonics Application and Research Center (CÜNAM), Sivas 58140, Türkiye — [3]Institute of Materials Science Nanotechnology, National Nanotechnology Research Center (UNAM), Bilkent University, Ankara 06800, Türkiye — [4]Department of Material Science and Nanotechnology Engineering, TOBB University of Economics and Technology, Ankara 06560, Türkiye

Layered indium iodide (InI) is a van-der-Waals semiconductor whose bandgap (1.6-2.8 eV) enables strong light-matter coupling but suffers from iodine-vacancy defects that limit stability. Surface passivation with lithium bis(trifluoromethanesulfonyl)imide (Li-TFSI) modifies near-surface electrostatics and bonding, improving optical and transport properties. Photoluminescence shows stronger emission and longer carrier lifetimes, consistent with reduced non-radiative recombination. Soft-X-ray absorption spectroscopy at the HESEB beamline probes F, N, O, C K-edges and I M4,5-edges, revealing how TFSI-ions coordination alters In-I bonding and orbital hybridization. These results link chemical passivation and defect energetics, outlining a route to stable halide-based optoelectronic devices.

HL 20.2 Tue 18:00 P1

Tensor network methods for electron-hole complex in nanoplatelets — •Bruno Hausmann and Marten Richter — Institut für Physik und Astronomie, Technische Universität Berlin, Germany

Nanoplatelets are colloidally grown, atomically thin, rectangular semiconductor nanostructures. Excitons in nanoplatelets are solutions of a four-dimensional Schrödinger equation. This is especially true as the structure is in between the weak and strong confinement regimes. Solving this equation is computationally expensive compared to the typical two-dimensional Wannier equation under weak confinement. Going beyond excitons to trions and biexcitons, the memory size of the discretized wavefunctions grows exponentially with the particle number. Tensor network methods have successfully been applied to solve high-dimensional eigenvalue problems. Here we adapt them to the eigenvalue equation for excitons and trions by decomposing the real-space wavefunctions into quantics tensor trains (QTT). Operators that transform the indices, e.g. shift operators in finite differences, become binary circuits, e.g. an addition network. We were able to compute ground and excited states together with their energies for platelet dimensions between strong and weak confinement with a resolution (up to 2048 grid points per dimension) infeasible to implement without tensor networks. For illustration, eigenenergies, oscillator strengths, and various wavefunction projections were calculated.

HL 20.3 Tue 18:00 P1

Markovian vs. Full Quantum-Kinetic Approach to Phonon-Assisted Incoherent Exciton Formation in Atomically Thin Semiconductors — •Leonard Schneider, Andreas Knorr, and Henry Mittenzwey — Nichtlineare Optik und Quantenelektronik, Institut für Physik und Astronomie, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Excitonic coherence decay and incoherent exciton formation in atomically thin semiconductors such as monolayer transition metal dichalcogenides are strongly influenced by the coupling between charge carriers and lattice vibrations. Based on Heisenberg's equations of motion, we derive the microscopic dynamics of excitonic transitions and incoherent exciton occupations coupled via phonon-assisted processes. For a consistent quantum-kinetical approach, we go beyond the usual one-phonon processes and include up to two-phonon-assisted and phonon-population-assisted transitions, which corresponds to a truncation of the hierarchy problem within a fourth-order Born approximation. We numerically evaluate the full quantum kinetics for the dephasing- and incoherent-exciton-generation dynamics and compare it to the corresponding Markovian limit. The corresponding influence of memory effects and multi-phonon processes is discussed in detail.

HL 20.4 Tue 18:00 P1

Far- and near-field photoluminescence of interlayer excitons in MoS2/WS2 heterostructures — •Johannes Holters and Iris Niehues — Institute of Physics, University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

Monolayers of transition-metal dichalcogenides show intense photoluminescence (PL) at room temperature due to their high exciton binding energies. Recently, heterostructures composed of two vertically stacked monolayers have gained significant attention because of the emergence of novel quantum phenomena within these materials. Of particular interest are interlayer excitons, where, in contrast to intralayer excitons, electron and hole reside in different layers of the heterostructure. Strain, nanobubbles, Moiré effects and other local inhomogeneities can localize the appearance of these interlayer excitons to several nanometer. Here we use a scattering-type scanning near-field microscope (s-SNOM) to investigate the photoluminescence (PL) of interlayer excitons in a MoS2/WS2 heterostructure with a spatial resolution below the diffraction limit. The obtained tip-enhanced PL (TEPL) images are compared to standard confocal microscopy images. Both intra- and interlayer excitons are visible in far- and near-field images. In the TEPL images an enhanced PL signal is observed in the form of arcs around nanobubbles. These features can be assigned to interference effects caused by the interaction of the far-field light with the tip. Additionally, it is found that the intensity of the interlayer exciton PL strongly depends on the polarization of the exciting laser as well as the distance between tip and sample in the TEPL setup.

HL 20.5 Tue 18:00 P1

Optical Properties of CrSBr/TMD heterostructures — •Nicole Engel[1], Luc Oswald[1], Sai Shradha[1], Lukas Krelle[1], Daria Markina[1], Zdenek Sofer[2], and Bernhard Urbaszek[1] — [1]Institute for Condensed Matter Physics, TU Darmstadt, Darmstadt, Germany — [2]Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Czech Republic

Monolayer transition metal dichalcogenides (TMDs) exhibit several fascinating properties. These characteristics can be further expanded by creating heterostructures with CrSBr. CrSBr is an antiferromagnetic semiconductor which exhibits promising magnetic interactions with monolayer TMDs. The magnetic order of CrSBr influences the optical properties of $MoSe_2$ and WSe_2, facilitating charge transfer processes [1,2]. This work investigates CrSBr/TMD heterostructures using low-temperature optical spectroscopy with applied magnetic fields to probe excitonic properties. Understanding the optical and valley properties of CrSBr/TMD heterostructures will be relevant for the development of spintronic and valleytronic devices and show a great potential for light harvesting and enhancement of emission from 2D-materials.

[1] C. Serati de Brito et. al., Nano Lett. 2023, 23, 11073-11081
[2] J. de Toledo et. al., Nano Lett. 2025, 25, 13212-13220

HL 20.6 Tue 18:00 P1

Optical Properties of Interlayer Excitons in Transition Metal Dichalcogenide Heterostructures — •Luc Frederik Oswald[1], Sai Shradha[1], Nicole Engel[1], Julian Führer[1], Md. Tarik Hossain[2], Lukas Krelle[1], Daria Markina[1], Andrey Turchanin[2], and Bernhard Urbaszek[1] — [1]Institute for Condensed Matter Physics, TU Darmstadt, Darmstadt, Germany — [2]Institute for Physical Chemistry, Friedrich Schiller University, Jena, Germany

Interlayer excitons (IXs) in van der Waals heterostructures arise from electrons and holes confined in different monolayers, forming long-lived quasi particles with strong spin-valley coupling. In $MoSe_2/WSe_2$ systems, type-II band alignment and conduction-band splitting give rise to multiple IX states whose optical signatures are highly sensitive to temperature, lattice vibrations, and magnetic fields. This work investigates the optical response of an hBN-encapsulated, $MoSe_2/WSe_2$ lateral-vertical heterostructure grown via chemical vapour deposition (CVD). A combination of temperature-dependent photoluminescence, excitation-spectroscopy approaches, and magneto-optical measurements is used to probe the formation, evolution, and valley properties of interlayer excitons in this hybrid geometry. Together, they reveal characteristic interlayer emission features, their excitation pathways, and signatures of spin-layer hybridization.

HL 20.7 Tue 18:00 P1

Study of irradiation-induced deep-level defects in transition metal dichalcogenides MX2 (M = Mo,W; X = S, Se) — •Andrii Bodnar, Łukasz Gelczuk, and Paweł Scharoch — Departament of Semiconductor Materials Engineering, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, Wroclaw 50-370, Poland

This work presents comprehensive density functional theory (DFT) calculations investigating native point defects in pristine and alpha-particle-irradiated MX_2 materials, where M represents Mo or W and X represents S or Se. The calculations focused on identifying deep-level defects and their charge transition levels, with subsequent experimental validation through deep level transient spectroscopy (DLTS) measurements. The satisfactory agreement between state-of-the-art DFT-calculated defect levels and DLTS experiments confirmed the reliability of the computational methodology and enabled identification of the origins of experimentally observed defect levels.

The validated DFT approach employing the HSE06 hybrid functional, which accurately predicts band gaps and eliminates self-interaction errors present in other approaches, was applied to calculate charge transition levels of defects in bulk MX_2 that are experimentally challenging to measure directly using DLTS. Using DFT-generated data, deep-level defects induced by alpha-particle irradiation in bulk MX_2 were identified and defect evolution under different irradiation doses was tracked.

HL 20.8 Tue 18:00 P1

Influence of hBN encapsulation on the degradation process of Hittorf phosphorus — •Maximilian Scharpey[1], Daniel Wigger[2], Nicolas Pajusco[3], Iker Herrero[3], Rainer Hillenbrand[3], and Iris Niehues[1] — [1]Institute of Physics, University of Münster, Germany — [2]Department of Physics, University of Münster, Germany — [3]CIC nanoGUNE BRTA, Donostia-San Sebastián, Spain

The van-der-Waals material Hittorf phosphorus (HP, violet phosphorus) has attracted increasing interest due to its promising semiconducting properties including high charge carrier mobility, a tuneable bandgap, and high optical absorption in the visible [1]. However, its degradation poses significant challenges for device applications. Here, we investigate the influence of hexagonal boron nitride encapsulation on the optical properties of thin flakes of mechanically exfoliated HP. By comparing photoluminescence and nanoscale Fourier transform infrared spectroscopy of encapsulated and non-encapsulated HP samples over a period of days, we gained insight on the degradation process. In addition, we used scattering-type scanning near field optical microscopy to localize the origin sites of degradation under the encapsulation layer with a resolution beyond the diffraction limit. These findings contribute to a deeper understanding of the degradation process of HP, which will play a crucial role in stabilizing this material for future applications.

[1] Ahmad et al., Adv. Funct. Mater. **34**, 2410723 (2024)

HL 20.9 Tue 18:00 P1

Graphene/WSe_2 heterostructures for optical investigation of proximity spin-orbit coupling — •Ernst Knöckl, Matthias Klein, Alexander Holleitner, and Christoph Kastl — Walter Schottky Institute, School of Natural Sciences, Technical University of Munich

We investigate proximity-induced spin-orbit coupling (SOC) in graphene/WSe_2 heterostructures using the circular photogalvanic effect (CPGE) as a symmetry-selective, experimentally simple optical probe of spin-valley-locked band textures [1]. By measuring helicity-dependent photocurrents as a function of gate voltage, excitation energy, and device geometry, we aim to disentangle Rashba and valley-Zeeman SOC contributions and to extract their magnitude and sign as a function of the graphene-WSe_2 twist angle. A key requirement is the fabrication of large, clean, and field-effect-gateable graphene/TMDC heterostructures. To this end, we demonstrate a modified dry-transfer process based on specifically prepaired polydimethylsiloxane (PDMS) stamps [2]. We further determine the relative twist angle using Raman spectroscopy and second-harmonic generation (SHG) spectroscopy.

[1] Kiemle, Jonas, et al. ACS nano 16.8, 12338-12344 (2022)
[2] Jain, A. et al. Nanotechnology 29.26, 265203 (2018)

HL 20.10 Tue 18:00 P1

Transport measurements in thin layers of $HfTe_5$ — •Freddy Sack[1], Christopher Belke[1], Sonja Locmelis[2], Lina Bockhorn[1], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Institut für Anorganische Chemie, Leibniz Universität, 30167 Hannover, Germany

Hafnium pentatelluride ($HfTe_5$) gained interest due to its topological insulator behavior and the pronounced anisotropy arising from highly disparate electron and hole masses. In recent works, a thickness dependent band gap was observed [1]. In contrast to the small band gap found in bulk $HfTe_5$, single layers are predicted to be quantum spin hall insulator with a large band gap [1-4]. In this study, we investigate temperature dependent transport properties of thin layers of $HfTe_5$ from 5 K to 270 K. Gate dependent measurements for different magnetic fields are utilized to characterize thin flakes with a thickness less than 50 nm and to investigate the resistance anomaly.

[1] C. Belke et al., 2D Mater. 8, 0350292021 (2021)
[2] K.C Dogan et al., Nanoscale, 16, 11262 (2024)
[3] Ling-Xioa Zhao et al., Chinese Phys. Lett. 34 037102 (2017)
[4] Bo Fu et al., Phys. Rev. Lett. 125, 258801 (2020)

HL 20.11 Tue 18:00 P1

Spectroscopic Imaging Ellipsometry at Cryogenic Temperatures Reveals Peak Splitting in 2D Polar Silver — •Ulrich Limberg[1], Jakob Henz[1], Siavash Rajabpour[2], Alexander Vera[2], Arpit Jain[2], Joshua A. Robinson[2], Su Ying Quek[3], and Ursula Wurstbauer[1] — [1]Institute of Physics, Munster, Germany — [2]MatSE PennState, Pennsylvania, USA — [3]Centre of Advanced 2D Materials, Signapore, Signapore

Two-dimensional (2D) polar metals are a new class of atomically thin materials created by confinement heteroepitaxial growth, where metallic species such as silver are intercalated between epitaxial graphene and a 6H-SiC substrate [1]. Silver intercalation leads to two competing semiconducting monolayer phases, the metastable Ag(1) and the stable Ag(2), each showing distinct opto-electronic behaviour [2].

Spectroscopic imaging ellipsometry (SIE) enables spatially resolved analysis of the complex dielectric function of both phases. Using temperature-dependent SIE from 5 K to room temperature, we investigate the modification of the linear light-matter interaction of 2D polar Ag with temperature. At low temperatures, we detect a splitting of the characteristic absorption peak of Ag(2). The experimentally determined dielectric function agrees well with theoretical predictions [2].

[1] N. Briggs et al., Nat. Mater. 19.6, 637-643 (2020).
[2] A. Jain et al. in preparation (2025).

HL 20.12 Tue 18:00 P1

Structural and Electrical Characterization of Graphene Thin Films from Dispersions — •Yasaman Jarrahi Zadeh[1], Lars Grebener[2], Shaghayegh Pourdahrany[3], Muhammad Ali[4], Nicholas Wilson[5], Mohaned Hammad[2], Günther Prinz[1], Martin Geller[1], Michael A. Pope[5], William Wong[3], Hartmut Wiggers[4], Doris Segets[2], and Axel Lorke[1] — [1]Faculty of Physics, and CENIDE, University of Duisburg-Essen, Germany — [2]Institute for Energy and Materials Processes, and CENIDE, University of Duisburg-Essen, Germany — [3]Department of Electrical and Computer Engineering, and WIN, University of Waterloo, Canada — [4]Institute for Combustion and Gas Dynamics, and CENIDE, University of Duisburg-Essen, Germany — [5]Department of Chemical Engineering, and WIN, University of Waterloo, Canada

Graphene powders were produced by microwave-plasma synthesis and sonicated into ethanol or water with carboxymethyl cellulose (CMC) or di-n-dodecyl dimethylammonium bromide (DDDA) stabilizers. Using ultrasonic spray coating or Langmuir deposition, thin films were deposited on sapphire and characterized by SEM, Raman spectroscopy, and transport measurements. Water-based CMC dispersions produced the most uniform films. Raman spectra showed good structural quality (judged by the intensity ratio $I_{2D}/I_G \sim 1.5$). CMC-stabilized spray-coated films (0.1 wt%) achieved the highest conductivity (2.5 mS) and mobility (11 $cm^2/V.s$). DDDA films were more porous with lower mobility, while multilayer Langmuir films reached higher mobility (19 $cm^2/V.s$) but reduced conductivity.

HL 20.13 Tue 18:00 P1

Raman polarization switching in CrSBr — Priyanka Mondal[1], Daria Markina[1], •Lennard Hopf[1], Lukas Krelle[1], Sai Shradha[1], Julian Klein[2], Mikhail Glazov[3], Iann Gerber[4], Kevin Hagmann[1], Regine v. Klitzing[1], Ksenia Mosina[5], Zdenek Sofer[5], and Bernhard Urbaszek[1] — [1]Institute for Condensed Matter Physics, TU Darmstadt — [2]Department of Materials Science and Engineering, Massachusetts Institute of Technology — [3]St. Petersburg, Russia — [4]Université de Toulouse, INSA-CNRS-UPS, LPCNO — [5]Department of Inorganic Chemistry, University of Chemistry and Technology Prague

In recent years, few-dimensional nanomaterials have sparked significant interest within the solid-state research community due to their novel properties and possible applications in quantum technologies. Layered CrSBr has attracted particular interest due to its quasi 1D nature, strong electron-phonon interaction and air-stability. This work probes the optical anisotropy using polarization resolved photoluminescence and Raman spectroscopy on mono and few-layer CrSBr. These techniques are sensitive to the crystal orientation and reveal the intricate dependence of phonon polarization on excitation energy. Additionally, a clear thickness dependence of the electronic and vibrational properties is found. These results shed light on the complex electron-phonon and photon-phonon interactions in CrSBr opening new avenues for future application in optoelectronic devices.

HL 20.14 Tue 18:00 P1

Tuning carrier type and electrical properties of 2D alloy transistion metal dichalcogenides — •Axel Printschler, Md Tarik Hossain, Nhat Lam Duong, Julian Picker, Rahul Sharma, Christof Neumann, Muhammad Sufyan Ramzan, Caterina Cocchi, and Andrey Turchanin — Friedrich Schiller University Jena, Germany

Two-dimensional (2D) transition metal dichalcogenide (TMD) alloys offer a powerful platform for engineering material properties beyond the limitations of their constituents. Controlling the electronic characteristics of TMDs is crucial for the development of advanced electronic and optoelectronic devices and functional circuitry. This study focuses on the electronic properties of monolayer $(V_xW_yMo_{1-x-y})S_2$ alloys synthesized via a liquid-precursor-based chemical vapor deposition (CVD) approach. We investigate the charge transport in these materials using field-effect transistor (FET) devices. Our electrical measurements demonstrate a controlled transition from n-type to p-type semiconducting behavior, culminating in a metallic state for high vanadium concentrations. This change is supported by density functional theory (DFT) calculations. The tunability, directly correlated with the alloy composition, provides a reliable strategy for tailoring the electronic character of 2D TMDs and underscores their significant potential for application in next-generation electronic devices.

HL 20.15 Tue 18:00 P1

Many-body effects and intervalley coupling mechanisms in monolayer transition metal dichalcogenides — •Oleg Dogadov[1,2], Henry Mittenzwey[3], Thomas Deckert[4], Micol Bertolotti[2], Daniele Brida[4], Giulio Cerullo[2,5], Andreas Knorr[3], and Stefano Dal Conte[2] — [1]Fritz Haber Institute, Berlin, Germany — [2]Politecnico di Milano, Milan, Italy — [3]Technische Universität Berlin, Berlin, Germany — [4]University of Luxembourg, Luxembourg — [5]CNR-IFN Milan, Italy

The strongly bound excitons and the spin-valley locking effect make monolayer (1L) transition metal dichalcogenides (TMDs) an ideal platform to study intra- and intervalley many-body effects. Despite extensive studies conducted during the last years, a unified description of the competing many-body interactions and intervalley coupling processes in 1L-TMDs is lacking. Here, we apply broadband helicity-resolved transient absorption spectroscopy combined with a microscopic theory based on the excitonic Bloch equations to investigate coherent optical response and valley polarization dynamics in 1L-WSe_2. We unambiguously unravel competing valley-dependent contributions of two- and four-particle correlations to the coherent optical response of the studied material. By exploring the valley (de)polarization dynamics, we dissect the roles of individual intervalley coupling mechanisms, including Coulomb exchange and Dexter-like interaction, as well as phonon-assisted scattering, providing a consistent picture of the processes governing spin-valley dynamics in 1L-TMDs.

HL 20.16 Tue 18:00 P1

Unconventional Nanopatterning of 2D Materials for Future Nanoelectronics — •Tawat Chen[1,2], Poonam Borhade[3], Ya-Ping Hsieh[4], and Mario Hofmann[1] — [1]Department of Physics, National Taiwan University, Taipei, 10617 Taiwan — [2]Institute of Solid State Physics, Friedrich Schiller University Jena, Helmholtzweg 3, 07743 Jena, Germany — [3]Institute of Physics, Academia Sinica, Taipei, 10617 Taiwan — [4]Institute of Atomic and Molecular Sciences, Academia Sinica, Taipei, 10617 Taiwan

Two-dimensional (2D) materials offer a promising pathway to surpass the physical scaling limits of silicon-based electronics in the post-Moore era. However, fabricating high-resolution nanofeatures on these materials using conventional photolithography is constrained by Rayleigh's diffraction limit and escalating processing costs. In this work, we demonstrate nanopatterning techniques that overcome these limitations. First, we utilize a self-expansion double patterning (SEDP) process to generate nanometer-scale features through a self-limiting, temperature-controlled oxidation mechanism, enabling the fabrication of graphene nanoribbons with precise control. Second, to achieve high-density patterning without standard lithography, we investigate the formation of porous anodic aluminum oxide (AAO) via anodization, successfully creating porous arrays with a diameter of 37 nm. Finally, we discuss the physical mechanisms governing these formation processes and their potential for the scalable, high-throughput fabrication of next-generation 2D material devices.

HL 20.17 Tue 18:00 P1

Universality of Raman spectroscopy for determining twist angle in diverse systems — •Ana Senkić[1], Nicolai Leonid Bathen[2], Thorsten Deilmann[1], Hendrik Lambers[1], Lara Blinov[1], Aleksandar Matković[3], and Ursula Wurstbauer[1] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Israel Institute of Technology, Haifa, Israel — [3]Chair of Physics, Department Physics, Mechanical Engineering, and Electrical Engineering, Montanuniversität Leoben, Leoben, Austria

Twisted bilayers of transition metal dichalcogenides form moiré superlattices, resulting in electronic moiré minibands [1]. Correlated phases hosted in these structures are prone to twist disorder given by lateral fluctuations of the moiré cell size [2]. We investigated this lateral twist inhomogeneity on twisted WSe2 bilayers using comprehensive correlative lateral force microscopy and Raman spectroscopy [3].

In this work, we expand the topic by investigating different twisted systems: artificially stacked fully encapsulated WSe2 bilayers, MoSe2/WSe2 hetero-bilayers and CVD-grown MoS2 bilayers. Moiré phonon frequencies obtained from Raman spectroscopy maps are utilized to determine the twist angle over micrometer-sized areas in these systems. Additionally, Raman mapping facilitates fast and non-destructive identification of homogeneous, high-quality regions in encapsulated and gated structures.

[1] N. Saigal, et. al., Phys. Rev. Lett. 133, 046902 (2024) [2] S. Shabani et al. Nat. Phys. 17, 720-725 (2021) [3] N.L. Bathen et al. in preparation

HL 20.18 Tue 18:00 P1

Nonlinear interference in a CrSBr BIC metasurface — •Fabian Glatz[1], Thomas Weber[2], Till Weickhardt[1], Luca Sortino[2], Andreas Tittl[2], and Giancarlo Soavi[1] — [1]Friedrich Schiller University Jena — [2]Ludwig Maximilians University of Munich

The active electrical [1] and all-optical [2] modulation of the nonlinear optical (NLO) response of layered materials has attracted great interest for nanophotonic applications. Ferroic layered materials, such as CrSBr, offer an alternative and powerful approach for NLO tuning thanks to temperature-dependent phase transitions [3]. Here, we present a new method where NLO modulation arises from interference effects between bound states in the continuum (BIC) resonances and the bulk NLO susceptibility of a CrSBr nanophotonic device. To achieve this, we patterned exfoliated CrSBr flakes into metasurfaces that exhibit BICs and investigated their NLO response. By varying the dimensions of the metasurface, we obtain direct control over the energy, linewidth and Q-factor of the BIC resonances [4]. When the energy of the BIC resonance is close to that of the CrSBr exciton, we further observe a strong modulation in third harmonic generation (THG), characterized by both constructive and destructive interference depending on the energy of the emitted TH signal. These results allow us to retrieve the real and imaginary parts of the BIC-resonance, and they further demonstrate a new powerful approach for NLO engineering at the nanoscale. *[1] Soavi et al. Nat. Nanotech. 13, (2018). [2] Klimmer et al. Nat. Photon. 15, (2021). [3] Wang et al. Nat. Com. 14, (2023). [4] Weber et al. Nat. Mater. 22, (2023).*

HL 20.19 Tue 18:00 P1

Surface acoustic wave spectroscopy on low dimensional semi-

conductor materials — •Paul Hollatz, Felix Ehring, Paromita Bhattacharjee, Emeline Nysten, and Hubert Krenner — Intitute of Physics, University of Münster, Germany

For future technologies, low-dimensional quantum materials such as 2D transition metal dichalcogenides (TMDCs), 1D Nanowires, or 0D Quantum Dots (QDs) are of highest relevance.

Studying the properties of such semiconductor nanomaterials can be achieved by various methods, including the combination of surface acoustic wave (SAW) spectroscopy and photoluminescence (PL) measurements, which provides unique access to carrier dynamics.

In this approach, SAWs operating in the MHz to GHz regime enable on-chip integration due to their micro- to nanometer wavelengths.

Here, we show that interaction of a SAW with co-integrated materials via its strain and the electrical field enables contact-free sensing and manipulation of their optical properties.

When combined with time-integrated and time-resolved PL measurements, it reveals excitation pathways and charge-carrier behaviour, offering deeper insight into the fundamental processes that govern these materials and paving the way for advanced optoelectronic applications.

HL 20.20 Tue 18:00 P1

Interfacial Electronic Coupling in WS2-PyMACl van der Waals Heterostructures — •Mohammed Adel Aly[1,2], Dominik Muth[3], Bettina Wagner[4], Martin Koch[2], Johanna Heine[4], and Marina Gerhard[3] — [1]Institute of Physics and Center for Nanotechnology, University of Münster, 48149 Münster, Germany — [2]Department of Physics and Marburg Centre for Quantum Materials and Sustainable Technologies, Semiconductor Photonics Group, Philipps-Universität Marburg, 35032 Marburg, Germany — [3]Department of Physics and Marburg Centre for Quantum Materials and Sustainable Technologies, Semiconductor Spectroscopy Group, Philipps-Universität Marburg, 35032 Marburg — [4]Department of Chemistry and Marburg Centre for Quantum Materials and Sustainable Technologies, Philipps-Universität Marburg, 35032 Marburg, Germany

Interfacial coupling in mixed van der Waals systems enables tuning of the optical response of 2D semiconductors. We investigate heterostructures based on monolayer WS2 and few-layer organic crystalline pyrenemethylammonium chloride (PyMACl). Time-resolved photoluminescence shows a pronounced shortening of the PyMACl emission lifetime, indicating efficient interfacial coupling. Polarization-resolved measurements show a clear polarization anisotropy in WS2 within the heterostructure, pointing to symmetry breaking induced by the organic crystal. These observations demonstrate electronic coupling across the interface and highlight ionic organic crystals as functional substrates for tailoring excitonic behavior in 2D materials.

HL 20.21 Tue 18:00 P1

Optical Properties of a Transition-metal Dichalcogenide - ZnO Nanowire Field-effect Transistor — •Yashvi Bulsara[1], Maximilian Tomoscheit[1], Omid Ghaebi[1], Edwin Eobaldt[1], Carsten Ronning[1], and Giancarlo Soavi[1,2] — [1]Institute of Solid State Physics, University of Jena — [2]Abbe Center of Photonics, University of Jena

Transition-metal dichalcogenide (TMD) monolayers combined with zinc-oxide (ZnO) nanowires (NW) represent a promising platform for electrically tunable nanophotonic devices. ZnO NWs can be used as nanoscale lasers, supporting waveguiding, field amplification and being the gain medium at the same time. A further major step towards the success and broad applicability of NW lasers, is the possibility to actively tune their laser properties via external stimuli, such as the piezo-electric effect[1]. Recently, we have demonstrated that coupling of ZnO NWs to monolayer TMDs leads to an increase of the lasing intensity threshold[2]. Building on this approach, in this poster I will propose a device where the laser emission of a ZnO NW can be electrically tuned by coupling it to a TMD based field-effect transistor. Besides the main idea and device architecture, I will present preliminary results of device fabrication and characterization.

[1] M. Zapf, Nano Lett., 2017, 17 (11), 6637-6643
[2] E. Eobaldt, Nanoscale, 2022,14, 6822-6829.

HL 20.22 Tue 18:00 P1

Optical Properties of He^{+}-Irradiated CrSBr — •Alison Pfister[1], Daria Markina[1], Shengqiang Zhou[2], Regine von Klitzing[1], Ksenia Mosina[3], Zdenek Sofer[3], and Bernhard Urbaszek[1] — [1]Institute for Condensed Matter Physics, TU Darmstadt, Hochschulstraße 6-8, D-64289 Darmstadt, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstraße 400, 01328 Dresden, Germany — [3]Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technicka 5, 166 28 Prague 6, Czech Republic

CrSBr, a van der Waals layered magnet, exhibits rich interactions among quasiparticles, involving photons, excitons, and spins. Although antiferromagnetic in its bulk pristine form with ferromagnetic intralayer order, irradiation with He^{+} ions drives CrSBr into a ferromagnetic state, enabling novel optical behaviour without applying an external magnetic field. We probe the optical response using polarization-resolved Raman spectroscopy together with absorption and photoluminescence excitation (PLE) measurements. Pronounced changes in Raman intensity and polarization alongside marked variations in absorption near the Curie temperature, and resonant features in PLE spectra were observed. Analysis of Raman tensor evolution and anomalous temperature-dependent behaviour of excitons in absorption highlights intricate coupling between lattice, electronic, and magnetic states, positioning CrSBr as an attractive platform for exploring quasiparticle physics in 2D magnets and related quantum technologies.

HL 20.23 Tue 18:00 P1

Creating Chalcogenide Aeromaterials through Atomic Layer Deposition — •Vladimir Ciobanu[1], Alejandra Ruiz-Clavijo[2], Tudor Braniste[1], Sebastian Lehmann[2], Niklas Wolff[3], Dongho Shin[2], Eduard Monaico[1], Rainer Adelung[3], Lorenz Kienle[3], Kornelius Nielsch[2], and Ion Tiginyanu[1] — [1]Technical University of Moldova, Chisinau, Moldova — [2]Leibniz Institute of Solid State and Materials Research, Dresden, Germany — [3]Kiel University, Kiel, Germany

In this work, we report the development of SnS2 and SnSe2 aeromaterials synthesized via ALD on sacrificial ZnO microtetrapod templates. The ALD process enables conformal coating of the 3D ZnO microtetrapod network with precise thickness control. The resulting SnS2 and SnSe2 shells retain the original tetrapodal morphology after selective ZnO removal in acid, forming a hollow microtubular structure with the wall thickness of about 50 nm and very high porosity. Structural characterization by XRD revealed that the as-deposited films are amorphous, while post-deposition annealing in a S or Se atmosphere at 250 °C induces crystallization of SnS2 or SnSe2. SEM demonstrated uniform coverage and preservation of the porous aeromaterial network. TEM revealed the presence of SnSx or SnSex phases with multidomain. These results highlight the capability of ALD to fabricate crystalline, compositionally controlled, and geometrically complex chalcogenide aeromaterials with strong potential for photoactive and catalytic applications. Acknowledgements: We thank the BMFTR and NARD for the funding of ProMoMo project DEHYCONA.

HL 20.24 Tue 18:00 P1

Creating Chalcogenide Aeromaterials through Atomic Layer Deposition — •Vladimir Ciobanu[1], Alejandra Ruiz-Clavijo[2], Tudor Braniste[1], Sebastian Lehmann[2], Niklas Wolff[3], Dongho Shin[2], Eduard Monaico[1], Rainer Adelung[3], Lorenz Kienle[3], Kornelius Nielsch[2], and Ion Tiginyanu[1] — [1]Technical University of Moldova, Chisinau, Moldova — [2]Leibniz Institute of Solid State and Materials Research, Dresden, Germany — [3]Kiel University, Kiel, Germany

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HL 20.25 Tue 18:00 P1

Investigating few-layer 3R-MoS_2 on top of laser-written waveguides — •Elisabeth Grune[1], Alina Schubert[1], Karoline Becker[1], Rico Schwartz[1], Andreas Thies[2], Alexander Szameit[1], Takashi Taniguchi[3], Kenji Watanabe[3], Matthias Heinrich[1], and Tobias Korn[1] — [1]Insitute of Physics, University of Rostock, Rostock, Germany — [2]Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Berlin, Germany — [3]National Institute for Material Science, Tsukuba, Japan

The properties of 3R-MoS_2, ranging from photoluminescence to second-harmonic generation, have attracted increasing scientific interest in recent years. Our goal is to couple these optical properties evanescently to an laser-written optical waveguide running along the substrate's surface. As a first step, we manufactured a system containing an hBN-encapsulated few-layer 3R-MoS_2 flake on top of a surface waveguide and investigated its photoluminescence signal in several optical geometries at room temperature as well as under cryogenic conditions. We find that when exciting the sample from above, the waveguide itself emits an unexpectedly high background fluorescence signal compared to the 3R-MoS_2 flake. We also use the waveguide itself to excite the flake, yet find that the previous fluorescence also dominates the spectrum. We discuss strategies for mitigating improving the present structures.

HL 20.26 Tue 18:00 P1

Transport simulations of bilayer graphene/WSe_2 electron-hole double quantum dots with spin-orbit coupling — •Nikita Berg[1,2], Hubert Dulisch[1,2], Roxana Anghel[1,2], Simone Sotgiu[1,2], Christian Volk[1,2], and Christoph Stampfer[1,2] — [1]JARA-FIT and 2nd Institute of Physics, RWTH Aachen University — [2]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich

The electron-hole (e-h) symmetry in bilayer graphene (BLG) gives rise to robust spin-valley blockade in double quantum dots (DQDs) operated in the e-h regime. This enables the system to serve as a sensitive probe for blockade-breaking mechanisms. BLG/WSe_2 heterostructures offer electrostatic tunability of proximity-induced spin-orbit coupling (SOC) through the layer selectivity of the electron and hole wave functions in BLG. In this system, one possible spin-blockade-breaking mechanism arises from Rashba-type SOC, which can mediate spin-flip tunneling between the dots.

We present a master-equation-based steady-state transport simulation framework that accounts for coherence effects in e-h BLG double quantum dots. Using this approach, we show that Rashba-mediated spin-flip tunneling produces a distinctive dependence of the e-h blockade lifting on the angle of the applied in-plane magnetic field. This predicted angular dependence provides a clear and experimentally testable signature of induced Rashba spin-orbit coupling in BLG/WSe_2 heterostructures.

HL 20.27 Tue 18:00 P1

Active Fabri-Perot interferometer cavity stabilization for high-resolution spectroscopy of low-light single-photon emitters — •F. Stechemesser[1], F. Schaumburg[1], C. Dietrich[2], H. Mannel[1], A. Rodriguez[2], J. König[2], C. Steiner[3], P. Pesch[3], A. Lorke[1], G. Prinz[1], M. Geller[1], and A. Kurzmann[2] — [1]Faculty of Physics, University of Duisburg-Essen and CENIDE, Germany — [2]Physikalisches Institut Fachgruppe Physik, Universität zu Köln, Germany — [3]Fachgruppe Physik, RWTH Aachen, Germany

Single-photon emission from solid-state quantum emitters, such as quantum dots and defects in 2D materials, with narrow linewidths is one of the key ingredients for future applications in quantum information processing. In photoluminescence spectroscopy, the linewidths of such emitters can be determined using a grating spectrometer. However, in resonance fluorescence and at low laser excitation intensity, such spectrometers reach their limits regarding resolution and optical sensitivity. We introduce an actively stabilized, narrow-linewidth (free spectral range of 30 GHz) Fabry-Perot interferometer (FPI) that is stabilized using the light from a frequency-tunable diode laser. The quantum emitter photons are sent through the FPI, which is scanned across the emitter resonances. This approach enables measurements on a single photon detector (APD) with extended integration times. The single photon sensitivity of an APD can then be used to resolve low-intensity optical resonances of the different quantum emitters with a resolution down to 60 MHz. We show first results of single photon emission from InAs quantum dots and defects in WSe_2 monolayers.

HL 20.28 Tue 18:00 P1

Temperature-Dependent Studies of Interlayer Exciton in PbI2/WS2 Heterostructure — •Tobias Manthei[1], Bhabani Sahoo[1], Ajay Kumar[2], Abhishek Misra[2], Chirag Palekar[1], and Stephan Reitzenstein[1] — [1]Institut für Physik und Astronomie, Technische Universität Berlin, Hardenbergstrasse 36, 10623 Berlin, Germany — [2]Department of Physics, Indian Institute of Technology Madras, Chennai 600036, India; Center for 2D Materials Research and Innovation, IIT Madras, Chennai 600036, India

We present temperature-dependent studies of interlayer exciton in PbI2/WS2 heterostructure. The interlayer exciton formed in such heterostructures consist of electron and hole situated at gamma point in Brillouin zone of respective materials. Hence these dipolar exction are twist angle independent and momentum direct while emitting at room temperature. Taking advantage of the stable nature of the interlayer exciton we investigated radiative lifetime along with polarisation as function of the temperature. We observe relatively long radiative lifetime at low temperature compared to room temperature. Furthermore, we measured the polarisation of the interlayer exciton, which suggests that the emission is elliptically polarised, with peak splitting occurring at high temperatures. This provides insight into spin-valley dynamics. Our studies establish solid foundation for further light-matter interaction experiments related to room temperature interlayer excitons integrated in microcavity.

HL 20.29 Tue 18:00 P1

Effective Theory of Feshbach Resonances in Two-Dimensional Semiconductors — •Maximilian Wolf and Richard Schmidt — Institut für Theoretische Physik, Universität Heidelberg, 69120 Heidelberg, Germany

Feshbach resonances in two-dimensional semiconductor bilayer systems have recently been demonstrated through experiments and first-principles calculations. Motivated by these findings, we introduce an effective model that captures the essential physics of these resonances. We show how the model parameters can be fixed directly from experimental data, enabling us to derive analytical scattering phase shifts and propagators in the few-body limit. With these results, observables at finite chemical potential can be computed using standard many-body techniques. As an example, we evaluate the exciton absorption spectrum in TMD materials and compare our predictions with experimental observations.

HL 20.30 Tue 18:00 P1

Manipulation of hybrid interlayer excitons in homobilayer MoS_2 — •Ankur Arora, Mathias Federolf, Atanu Patra, Subhamoy Sahoo, Monika Emmerling, Anuj Kumar Singh, Simon Betzold, and Sven Höfling — Lehrstuhl für Technische Physik, Julius-Maximilians-Universität Würzburg, Würzburg, Germany

Van der Waals (vdW) heterostructures of transition metal dichalcogenide materials provide a versatile platform for novel excitonic phenomena. Homobilayer MoS_2 is particularly attractive, as its hybrid interlayer excitons (hIX) possess a permanent dipole moment with high oscillator strength, even at room temperature and exhibit tunability via the quantum-confined Stark effect under an external DC electric field. In this work, we investigated the optical properties of hIX in homobilayer MoS_2, which is electrically contacted with few-layer graphene (FLG) and encapsulated in hexagonal boron nitride (hBN). The hBN encapsulation improves the optical response by narrowing the excitonic linewidths, revealing the effect of the dielectric environment. By applying a vertical electric field, we show the Stark splitting of the peaks of the hIX. The vdW heterostructure is transferred onto a distributed Bragg reflector (DBR) with pre-patterned contacts forming a half-cavity design. This architecture serves as a critical first step toward the fabrication of a full microcavity, enabling the exploration of strong light-matter coupling. Our results pave the way for electrically tuning these dipolar hIX polaritons inside a microcavity for fundamental studies on exciton condensates and exciton polariton-induced superconductivity.

HL 20.31 Tue 18:00 P1

SH modulation in a TMD-graphene heterostructure — •Raja Hoffmann[1], Lisa Suchomel[1], Omid Ghaebi[1], Till Weickhardt[1], and Giancarlo Soavi[1,2] — [1]Friedrich-Schiller-Universität Jena, Germany — [2]Abbe Center of Photonics, Jena, Germany

One of the most fascinating properties of layered materials is arguably the possibility to combine them in heterostructures with engineered electronic and optical properties. In the field of nonlinear optics, a clear example is the emergence of second harmonic generation (SHG)

in layered heterostructures realized by combining centrosymmetric materials. In such samples, interface broken space inversion symmetry can be engineered in different ways depending on the choice of materials and twist angle. An interesting example, which has been investigated recently in Ref.[1], are heterostructures composed of bilayer TMDs and monolayer graphene. As charges move from the TMD into the graphene, an imbalance between the bottom and top layers in the TMD bilayer leads to breaking of the inversion symmetry.
Building on these previous seminal results, we further investigate a bilayer TMD-monolayer graphene gated device, focusing in particular on both gate and all-optical tuneability of its engineered SHG. With this, we aim to add another prototype sample to the growing list of nonlinear nanophotonic devices based on layered materials and displaying ultrafast tunable optical properties [2,3].

[1] Zhang et al. Science Advances 9, 4571 (2023).
[2] Ghaebi et al. Advanced Science 11, 2401840 (2018).
[3] Klimmer et al. Nature Photonics 15, 837-842 (2021).

HL 20.32 Tue 18:00 P1

Electrical and optical studies of twisted graphene bilayers — •Anselm Watschke, Monica Kolek Martinez de Azagra, and Thomas Weitz — I. Physikalisches Institut, University of Goettingen

As a van der Waals heterostructure, twisted bilayer graphene shows rich angle-dependent electronic behavior, including magic-angle superconductivity [1] and near-30° interlayer decoupling [2], motivating efforts to tune its electrical properties through multiple degrees of freedom. Furthermore, in situ quantum twisting microscope measurements revealed the angle dependent tunneling current for small regions of twisted bilayer graphene [3].

In this work, we fabricated devices incorporating a locally twisted bilayer graphene region, enabling simultaneous investigation of the off-angle regime and adjacent monolayer domains. Encapsulation in hexagonal boron nitride was used to maintain the intrinsic behavior of graphene, and vibrational and electronic properties were subsequently examined through Raman spectroscopy and gate-tunable transport measurements.

[1] Cao, Y., Fatemi, V., Fang, S. et al. Nature 556, 43*50 (2018). https://doi.org/10.1038/nature26160
[2] H. Schmidt, T. Lüdtke, P. Barthold, E. McCann, V. I. Fal'ko, R. J. Haug; Appl. Phys. Lett. 27 October 2008; 93 (17): 172108. https://doi.org/10.1063/1.3012369
[3] Inbar, A., Birkbeck, J., Xiao, J. et al. Nature 614, 682*687 (2023). https://doi.org/10.1038/s41586-022-05685-y

HL 20.33 Tue 18:00 P1

Laser induced oxidation of thin layered MoS2 — •Aniketa Anampally, Gerhard Berth, Klaus Jöns, and Henry Hübschmann — Paderborn University, Germany

Transition metal dichalcogenides (TMDs) have gained great attention within the growing field of 2D materials. Due to their inherent semiconductor properties, materials like molybdenum disulfide (MoS2) have been implemented in many components of photonic and optoelectronic devices [1,2]. Precise structural modification has been proven to exhibit significant benefits to build tailored devices on the nanoscale [3]. In this work nonlinear microscopy is utilized for in-situ probing and laser oxidation of mechanically exfoliated 2H-MoS2. Precise locally resolved oxidation has been performed by second harmonic microscopy. The arising layer number dependency of this treatment is investigated further supported by polarization resolved analysis.

HL 20.34 Tue 18:00 P1

Optimization of quantum dot in nanowire for efficient emission in telecom spectral range — •Tomasz Gzyl[1], Giada Bucci[2], Valentina Zannier[2], Paweł Mrowiński[1], Anna Musiał[1], Elisa García-Tabarés[3], Ileana Florea[4], Beatriz Galiana[3], Lucia Sorba[2], Wojciech Rudno-Rudziński[1], and Grzegorz Sek[1] — [1]Wrocław University of Science and Technology, 50-370 Wrocław, Poland — [2]NEST Istituto Nanoscienze CNR and Scuola Normale Superiore, 56127 Pisa, Italy — [3]Universidad Carlos III de Madrid, 28903 Getafe, Spain — [4]CNRS-CHREA, 06560 Valbonne, France

One of the promising platforms for realization of a single photon source emitting in telecom wavelengths is an InAs(P) quantum dot (QD) embedded in a nanowire (NW), designed to enhance extraction efficiency and directionality of QD emission. Chemical Beam Epitaxy technique is employed to grow the QD within novel zinc-blende InP NW or wurzite InAsP NW. Here, we present numerical simulations of the QD-NW system, using finite-difference time-domain method to find optimal NW geometry for maximal extraction efficiency, within numerical aperture of 0.4 used in experiment and taking into account parameters space limited by the growth technology. To verify the calculations and further guide the growth of optimized structures, we performed micro-photoluminescence measurements as a function of excitation power on samples with different composition and NW shell diameter. The structural quality of the samples was confirmed using Scanning Transmission Electron Microscopy with Energy Dispersive X-ray Spectroscopy.

HL 20.35 Tue 18:00 P1

Electrostatic Inter-Layer Coupling Between Self-Assembled Quantum Dot Layers — •Jan Lange[1], Lukas Berg[1], Laurin Schnorr[1], Charlotte Rothfuchs-Engels[2], Nikolai Bart[2], Severin Krüger[2], Sven Scholz[2], Arne Ludwig[2], Andreas Wieck[2], and Thomas Heinzel[1] — [1]Condensed Matter Physics Laboratory, Heinrich Heine University, Düsseldorf, Germany — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität, Bochum, Germany

In this study, transient capacitance spectroscopy is used to examine the coupling between self-assembled quantum dots (SAQDs) - made of InAs in a GaAs heterostructure - in spatially separated layers. A rate equation model was developed, incorporating self-consistent band bending calculations, to describe the impact of the inter-layer coupling on the charge transfer processes. Here, also effects caused by the wetting layer are described and included into the model. The findings indicate that the coupling arises from the electrostatic field generated by the charged quantum dots in the adjacent layer as well as charge in a wetting layer, providing a quantitative explanation for the altered electron capture and emission dynamics.

HL 20.36 Tue 18:00 P1

Illumination Response of Electron Capture and Emission Dynamics in Self-Assembled Quantum Dots — •Till Draxler[1], Jan Lange[1], Julia Avdeev[1], Sven Scholz[2], Arne Ludwig[2], Andreas Wieck[2], and Thomas Heinzel[1] — [1]Condensed Matter Physics Laboratory, Heinrich-Heine University Düsseldorf — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum

InAs Self Assembled Quantum Dots (SAQDs) are nanoscale semiconductor structures that confine charge carriers in all three spatial dimensions, leading to discrete, atom-like energy levels. Using Deep Level Transient Spectroscopy (DLTS) the influence of infrared irradiation with photon energies in respect to the bandgap energies of GaAs and InAs on the electron transfer dynamics is studied. To maintain a proper illumination of the SAQDs, semi-transparent NiCr Schottky gates are manufactured instead of classical Au gate.

HL 20.37 Tue 18:00 P1

Optimized quantum dot emitters for telecom applications: from growth to diode integration — •Tobias Bruggesser, Ponraj Vijayan, Patrick Pietrantuono, Sergej Vollmer, Philipp Noack, Justus A. Unfried, Ulrich Pfister, Michelle Weiss, Simone L. Portalupi, Michael Jetter und Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen, University of Stuttgart, Germany

Quantum communication and quantum computing applications require a reliable high-purity single photon source. Stranski-Krastanov grown indium arsenide (InAs) quantum dots (QDs) are among the most widely studied candidates, as they possess high purity, brightness, and indistinguishability. When embedded in a GaAs semiconductor matrix, these QDs emit in the near-infrared region (≈ 900 nm), and this can be shifted to the technologically important telecom C-band (1530-1565 nm) by introducing an InGaAs metamorphic buffer (MMB) beneath the QDs to engineer the strain. Our group has previously developed a thin InGaAs MMB based on a non-linear grading of the indium content with a so-called jump-convex-inverse (jci) design. This design is compatible with optical device fabrication, as it can be incorporated into a high-quality 1λ-cavity structure. In this work, we present our approach towards integrating these telecom C-band emitting InAs QDs into a p-i-n diode structure. Our goal is to control the charge carrier environment of the QDs, improve their optical properties, and achieve fine-tuning of the emission energy via the quantum-confined Stark effect.

HL 20.38 Tue 18:00 P1

Design and optimization of photonic nanostructures for

embedding GaAs quantum dots emitting at 780 nm — •Mrunmayee Deodhar[1], Ponraj Vijayan[1], Katharina Dahler[1], Ulrich Pfister[1], Michelle Weiss[1], Melina Peter[2], Ailton José Garcia Jr.[2], Thomas Oberleitner[2], Michael Jetter[1], Simone Luca Portalupi[1], Armando Rastelli[2], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Allmandring 3, Germany — [2]Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, 4040 Linz, Austria

Droplet-etched GaAs quantum dots (QDs) are a promising source for single and highly indistinguishable photons. Their optical properties like a narrow wavelength distribution, short decay times, linewidths close to the Fourier limit, and the resulting highly indistinguishable photons make them highly appealing for several quantum technologies. We demonstrate the integration of these QDs into photonic nanostructures such as single-mode waveguides, multimode interference splitters, and Bragg grating waveguides. We also present simulations and describe the fabrication process used to realize these photonic nanostructures.

HL 20.39 Tue 18:00 P1

Auger-recombination in no-wetting layer InAs self-assembled quantum dots — •M. Rasulyar[1], H. Mannel[1], F. Rimek[1], A. Ludwig[2], A. Lorke[1], and M. Geller[1] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, 47057 Duisburg, Germany — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

The Auger-Meitner effect is a non-radiative recombination pathway in which the energy of an electron-hole pair is transferred to a third carrier. In colloidal quantum dots, this mechanism is known to suppress radiative emission, while in self-assembled InAs/GaAs quantum dots, both non-radiative Auger processes [1] and radiative Auger-like channels [2] have been reported. However, as Auger recombination is a dephasing effect in quantum dot-based single-photon devices, we study the influence of the confining potential on the non-radiative Auger recombination rate.

We investigate the Auger-Meitner dynamics in a no-wetting layer quantum dot incorporated in a gate-tunable p-i-n diode. Under resonant excitation of the trion transition, we observe a pronounced quenching of the resonance-fluorescence signal. The intensity reduction is quantitatively explained by the competition between the electron emission rate and the electron tunneling-in rate. The Auger recombination rate is in the order of $1\,\mu s^{-1}$ and in accordance with previous measurements with a rate of $\gamma_a = 2.3\,\mu s^{-1}$ [1]. [1]A. Kurzmann et al., Nano Lett. 16, 3367 (2016). [2]M. Löbl et al., Nat. Nanotechnol. 15, 558-562 (2020). [3]M. Löbl et al., Commun. Phys. 2, 93 (2019).

HL 20.40 Tue 18:00 P1

Single-electron charging events on double quantum dots in InSb nanowires — •Kanji Furuta[1], Marcus Liebmann[1], Fenja Thomsen[1], Sasa Gazibegovic[2], Diana Car[2], Erik Bakkers[2], and Markus Morgenstern[1] — [1]II. Phys. Inst. B, RWTH Aachen Univ., Germany — [2]Dept. of Appl. Phys., Eindhoven Univ., The Netherlands

As a step to develop a single-electron counting tip for a scanning tunneling microscope, we investigate the charge states of a double quantum dot (DQD) formed in an InSb nanowire by monitoring the current through a floating-gate-coupled sensor quantum dot (QD). The DQD and sensor QD are defined electrostatically by bottom finger gates below hexagonal boron nitride (h-BN) used as the gate dielectric. Time-resolved measurements of the sensor QD current reveal single-electron charging events in the DQD. The asymmetric capacitive coupling of the floating gate allows us to identify which dot acquires an electron. The time traces of the double quantum dot movement of individual electrons are analyzed using full counting statistics, from which the Fano factor and factorial cumulants [1] are extracted.

[1] P. Stegmann *et al.*, Phys. Rev. B **92**, 155413 (2015).

HL 20.41 Tue 18:00 P1

Towards a Quantitative Framework for Capacitance-Voltage Spectroscopy in Quantum Dot Ensembles — •Phil Julien Badura[1], Nico Frédéric Brosda[1], Ismail Bölükbaşi[1], Ibrahim Engin[1], Patrick Lindner[1], Sascha René Valentin[1], Andreas Dirk Wieck[1], Björn Sothmann[2], and Arne Ludwig[1] — [1]Fakultät für Physik und Astronomie, Experimentalphysik VI, Ruhr-Universität Bochum, Bochum, Germany — [2]Fakultät für Physik and CENIDE, Universität Duisburg-Essen, Lotharstraße 1, D-47048 Duisburg, Germany

This study investigates an inhomogeneous ensemble of quantum dots coupled to a charge reservoir using capacitance-voltage spectroscopy. Experimental measurements reveal shifts in capacitance peak positions influenced by AC frequency and temperature, with frequency-dependent shifts remaining unexplained by existing models. To address this, we develop a master-equation-based theoretical model incorporating energy-dependent tunneling effects, which successfully reproduces the experimental data. Our findings emphasize the role of energy-dependent tunneling in distinct regimes: at low temperatures, energy-level dispersion dominates, while at high temperatures and frequencies, shifts arise from optimized sequences of in- and out-tunneling events.

HL 20.42 Tue 18:00 P1

Towards the integration of telecom C-band QDs into photonic integrated circuits — •Michelle Weiss, Ulrich Pfister, Ponraj Vijayan, Simon Oberle, Justus Unfried, Philipp Noack, Tobias Bruggesser, Sergej Vollmer, Raphael Joos, Michael Jetter, Simone L. Portalupi, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), University of Stuttgart, Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Allmandring 3, Germany

Photonic integrated circuits (PICs) pave the way to the realization of several quantum technologies on a small footprint, which makes them highly desirable for applications in quantum communication, computing, simulation and sensing. Silicon and silicon nitride are leading materials for PICs due to the high quality optical components and low optical propagation losses. Due to the indirect bandgap of silicon most of the single-photon sources (SPSs) are based on probabilistic implementations. However, the probabilistic generation of the photons can limit the scalability and requires the use of high laser powers, which is a potential drawback regarding the integration of on-chip detectors. In this regard, In(Ga)As quantum dots (QDs) are promising candidates as on-demand SPSs with high single-photon purity. For their integration on low-loss PICs, several approaches already exist, like monolithic integration techniques and hybrid approaches used for interfacing with silicon-based platforms. We present the progress on various PIC integration techniques for InGaAs QDs grown on a metamorphic buffer layer and so emitting in the telecom C-band.

HL 20.43 Tue 18:00 P1

Aharonov-Bohm interferometry with interacting quantum dots — •Oliver Oing, Alexander Hahn, Jürgen König, and Fred Hucht — Theoretische Physik, Universität Duisburg-Essen

We describe an Aharonov-Bohm interferometer consisting of two leads and two tunnel-coupled quantum dots with on-site Coulomb interaction using first order perturbation theory in the tunnelling strength. In earlier work, a diagrammatic approach was chosen. The complexity of the diagrams for arbitrary parameters limited the calculations to symmetric systems in energies and couplings. By developing a systematic routine in *Mathematica* to generate all possible diagrams, we can explore a wider range of system configurations. Eleven system parameters can be arbitrarily tuned, namely the finite Coulomb interactions, the quantum dot level energies as well as the tunneling strengths, magnetic flux, bias voltage and temperature, enabling us to describe both symmetric and asymmetric systems. A finite bias voltage makes it possible to explore the non-linear response regime. The routine calculates density matrix elements and uses these to obtain the occupations of the quantum dots, the current and the conductance through the system. With this, we compare to analytic results and numerically exact results obtained with the TraSPI method [1].

[1] S. Mundinar, A. Hahn, J. König, A. Hucht, Phys. Rev. B **106**, 165427 (2022)

HL 20.44 Tue 18:00 P1

Characterization of Quantum Dots after Rapid Thermal Annealing in Photonic Layer Structures — •Jasper Ullrich, Severin Krüger, Elias Kersting, and Arne Ludwig — Universitätsstraße 150, Bochum 44801

Rapid thermal annealing (RTA) is an effective post-growth technique for engineering the structural and optoelectronic properties of InGaAs quantum dots (QDs). Short, high-temperature pulses induce controlled interdiffusion that blueshifts the emission wavelength, reduces inhomogeneous broadening, and modifies carrier confinement. In this work, we investigate how specific annealing conditions*temperature, duration, and ambient environment*govern these changes and, in particular, how they influence the oscillator strength of confined excitonic transitions. We expect to show that optimized RTA parameters significantly enhance radiative coupling of QDs, leading to increased oscillator strength and faster emission dynamics. These results would provide a systematic framework for tailoring the optical performance of InGaAs QDs for quantum-light sources, high-speed emitters, and infrared photonic devices.

HL 20.45 Tue 18:00 P1

Ohmic contact for charge tuning devices — •Krupali Dobariya[1], Tom Fandrich[1], Yiteng Zhang[1], Arijit Chakraborty[1], Sulabh Shrestha[1], Doaa Abdelbarey[1], Eddy P. Rugeramigabo[1], Michael Zopf[1,2], and Fei Ding[1,2] — [1]Leibniz Universität Hannover Institut für Festkörperphysik, Appelstraße 2, 30167 Hannover, Germany. — [2]Leibniz Universität Hannover Laboratorium für Nano- und Quantenengineering, Schneiderberg 39, 30167 Hannover, Germany.

Semiconductor quantum dots have shown unique properties as deterministic single photon and entangled photon pair sources. Their outstanding optical properties have the potential for use in quantum applications like quantum communication, quantum key distribution and quantum computing. Nevertheless, due to the stochastic nature of the self-assembly growth process, quantum dots typically emit photons with a broad wavelength distribution across the entire chip, posing challenges for applications requiring specific wavelengths. To address this issue, various tuning techniques have been developed. Electrical tuning, in particular, has emerged as an effective method for adjusting the wavelength and mitigating charge noise in semiconductor quantum dots. Here we study the impact of contact fabrication on the emission properties of GaAs quantum dots. We aim to optimize the process of forming ohmic contacts to n- and p-doped GaAs, placing special emphasis on the selection of materials and the reduction of contact resistance. The quality and performance of the electrical contacts are evaluated through the photoluminescence characterization.

HL 20.46 Tue 18:00 P1

Mixed-dimensional Silicon Junctionless Nanowire Transistors with Hexagonal Boron Nitride Gate Dielectrics — •Ahmed Elwakeel[1,2], Sayantan Ghosh[1,2], Alessandro Puddu[1,2], Madhuri Chennur[1,2], Slawomir Prucnal[1], Yordan Georgiev[1], Ahmad Echresh[1], and Artur Erbe[1,2] — [1]1Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01069 Dresden, Germany

The investigation of two-dimensional hexagonal boron nitride (hBN) as a gate dielectric arises from the intrinsic limitations of conventional oxide layers in aggressively scaled devices. Owing to its atomically thin structure, excellent insulating characteristics, and inherently clean surface free of dangling bonds, hBN enables improved electrostatic control and effective channel passivation. In Junctionless Nanowire Transistors (JNTs), which remain strong contenders for extending Moore's Law, the use of hBN offers the potential to suppress interface trap states and enhance carrier transport. In this work, a top-down fabrication approach was employed to define the n-type doped silicon nanowires (C = 1E19 cm-3). Two distinct JNT devices were prepared: one with native oxide and another incorporating a thermally grown oxide. Subsequently, exfoliated hBN flakes were dry-transferred onto both samples as a gate dielectric. The hBN-integrated JNTs with thermally grown oxide exhibited pronounced improvements in subthreshold swing, on-state current, and the ION/IOFF ratio.

HL 20.47 Tue 18:00 P1

Importance of Aluminium Quality for High-Quality Quantum Emitter — •Severin Krüger[1,2], Elias Kersting[1], Phil Badura[1], and Arne Ludwig[1] — [1]Ruhr-Universität Bochum, Bochum, Germany — [2]Sparrow Quantum Aps, Copenhagen, Denmark

InAs quantum dots are regarded as excellent candidates for single photon emitters due to their high photon rates, good single photon properties, and compatibility with scalable and integratable photonic platforms.

Despite remarkable progress for quantum dots emitting at 950 nm, achieving the same results for quantum dots emitting in the important optical fibre transparency window around 1.3 *m has remained a major challenge.

Here we present a routine we used to monitor and improve the quality of aluminium containing layers grown in our MBE. We find that high quality Al in MBE significantly improves the interface quality and smoothness of Al(Ga)As layers by reducting the surface roughness.

These improvements enabled the growth of pristine distributed Bragg reflectors beneath a defect free, charge tunable quantum dot device, emitting near transform-limited single photons in the O-band at 1.3 um.

HL 20.48 Tue 18:00 P1

RoHS-Compliant Nanocrystal LEDs for Flexible Near-Infrared Biomedical Emitters — •Simon Letzer[1], Andrey Iodchik[2], Rabiul Islam[1], Vladimir Lesnyak[2], and Caroline Murawski[1] — [1]Institute of Solid State Electronics, TU Dresden, Germany — [2]Physical Chemistry, TU Dresden, Germany

The near-infrared (NIR) biological window enables deep-tissue access for non-invasive imaging and health monitoring. Wearable emitters for this range require flexible and efficient materials, yet organic LEDs lose performance above 850 nm. Colloidal nanocrystals (NCs) offer a promising alternative for NIR emission, although most efficient systems contain Hg, Cd, or Pb, restricting their use in biomedical settings. We therefore investigate RoHS-compliant NCs for solution-processed NIR emitters. As a baseline, we employed CdHgSe/CdZnS core/shell NCs, which have already demonstrated strong performance in LEDs and provide a reliable platform for optimizing device processing [1]. Film quality is strongly influenced by concentration, solvent, dispense time, spin profile, and baking conditions. High-boiling-point solvents produced uniform macroscopic films, while low-temperature baking and high spin speeds improved nanoscale smoothness. Building on these conditions, we fabricated our first RoHS-compliant devices based on CuInS2/ZnS NCs. Processing parameters were refined for this material, and different transport layers and device architectures were evaluated. These results demonstrate a viable path toward cadmium-free NIR emitters for wearable biomedical sensors.

[1] Adv. Funct. Mater. 2024, 34, 2310067.

HL 20.49 Tue 18:00 P1

Stark Tuning of CsPbBr3 Quantum Dots — •Christopher Borchers[1], Johann Dzeik[1], Maximilian Heller[1], Frederik Benthin[1], Eddy Rugeramigabo[1], Chenglian Zhu[2,3], Ihor Cherniukh[2,3], Gabriele Rainò[2,3], Maksym Kovalenko[2,3], Michael Zopf[1,4], and Fei Ding[1,4] — [1]Leibniz Universität Hannover, Institut für Festkörperphysik, Appelstraße 2, 30167 Hannover — [2]Institute of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, CH-8093 Zürich, Switzerland — [3]Laboratory for Thin Films and Photovoltaics, Empa - Swiss Federal Laboratories for Materials Science and Technology, CH-8600 Dübendorf — [4]Laboratory of Nano and Quantum Engineering, Leibniz University Hannover, Schneiderberg 39, D-30167 Hannover, Germany

CsPbBr3 perovskite quantum dots are bright, solution-processable nanocrystal emitters with size-tunable color and high oscillator strength. Furthermore, they can be fabricated and processed in a cheap and facile way. We investigate electric-field tuning of single dots through the quantum-confined Stark effect to minimize exciton fine-structure splitting and tune separate emitters into resonance with each other. This opens up possibilities of creating entangled photon pairs of super- and subradiance with perovskite quantum dot based photonic devices.

HL 20.50 Tue 18:00 P1

Low temperature dry etching of InAlAs/InP nanostructures for telecom band single photon sources — •Ankita Choudhary[1], Chenxi Ma[1], Yiteng Zhang[1], Eddy Patrik Rugeramigabo[1], Michael Zopf[1,2], and Fei Ding[1,2] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover, Germany — [2]Laboratorium für Nano- und Quantenengineering, Leibniz Universität Hannover, Schneiderberg 39, 30167 Hannover, Germany

Epitaxial InP-based quantum dots are excellent candidates for telecom band single photon sources for long-distance quantum communication. Enhancing photon extraction requires integration into photonic nanostructures through high resolution lithography and dry etching. Conventional chlorine-based ICP-RIE etching of InP is challenging due to competing thermal demands that lead to uncontrollable volatilisation of chlorine byproducts at high temperatures, while low-temperature cyclic methods result in defect-rich interfacial layers.Here we demonstrate low temperature chlorine based etching that circumvents byproduct volatilisation and stoichiometric imbalance and eliminates defect layer formation without intermediate chemical treatments. we demonstrate the fabrication of a submicron truncated cone with smooth sidewalls, enhancing spontaneous emission directionality. The fabricated nanostructure shows 3-4 times improved extraction efficiencies compared to as-grown samples, with an NA of 0.7 detection optics. This process provides a robust pathway for fabricating high-quality photonic nanostructures for quantum telecommunications.

HL 20.51 Tue 18:00 P1

Lateral Electric Field Tuning of Quantum Dots — •Johann Dzeik[1], Christopher Borchers[1], Chenxi Ma[1], Ankita Choudhary[1], Xian Zheng[1], Yiteng Zhang[1], Tom Fandrich[1], Arijit Chakraborty[1], Michael Zopf[1,2], and Fei Ding[1,2] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover, Germany — [2]Laboratorium für Nano- und Quantenengineering, Leibniz Universität Hannover, Schneiderberg 39, 30167, Hannover, Germany

Quantum dots are among the most promising material systems for single photon sources in quantum communication and computation. However, they exhibit a stochastic distribution of emission wavelengths and fine-structure splitting, necessitating post-growth tuning that must be compatible with their fabrication and photonic environment. In this study, we use planar electrodes in parallel and quadrupolar configurations at varying distances to investigate the influence of electric fields on the emission wavelength and fine-structure splitting of GaAs/ AlGaAs quantum dots.

HL 20.52 Tue 18:00 P1

SUPER Scheme in Telecom-Wavelength Quantum Dots — •Zenghui Jiang — Leibniz Universität Hannover, Institut für Festkörperphysik, Appelstraße 2, 30167 Hannover

Co-authors: Vikas Remesh, Frederik Benthin,Thomas Bracht, Michael Jetter, Simone Portalupi, Doris Reiter, Peter Michler, Michael Zopf, Fei Ding

Abstract:

To obtain the best photon properties from quantum dots (QDs), direct driving between the S-shell and the ground state i.e., resonant excitation is typically required. However, laser filtering under resonant excitation is extremely challenging because the QD emission and the excitation laser lie at essentially the same wavelength. The recently proposed and experimentally demonstrated SUPER scheme addresses this challenge by using two relatively detuned laser pulses to directly drive the two-level system. Since the excitation and emission wavelengths are well separated, the scattered excitation laser can be spectrally filtered much more easily. In our work, we implement a pulse shaper based on a spatial light modulator to generate two well-defined laser pulses from a single broadband pulse for the SUPER scheme. In addition, we investigate SUPER excitation using two narrow-linewidth continuous-wave lasers as a comparison, enabling a clearer understanding of the excitation dynamics and the differences relative to pulsed operation.

HL 20.53 Tue 18:00 P1

Andreev Spin Qubits in Hole-Gas Based Nanowires with Mixed Superconducting Pairing — •Markus Plautz — Norwegian University of Science and Technology, Norway

Ge-based lower-dimensional hole gases proximitized by superconductors represent a promising platform for future quantum technologies, largely related to the complicated p-wave nature of the orbital wavefunctions of the valence band. While standard models often treat the induced superconductivity as purely s-wave, recent microscopic theories indicate that the proximity effect in these systems is far more complex. They reveal that the strong spin-orbit interaction can induce non-trivial mixed pairing correlations, featuring coexisting s- and p-wave terms.

We calculate the Andreev reflection phases and determine the Andreev bound state (ABS) energy spectrum in the presence of Zeeman and spin-orbit fields. In particular, we show how these odd-parity correlations influence the spin splitting, leading to distinct changes in the qubit energy levels. Furthermore, we discuss the coherent control of the qubit subspace by considering a time-dependent perturbation of the spin-orbit coupling. By deriving the exact transition matrix elements, we construct an effective Hamiltonian for the ASQ and investigate how this mechanism can be utilized to coherently drive the qubit.

HL 20.54 Tue 18:00 P1

Nonequilibrium transport in designed random obstacle arrays — •Frederik Bartels[1], Johannes Strobel[1], Beate Horn-Cosfeld[1], Mihai Cerchez[1], Klaus Pierz[2], Hans Werner Schumacher[2], Dominique Mailly[3], and Thomas Heinzel[1] — [1]Condensed Matter Physics Laboratory, Heinrich Heine University, Düsseldorf, Germany — [2]Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany — [3]CNRS, Université Paris-Saclay, C2N Marcoussis, 91460 Marcoussis, France

Nonequilibrium transport phenomena in two-dimensional electron systems include Hall field induced resistance oscillations (HIROs), zero resistance states (ZRS), phase inversion of SdH oscillations, and modifications of the giant negative magnetoresistance (GNMR). In our recent work [1], we studied HIROs in two-dimensional electron gases dominated by scattering at artificially introduced, randomly distributed circular obstacles. For sufficiently high obstacle densities, these scatterers dominate the HIROs. The HIRO period increases with obstacle density, indicating a localization of the Hall field around the obstacles and providing an alternative explanation of the scaling factor γ in terms of spatially varying Hall fields. Here, we extend these studies to cross-shaped obstacle geometries designed to enhance backscattering - the central mechanism in the theory of HIROs [2]. The findings may help to establish a more unified understanding of nonlinear resistance oscillations in two-dimensional systems with artificial scatterers. [1] Bartels *et al.* Phys. Rev. B **111**, 165301 (2025), [2] Yang *et al.* Phys. Rev. Lett. **89**, 076801 (2002)

HL 20.55 Tue 18:00 P1

Tenfold Conductance Enhancement in Graphene Nanoscrolls via Interlayer Hopping — •Jia-Cheng Li[1], Yu-An Cheng[2], Ying-Je Lee[2], Xuan-Fu Huang[2], Yu-Jie Zhong[2], Carmine Ortix[3], and Ching-Hao Chang[2] — [1]Program on Key Materials, Academy of Innovative Semiconductor and Sustainable Manufacturing, National Cheng Kung University, Tainan 70101, Taiwan — [2]Department of Physics, National Cheng Kung University, Tainan 70101, Taiwan — [3]Institute for Theoretical Solid State Physics, IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany

Rolling a graphene nanoribbon into a nanoscroll, a radial superlattice, offers a simple yet powerful way to control electronic transport at the nanoscale. In this work, we show that a one-turn nanoscroll exhibits a dramatic enhancement of quantum conductance compared to a flat ribbon, reaching nearly an order of magnitude in our tight-binding transport calculations. This effect does not rely on curvature-induced gauge fields or external perturbations. Instead, it arises purely from interlayer hopping at the overlapping edges of the scroll, which hybridizes the zigzag edge states and reconstructs the low-energy band structure. The resulting collapse of the flat bands reduces the density of states and shifts the Fermi level upward at fixed carrier density, activating multiple propagating modes. As the number of turns increases, these effects gradually weaken. Our findings identify nanoscrolls as a tunable geometry-driven platform for engineering transport in low-dimensional carbon systems.

HL 20.56 Tue 18:00 P1

Top-Down Fabrication and characterization of Al-Si-Al Nanowire Schottky barrier field-effect transistors — •Banafsheh Aghvami[1], Alessandro Puddu[1,2], Ahmed Elwakeel[1,2], Sayantan Ghosh[1], Ahmad Echresh[1], and Artur Erbe[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, Dresden, 01328, Germany — [2]Technische Universität Dresden, Dresden, 01069, Germany

In Schottky barrier field-effect transistors (SBFETs), the channel length plays a crucial role in device performance. Shorter channels lead to lower channel resistance, stronger electrostatic gate control, reduced threshold voltage, and improved ON/OFF current ratios. However, to achieve sub-100 nm channel lengths using conventional top-down patterning approaches is extremely challenging due to resolution limits, line-edge roughness, and probable alignment errors. In contrast, the Al-Si-Al solid-state exchange process via rapid thermal annealing (RTA) enables the formation of well-defined and self-aligned short silicon channels. In this study, electron beam lithography (EBL) is used to define nanowire structures into HSQ resist. Then, the patterned structures will be transfered into the silicon layer by Inductively Coupled Plasma-Reactive Ion Etching (ICP-RIE). The Aluminium metal contacts will be formed by sputtering deposition. Scanning Electron Microscopy (SEM) will be employed to analyse the Al-Si-Al heterostructure. In addition, the performance of fabricated SBFETs will be evaluated by electrical characterisation using back-gated configuration.

HL 20.57 Tue 18:00 P1

Organic LEDs for optogenetic cochlear implants — •Nirbhika Nandakumar and Caroline Murawski — Dresden University of Technology, Dresden, Germany

Recent studies have highlighted the potential of optogenetic cochlear implants (oCIs) to surpass the spatial resolution limitations of conventional electrical stimulation by utilizing confined light to activate genetically modified auditory neurons [1]. Existing oCI prototypes predominantly use micro-LEDs, which can generate high optical power but are constrained by thermal load, rigidity, and limited scalability toward dense stimulation arrays [2]. In this work, we investigate organic light-emitting diodes (OLEDs) as alternative light sources for next-generation oCIs. Bottom-emitting OLEDs were fabricated and experimentally characterized with respect to spectral emission, efficiency, and achievable optical power density. The micro-cavity was designed by complementary optical simulations to generate a forward-directed, spatially confined illumination capable of efficiently reaching the intended spiral ganglion neurons. An implant design is proposed based on the geometry of the cochlea, required pixel size, and spacing. The combined experimental and simulation results establish OLEDs as promising alternatives to micro-LEDs for integration into future oCI architectures.

[1] A. Huet et al., Annu. Rev. Neurosci. 47, 103 (2024).
[2] L. Jablonski et al., J. Neural Eng. 22, 046034 (2025).

HL 20.58 Tue 18:00 P1

Creation and characterization of color centers in hexagonal Boron Nitride — •Dennis Heinz Bruno Mors[1,2], Iris Niehues[1], and Daniel Wigger[3] — [1]Institute of Physics, University of Münster, 48149 Münster, Germany — [2]Faculty of Science and Technology, University of Twente, 7522 NB Enschede, Netherlands — [3]Department of Physics, University of Münster, 48149 Münster, Germany

Color centers (CCs) in hexagonal boron nitride (hBN) are promising candidates for stable and bright quantum light sources, despite their unknown origin due to their single-photon emission properties even at room temperature. To explore their potential, we investigate various material sources for their ability to host CCs. We employ mechanical exfoliation to reduce the thickness of bulk crystals to a few layers, resulting in thin hBN flakes that are then transferred onto Si or SiO_2 samples. To enhance the yield of CCs, we thermally anneal the hBN. We then examine our samples using confocal photoluminescence to identify the CCs in the host crystal. Additionally, we utilize a scattering-type scanning near-field optical microscope (sSNOM) to study the photoluminescence (PL) emission characteristics of these quantum emitters. By using a sharp metallic tip, we concentrate the illuminating light field into a nanofocus, enabling us to achieve nanoscale resolution beyond the diffraction limit.[1]

[1] I. Niehues et al., Nanophotonics 2025, 14(3), 335-342.

HL 20.59 Tue 18:00 P1

Spectral wandering of single-photon emitters in the van der Waals material hBN — •Akhilesh Dubey, Robert Schmidt, Johannes Kern, Steffen Michaelis de Vasconcellos, and Rudolf Bratschitsch — Institute of Physics and Center for Nanotechnology, University of Münster, 48149 Münster, Germany

Single-photon emitters in hexagonal boron nitride (hBN) exhibit favorable photophysical optical properties at both room and cryogenic temperatures. However, their performance is limited by various line broadening mechanisms. Here, we present a low-temperature study of the photoluminescence of hBN emitters, investigating linewidth reduction and spectral diffusion at cryogenic temperatures. We believe that the spectral wandering is due to migrating charges in the vicinity of the nanoscale emitter, which could be mitigated by applying an external electric field. Our results essential for developing nanoscale quantum photonic devices based on robust hBN emitters.

HL 20.60 Tue 18:00 P1

2D Lattices of Rb Quantum Emitters on Isolating Substrates — •David Bergmann, Katharina Lorena Franzke, Wolf Gero Schmidt, and Uwe Gerstmann — Paderborn University, Paderborn, Germany

Entanglement plays a decisive role in modern application of quantum information, such as memory atoms and quantum emitters. The central challenge in this context is to address, control and protect systems of many qubits against decoherence.[1] Recently, efficient generation of entangled multiphoton graphs from single ^{87}Rb atoms was reported, overcoming the limitations encountered by probabilistic schemes.[2]

In this theoretical work, we investigate the applicability of different isolating materials to be used as substrate for a 2D lattice or clusters of ^{87}Rb atoms. In contrast to MgO, frequently used in previous investigations [3], NaCl was found to be a substrate that minimizes substrate-mediated interaction between neighboring Rb atoms. It is thus expected to allow entanglement of several individual atoms as single emitters in the same cavity. Therefore, the system Rb/NaCl promises improved scalability and opens new possibilities for quantum computation and communications.

[1] J. Preskill et al., Quantum 2, 79 (2018).
[2] P. Thomas et al., Nature 608, 677–681 (2022).
[3] R. Broekhoven et al., npj Quantum Information 10, 92 (2024)

HL 20.61 Tue 18:00 P1

Dry transfer of 2D van der Waals heterostructures for quantum sensing — •Timo Strobl, Korbinian Felber, Paul Konrad, Andreas Sperlich, and Vladimir Dyakonov — Experimental Physics 6, University of Würzburg, 97074 Würzburg, Germany

A highly dynamic research area is dedicated to the development of quantum sensors based on solid-state spin defects. This field was previously focused on three-dimensional (3D) material systems, which posed challenges in positioning spin centers close to the sample surface. The recent discovery of V_B^- spin defects in the 2D van der Waals (vdW) material hexagonal boron nitride (hBN) provided a new approach to overcome this inherent positioning limitation. These defects are suitable for sensing local magnetic fields, temperature, and lattice strain when utilizing the method of optically detected magnetic resonance (ODMR). Hence, these functional hBN layers constitute a powerful tool for investigating fundamental 2D material properties.

To apply the potential in this area, the fabrication of a van der Waals heterostructure is necessary, combining the spin-active hBN with another 2D material. The precise fabrication by stacking these multilayer 2D materials via established dry-transfer polymer techniques is an essential prerequisite for such quantum sensor structures. The preparation procedures presented here provide essential insights required to implement in situ quantum sensing of 2D materials utilizing hBN.

HL 20.62 Tue 18:00 P1

Development of open-source DRC scripts for physical verification of integrated circuits with FinFET technology. — •Lev Churkin — Moscow, Russia

The development of open-source DRC scripts for FinFET technologies necessitates a fundamental shift from planar-based verification. It must encapsulate the three-dimensional nature of the transistor, enforcing complex rules for fin formation, cut patterning, and their strict alignment. Furthermore, rules must integrate with multi-patterning lithography, addressing color decomposition and spacing constraints to prevent printability errors. This requires checking more than simple geometrics. Consequently, a modern DRC script is a complex software model, which needs to manage the interdependencies of density, stress engineering, and manufacturing variability at a more advanced level.

HL 20.63 Tue 18:00 P1

Exciton dressing by extreme nonlinear magnons in a layered semiconductor — •Geoffrey M. Diederich — University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore MD, USA

Collective excitations presenting nonlinear dynamics are fundamental phenomena with broad applications. A prime example is nonlinear optics, where diverse frequency-mixing processes are central to communication and attosecond science, and extreme (>sixth-order) harmonic generation provides broad wavelength conversion. Leveraging recent progress in van der Waals magnetic semiconductors, we demonstrate nonlinear optomagnonic coupling. In the layered antiferromagnetic semiconductor CrSBr, we observe exciton states dressed by up to 20 harmonics of magnons, resulting from their extreme nonlinearities. We also create tunable optical sidebands via sum- and difference-frequency generation between two optically bright magnon modes under symmetry-breaking magnetic fields. Moreover, we can tune the observed difference-frequency generation mode into resonance with one of the fundamental magnons, which results in parametric amplification of magnons. Our findings realize the modulation of the optical-frequency exciton with the extreme nonlinearity of magnons at microwave frequencies, which could find applications in magnonics and hybrid quantum systems, and provide a method for optomagnonic neuromorphic computing devices.

HL 20.64 Tue 18:00 P1

Synthesis and characterization of new materials from the Sb-Ag-Te system — •Trayana Dolchinkova, Vladislava Ivanova, and Yordanka Trifonova — University of Chemical Technology and Metallurgy, Department of Physics, 8 Kl. Ohridski Blvd., 1797 Sofia, Bulgaria

New bulk chalcogenide materials from the Sb-Ag-Te system were synthesized by single-temperature synthesis in a closed volume. The density of the bulk samples was estimated using the pycnometer technique. Some physicochemical properties such as compactness, the molar volume and the free volume percentage of the materials were calculated, and their dependences on composition were determined. XRD analysis was performed to determine the structure and phase composition of the synthesized samples. A scanning electron microscope were used to study the surface morphology and EDS determined the chemical composition of the bulk samples.

Conclusions were drawn based on the results obtained regarding the influence of Ag content on the properties of the bulk samples.

HL 20.65 Tue 18:00 P1

Investigation of the Thermoelectric Properties of Single-Crystalline and Polycrystalline Bi1-xSbx (x =0, 0.1, 0.15) Alloys — •Fangyi Hu, Yuan Yu, and Matthias Wuttig — I. Physikalisches Institut (IA), RWTH Aachen University, 52074 Aachen, Germany

Thermoelectric (TE) materials can directly convert heat into electricity and vice versa, providing a sustainable and clean energy solution. Bi1-xSbx, a low-temperature n-type TE alloy with great potential between 20-200 K, has drawn increasing attention in cooling applications. Single crystals and polycrystals exhibit different performance and application prospects. In most cases, particularly below 200 K, single-crystal Bi-Sb shows much higher TE performance than polycrystals. However, polycrystalline Bi-Sb offers lower fabrication cost, better mechanical strength, and easier processing, making it attractive for large-scale use. This study compares the TE properties of Bi-Sb alloys in these two forms and clarifies their intrinsic relationship. Single-crystalline and polycrystalline Bi1-xSbx (x = 0, 0.1, 0.15) were prepared by Bridgman and melt-air-cooling methods, respectively. TE properties, with and without magnetic fields, were measured using Thermal Transport Option in a physical property measurement system (PPMS). Microstructures and bonding mechanisms were analyzed via atom probe tomography. By establishing the bonding-structure-property connection, we aim to reveal the origin of the performance difference between the two forms. These results provide insights into improving ZT in polycrystalline Bi-Sb alloys, which are more suitable for practical deployment.

HL 20.66 Tue 18:00 P1

Oxygen Vacancy-Mediated Non-Volatile Memory in RF-Sputtered Ga_2O_3 films — •Aman Bauntiyal, Jon-Olaf Krisponeit, Marco Schowalter, Alexander Karg, Andreas Rosenauer, Martin Eickhoff, and Jens Falta — Institute of Solid State Physics, University of Bremen, Bremen, Germany

To address the memory bottleneck in conventional electronics, resistive switching (RS) has emerged as a promising route for next-generation memory technologies. Among various materials used in RS devices, β-Ga_2O_3 offers advantages such as high breakdown strength and defect-mediated conductivity. However, its direct growth on metal electrodes with controlled microstructure, crucial for scalable vertical devices, remains largely unexplored. Here, we investigate RF-sputtered Ga_2O_3 deposited on smooth Ru(0001) films for non-volatile RS applications.

XRD and TEM confirm the temperature-dependent structural evolution of Ga_2O_3 and its correlation with the I–V response. Devices grown at intermediate temperatures ($\sim$400°C) show the best switching window (up to 10^4), with thinner films enabling low set voltages ($\sim$1.5 V) [1] but poorer stability. In contrast, thicker layers require higher voltages ($\sim$4 V) yet offer better reliability [2]. This behaviour arises from temperature-driven grain growth and the $\gamma \rightarrow \beta$ phase transition [3], which creates mixed phases and grain boundaries that govern oxygen-vacancy-mediated filament dynamics.

[1] A. Bauntiyal *et al.*, *Appl. Phys. Lett.* **123**, 213504 (2023). [2] A. Bauntiyal *et al.*, *2023 IEEE NMDC*, pp. 536-540. [3] A. Bauntiyal *et al.*, *APL Mater.* **13**, 041130 (2025).