HL 14: Poster II

Topics:
- Quantum dots and wires
- Quantum transport and quantum Hall effects
- Spin phenomena in semiconductors

Time: Monday 15:00–18:00 Location: Poster F

HL 14.1 Mon 15:00 Poster F

Restoral of the Single-Photon Purity at a 2π Excitation of a Quantum Two-Level System — •Patricia Kallert[1], Lukas Hanschke[1], Melina Peter[2], Ailton José Garcia Junior[2], Eva Schöll[1], Saimon Filipe Covre Da Silva[2], Santanu Manna[2], Armando Rastelli[2], and Klaus D. Jöns[1] — [1]PhoQS Institute, CeOPP, and Department of Physics, Paderborn University, Paderborn, Germany — [2]Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, Linz, Austria

Exploring the properties of single-photons and their generation from for instance semiconductor quantum dots is critical to developing photonic quantum technologies. The coupling of resonant, coherent laser pulses to a quantum two-level system leads to Rabi rotations between the ground and excited state. In a dephasing-free system, a 2π rotation then leads to either (i) two population inversions and therefore no photon emission or (ii) the emission of two successive photons, if after an emission during the presence of the pulse the system is re-excited.[1] Due to the different temporal shapes, the consecutive photons exhibit different spectral bandwidths, as related by the Fourier transform limit. Here we verify this prediction of different bandwidths for both photons using narrow filtering. By filtering the spectrally broad first photon, we*re reducing the probability of detecting two photons from the same excitation pulse. Our study should help to identify the optimal excitation conditions for applications in quantum technologies.

HL 14.2 Mon 15:00 Poster F

Examination of charge carrier dynamics and their influence on mechanical curvature in a highly strained bent single AlxIn1-xAs/GaAs core shell nanowires as function of diameter via optical laser excitation and X-ray probe method — •Taseer Anjum[1], Francisca Marín Largo[2], Philipp Jordt[3], Ali Al Hassan[5], Rajendra Prasad Giri[3], Lukas Petersdorf[3], Vahid Salehi[1], Matthias Rössele[4], Bridget Murphy[3], Oliver Brandt[2], Lutz Geelhaar[2], and Ullrich Pietsch[1] — [1]Universität Siegen, Siegen, Germany — [2]Paul-Drude-Institut für Festkörperelektronik, Leibniz-Institut im Forschungsverbund Berlin e.V., Berlin, Germany — [3]Institute of Experimental and Applied Physics, Kiel, Germany — [4]Helmholtz-Zentrum Berlin für Materialien und Energie, BESSY II, Berlin, Germany — [5]Karlsruhe Institute of Technology, Karlsruhe, Germany

Extreme bending of semiconductor nanowires (NWs) through asymmetric shell deposition, creates strain gradients that impact their electronic properties. This deformation induces a gradient in the electronic band gap, fostering the formation of an intrinsic quasi-electric field. The study delves into understanding spatially complex electric fields via time-resolved nano x-ray diffraction experiments, tracking elastic deformation in bent NWs. Observation of the GaAs NW 111 Bragg peak evolution reveals plastic deformation due to excess photoexcited charge carriers, mitigated by laser fluence adjustment. This exploration leads to the direct observation of eigenmodes associated with piezo-flexoelectric field screening in bent NWs.

HL 14.3 Mon 15:00 Poster F

Microscopic Simulations of Photonic Cluster-State Generation with Lambda-Type Systems — •Nikolas Köcher, David Bauch, Nils Heinisch, and Stefan Schumacher — Physics Department, CeOPP, and PhoQS, Paderborn University, Germany

In this work, we conduct an in-depth exploration of microscopic quantum-mechanical simulations of the deterministic generation of photonic cluster states from lambda-type systems, with a particular focus on time-bin encoded linear cluster states. Our analysis includes a thorough examination of second and third order time-bin correlations, including stabilizer generator expectation values to quantify the quality of the generated states. The foundation of our exploration lies in the lambda-type system, where proposed protocols for deterministic generation are established [1], utilizing a hole-spin qubit in quantum dot molecules. The quantum dot molecule's lambda system serves as the backdrop for our simulations, providing detailed insights into the efficiency and viability of the proposed protocols. Our aim is to contribute to the understanding of these quantum systems and their potential applications in the generation of highly entangled photonic cluster states [2], considering both the quality and localizable entanglement in the generated quantum states. [1] Vezvaee et al., Phys. Rev. Appl. 18.L061003 (2022). [2] Raissi et al., arXiv preprint 2211.13242 (2022).

HL 14.4 Mon 15:00 Poster F

Acoustic control of light scattering from a single-photon emitter in the strong driving limit — •Daniel Wigger[1] and Paweł Machnikowski[2] — [1]Fachbereich Physik, Universität Münster, Münster, Germany — [2]Institute of Theoretical Physics, Wrocław University of Science and Technology, Wrocław, Poland

In the recent developments of quantum technologies, the combination of different solid state excitations into hybrid infrastructures renders a promising perspective to circumvent drawbacks of individual approaches. In this context phonons represent a versatile platform to dynamically manipulate charge carriers or spin degrees of freedom in the solid state [1]. We have recently demonstrated that in the weak optical driving limit the single-photon emission characteristics of quantum dots can be precisely controlled by surface acoustic waves (SAWs) in the spectral and the temporal domain [2]. We have also made the first steps towards acousto-optical quantum transduction [3].
In this contribution we discuss the opportunities of SAW control of spectral tuning of single emitter spectra in the strong driving limit where the spectrum is given by the Mollow triplet. We find theoretically that phonon sidebands develop which involved mixing behaviors that can exhibit crossing, anticrossing, and extinction behaviour.

[1] Adv. Quantum Technol. 4, 2000128 (2021); IEEE Trans. Quantum Eng. 3, 5100217 (2022)
[2] Optica 8, 291 – 300 (2021); Phys. Rev. Res. 3, 033197 (2021)
[3] AVS Quantum Sci. 4, 011403 (2022); Adv. Quantum Technol. 2300153 (2023)

HL 14.5 Mon 15:00 Poster F

Assessing the alignment accuracy of state-of-the-art deterministic fabrication methods for single quantum dot devices — Abdulmalik Madigawa[1], •Jan Donges[2], Benedek Gaal[1], Shulun Li[2,3,4], Hanqing Liu[3,4], Deyan Dai[3,4], Xiangbin Su[3,4], Xiangjun Shang[3,4], Haiqiao Ni[3,4], Johannes Schall[2], Sven Rodt[2], Zhichuan Niu[3,4], Niels Gregersen[1], Stephan Reitzenstein[2], and Battulga Munkhbat[1] — [1]TU Denmark — [2]TU Berlin — [3]Institute of Semiconductors Beijing — [4]University of Chinese Academy of Sciences Beijing

The realization of efficient quantum light sources relies on the integration of self-assembled quantum dots (QDs) into photonic nanostructures with high spatial positioning accuracy. In this work, we present a comprehensive investigation of the QD position accuracy, obtained using two markerbased QD positioning techniques, photoluminescence (PL) and cathodoluminescence (CL) imaging, as well as using a marker-free in-situ electron beam lithography (in-situ EBL) technique. We employ four PL imaging configurations with three different image processing approaches and compare them with CL imaging. We fabricate circular mesa structures based on the obtained QD coordinates from both PL and CL image processing to evaluate the final positioning accuracy. We discuss the possible causes of the observed offsets, which are significantly larger than the QD localization uncertainty obtained from simply imaging the QD light emission from an unstructured wafer.

HL 14.6 Mon 15:00 Poster F

A Versatile Transfer Printing Toolbox for Device Stacking — •Ioannis Caltzidis[1], Oscar Camacho Ibarra[1], Normen Auler[2], Jan G. Hartel[1], Dirk Reuter[2], and Klaus D. Jöns[1] — [1]PhoQS

Institute, CeOPP, and Department of Physics, Paderborn University, Paderborn — [2]Nanostructuring, Nanoanalysis and Photonic Materials, Department of Physics Paderborn University, Germany

To scale up photonic quantum technologies such as quantum communication, or quantum computing, integration in photonic circuits is required. One challenge is the efficient integration of single-photon emitters into photonic integrated circuits (PIC). The integration approaches of single photon emitters can be categorised into monolithic, heterogeneous and hybrid methods. Monolithic integration is the fastest in terms of fabrication overhead, while heterogeneous, and especially hybrid integration offers a diverse choice of materials and properties to be combined. Here we use molecular beam epitaxy-grown InxGa1-xAs/GaAs quantum dots integrated into a nanobeam cavity. The resulting nanophotonic device is transferred via a pick-and-place technique into a Lithium niobate on insulator (LNOI) waveguides which we fabricate using a triple-layer nanofabrication approach. We employ a thermal release transfer method with polypropylene carbonate as a release agent. The transfer stage's translational, rotational, and azimuthal degrees of freedom enable deterministic positioning and control in the fabrication process.

HL 14.7 Mon 15:00 Poster F

Spectroscopic characterization of site-controlled quantum dots in hexagonal pillar arrays — •Priyabrata Mudi, Martin Podhorský, Maximilian Klonz, Imad Limame, Kartik Gaur, Sven Rodt, and Stephan Reitzenstein — Institute for Solid State Physics, Technical University of Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

The integration of quantum dots (QDs) into nanoscale structures holds significant promise for advancing the fields of quantum information processing and optoelectronics. This study investigates site-controlled quantum dots embedded in hexagonal pillar arrays, offering precise positioning for applications in fiber coupling. Advanced spectroscopy explores optical properties, exciton dynamics and single photon emission characteristics of these nanostructures, guiding future quantum device design. The work examines growth parameters' influence on QD uniformity, establishing guidelines for fabrication precision. Controllable QD placement via the buried stressor concept is crucial for achieving reproducible and reliable quantum systems. The gained knowledge informs design principles for quantum systems, with implications for computing, secure communication, and optoelectronic devices.

HL 14.8 Mon 15:00 Poster F

Quantum-state tomography of polarization-entangled telecom photons from semiconductor quantum dots — •Ilenia Neureuther[1], Tim Strobel[1], Stefan Kazmaier[1], Tobias Bauer[2], Marlon Schäfer[2], Ankita Choudhary[3], Nand Lal Sharma[3], Raphael Joos[1], Cornelius Nawrath[1], Weijie Nie[3], Ghata Bhayani[3], André Bisquerra[1], Caspar Hopfmann[3], Simone L. Portalupi[1], Christoph Becher[2], and Peter Michler[1] — [1]Institut für Halbleiter und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQ^{ST}) and SCoPE, University of Stuttgart, Allmandring 3, Germany — [2]Fachrichtung Physik, Universität des Saarlandes, Campus E2.6, 66123 Saarbrücken, Germany — [3]Institute for Integrative Nanosciences, Leibniz IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany

For the future development of quantum communication, triggered entangled-photon pairs are of fundamental importance. The integration of single photons into existing optical fiber networks requires the use of telecom wavelengths. Semiconductor quantum dots (QDs) are promising candidates for providing on-demand, indistinguishable polarization-entangled photon pairs. Here, we generate photons emitted via the biexciton-exciton cascade in GaAs QDs formed via Al droplet etching, emitting at 780nm. In a bi-directional polarization-conserving quantum frequency converter, we convert the biexciton emission to 1515nm. Polarization-entanglement is measured after the transmission through a 35km inner-city fiber network.

HL 14.9 Mon 15:00 Poster F

Investigation of Temperature Dependent Intensity Anomalies of Local Droplet Etched Gallium-Arsenide Quantum Dots — •Sayed Shkeebullah Sadat, Hans-Georg Babin, Andreas Wieck, and Arne Ludwig — Ruhr-Universität Bochum, Bochum, Deutschland

Liquid droplet etched (LDE) quantum dots (QD) made with molecular beam epitaxy (MBE) show an interesting behavior when photoluminescence (PL) spectroscopy is performed: during the growth process of the QDs an AlAs-wall can emerge around the nanoholes, which acts as a potential barrier between the QDs and the surrounding wetting layer (WL). By temperature- and power-dependent measurements anomalous behavior of photoluminescence intensity can be observed * in the here measured range of 83K-283K the intensity increases significantly to a certain sweetspot-temperature, before decreasing due to thermally activated non-radiative recombination. This initial behavior can be explained by an increase of available charged carriers from the WL with increasing temperature. Here not only the generation and recombination of excitons play an important role, but specifically the influence of temperature on thermally activated and assisted processes such as overcoming the barrier between WL and QDs and tunneling through the barrier. As part of this work a rate equation is developed, which considers the different thermal dependencies and thus should provide a quantitative insight into the complex anomalous behavior.

HL 14.10 Mon 15:00 Poster F

Growth Optimization and fabrication of Site-Controlled InGaAs Quantum Dots in Hexagonal Arrays — •Martin Podhorský, Imad Limame, Kartik Gaur, Maximilian Klonz, Priyabrata Mudi, Sven Rodt, and Stephan Reitzenstein — Institute of Solid State Physics, Technical University of Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

Optimized site-controlled quantum dots (SCQD) arrays have significant potential for practical applications in fields such as quantum computing and secure communication. This study focuses on the growth and optimization of InGaAs SCQDs within hexagonal arrays, aiming to enhance the precision and reliability of the quantum dot placement for advanced optoelectronic applications. We employ a systematic approach to optimize growth parameters to achieve uniform and reproducible site-controlled growth. The impact of these growth conditions on the structural and optical properties of SCQDs is thoroughly investigated via atomic force microscopy (AFM), scanning electron microscopy (SEM), confocal laser scanning microscopy (CLSM), X-Ray diffraction (XRD) and photoluminescence (PL) spectroscopy.

HL 14.11 Mon 15:00 Poster F

Hybrid combination of InGaAs-QDs and Si-based photonic integrated circuits for telecom wavelengths — •Elias Herzog[1], Ulrich Pfister[1], Daniel Wendland[2], Ponraj Vijayan[1], Lena Engel[1], Peter Gierss[1], Erik Jung[3], Michael Jetter[1], Simone L. Portalupi[1], Wolfram Pernice[2,3], 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]Physikalisches Institut AG Pernice, University of Münster, Heisenbergstraße 11, Germany — [3]Kirchhoff-Institut für Festkörperforschung, University of Heidelberg, Im Neuenheimer Feld 227, Germany

Silicon based materials are widely used for photonic integrated circuits (PICs), because of their low losses in the telecom wavelength regime and available manufacturing expertise. These properties makes them suitable for potential large scale PICs for on-chip quantum technologies. On demand single-photon sources are hard to realize in these systems, due to the indirect bandgap of silicon. On the other hand, InGaAs Quantum Dots (QDs) can emit high quality single photons at telecom wavelengths making it desirable to combine both material platforms. Here we discuss our first steps in combining the benefits of III-V QDs and SiN photonic chips.

HL 14.12 Mon 15:00 Poster F

A model study on multiple optically driven emitters coupled to a common phononic environment — •Daniel Groll[1], Daniel Wigger[2], and Tilmann Kuhn[1] — [1]Institute of Solid State Theory, University of Münster, Germany — [2]Department of Physics, University of Münster, Germany

Single photon emitters in a solid state environment are inevitably coupled to the phonon modes of the host material. While this interaction channel is often seen as a drawback, leading to decoherence, it also allows for control of emitters via phonons in the context of hybrid quantum systems. Here we investigate the optically induced dynamics of multiple emitters interacting with a common phononic environment and show that such a coupling leads to an effective interaction between the spatially separated emitters.

In the case of emitters coupling strongly to a single phonon mode, e.g., realized by multiple quantum dots embedded in a surface acoustic wave resonator, we predict distinct deviations from the Mollow triplet spectrum in resonance fluorescence under strong optical driving.

In the case of coupling to an anharmonic phonon bath, leading to pure dephasing in addition to the effective emitter-emitter–coupling, we investigate the complex dynamics of such a driven-dissipative quantum system.

HL 14.13 Mon 15:00 Poster F

Self-assembly based quasi-1D metallic nanowires — Borja Rodriguez-Barea[1], •Raghda Abdelfattah[1], Charlotte Kielar[1], Ulrich Kemper[2], Jingjing Ye[2], Foram Joshi[3], Brenda Romero-Palestino[3], Ralf Seidel[2], Stefan Diez[3], and Artur Erbe[1] — [1]Institute of Ion Beam Physics und Material Science, Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Peter Debye Institute for Soft Matter Physics, Universität Leipzig, Germany — [3]B CUBE - Center for MolecularBioengineering, TU Dresden, Germany

Self-assembly, autonomous organization of materials into hierarchical structures, offers a unique bottom-up approach for the controlled fabrication of electronic components. Potentially, self-assembled low-dimensional materials could be integrated into functional architectures without the need of expensive cleanroom tools and facilities.

Here we report a study on the electrical characterization of quasi-1D metallic nanostructures using two biotemplates. The first employs the DNA origami technique, while the second utilizes the microtubule lumen for growth. In both cases, metallic seed nanoparticles are bound to the template and reduced forming a continuous nanowire. Thus, the shape and length of the wire can be controlled. The electrical characterization data shows two kinds of transport behaviours: linear and non-linear current-versus-voltage responses, depending on the continuity of the metal nanowires. Temperature-dependent charge transport measurements reveal the dominating mechanisms along these wires, offering an insight into the reliability for this cost-effective electronic device fabrication.

HL 14.14 Mon 15:00 Poster F

Thermal scanning probe lithography (t-SPL) for quasi-1D DNA origami-based Pd nanowires — •Raghda Abdelfattah[1], Borja Rodriguez-Barea[1], Charlotte Kielar[1], Ulrich Kemper[2], Jingjing Ye[2], Ralf Seidel[2], and Artur Erbe[1] — [1]Institute of Ion Beam Physics und Material Science, Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Peter Debye Institute for Soft Matter Physics, Universität Leipzig, Germany

Theoretically, low-dimensional materials are sensitive and damaged by high energetic e-beams reducing the device conductance. Non-invasive thermal scanning probe lithography (t-SPL) has lead to clean and undamaged contact areas to atomically thin materials after pattering, reporting lower contact resistance from patterned electrodes.

In this work, we have turned our eyes to studying the recently reported DNA origami-based Pd nanowires and further performing electrical characterization to reveal the charge transport mechanism in such kind of structures. We aim to use thermal probe lithography, specifically the Nanofrazor, as a top-down fabrication tool to pattern multiple electrodes positioned on top of such nanowires. The main advantage of this technique is given by the fact that imaging of the nanostructures can be performed at the same time as structuring the electrodes. This increases the precision of contacting without the requirement of additional alignment markers. Hence, it allows us to perform electrical local characterization through various segments of the wire, providing an insight into the relationship between the nanowires' morphology and its electronic properties.

HL 14.15 Mon 15:00 Poster F

Two-color resonant excitation to study the Auger effect in a single photon emitter — •Nico Schwarz[1], F. Rimek[1], H. Mannel[1], M. Zöllner[1], B. Maib[1], A. Ludwig[2], A. D. Wieck[2], A. Lorke[1], and M. Geller[1] — [1]Faculty of Physics and CENIDE, University Duisburg-Essen, Germany — [2]Chair of Applied Solid State Physics, Ruhr-University Bochum, Germany

A quantum dot (QD) as a single photon emitter is an ideal system to study the Auger effect in a confined nanostructure. The recombination energy is transferred to a third charge carrier that leaves the dot [1], hence, the Auger effect destroys the radiative recombination of the negatively charged exciton (trion X^-) - an effect, which should be minimized in future optical applications. In order to minimise the Auger recombination, we studied the effect of an applied magnetic field on the Auger recombination [2]. However, in a magnetic field, the trion transition of the QD is no longer spin degenerate, and besides the Auger recombination, the spin-flip and spin-flip Raman transitions make it difficult to determine the Auger rate. Here, we use two-color time-resolved resonance fluorescence measurements with two-color spectral analysis of the emitted single photons from the QD to distinguish between the different state transitions. In this way, spin relaxation and spin-flip Raman scattering can be neglected. This ensures that we can directly measure all important transition and tunneling rates into the quantum dot and get a high accuracy for the influence of the magnetic field on the Auger rate. [1] P. Lochner et al., Nano Lett. **20**, 1631-1636 (2020). [2] H. Mannel et al., JAP **134**, 154304 (2023).

HL 14.16 Mon 15:00 Poster F

Towards Low Temperature Imaging of Telecom Wavelength InGaAs Quantum Dots — •Lukas Wagner, Stephanie Bauer, Ponraj Vijayan, Michael Jetter, Simone Luca Portalupi, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

Semiconductor quantum dots are a promising non-classical light source for quantum information technology. To boost the fabrication yield of bright single and entangled photon pair sources, deterministic fabrication techniques can be employed. For this purpose, three techniques have been developed: low temperature deterministic optical lithography, low temperature deterministic electron beam lithography, and low temperature imaging, with recent interesting results also at telecommunication wavelengths. Markers from electron-beam lithography are used as reference points for determining the position of viable quantum dots for deterministic fabrication of spatially and spectrally matching micro cavities. Using standard micro photoluminescence techniques at telecom wavelengths for preselection and precise position determination is effective, but there is room for improvement in the upscaling of the process. To tackle this challenge an imaging setup is employed to speed up and enhance the precision of determining the position. In this contribution, a precise comparison between low temperature lithography and low temperature imaging at telecommunication wavelength will be discussed.

HL 14.17 Mon 15:00 Poster F

Deterministically fabricated InAs/InP quantum dot-based single-photon sources at telecom wavelengths — •Monica Pengerla[1], Yury Berdnikov[2,3], Pawel Holewa[2,3], Alexander Kosarev[1], Sven Rodt[1], Elizaveta Semenova[2,3], and Stephan Reitzenstein[1] — [1]Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany — [2]DTU Electro, Technical University of Denmark, Kongens Lyngby, Denmark — [3]NanoPhoton-Center for Nanophotonics, Technical University of Denmark, Kongens Lyngby, Denmark

Quantum dot (QD) based single-photon sources are key elements of photonic quantum networks. In huge demand are sources emitting at telecom wavelengths, especially in the C-band at 1.55 μm, which enables long-distance fiber-based quantum communication. Here, we report the development of single-photon sources based on InAs/InP QDs in circular Bragg grating photonic cavities with back-side Al mirror and bonded to the Si substrate. Numerical simulations of such quantum devices reveal a noticeable rise of photon extraction efficiency beyond 80% for NA = 0.65, as well as Purcell enhancement of the QD transition rate. The devices are deterministically fabricated using a state-of-the-art electron beam lithography system with integrated cathodoluminescence (CL) at 20 K, allowing us to perform in situ electron beam lithography with a high spectral and spatial resolution. Micro-photoluminescence studies reveal cavity-enhanced emission and excellent quantum optical properties from the deterministically fabricated quantum devices.

HL 14.18 Mon 15:00 Poster F

Spin relaxation dynamics of the excited triplet state in self-assembeld quantum dots — •Carl Nelson Creutzburg[1], Jens Kerski[1], Arne Ludwig[2], Andreas D. Wieck[2], Martin Geller[1], and Axel Lorke[1] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, Germany — [2]Chair of Applied Solid State Physics, Ruhr-University Bochum, Germany

The two-electron triplet state in a self-assembled quantum dot can form a spin qubit with the singlet ground state. It is electrically adressable and therefore of interest for quantum information processing. This requires a long coherence time T_2, which is limited by the spin relaxation time T_1. While T_1 has already been investigated by optical measur-

ments, we present our all-electrical measurment approach.
We embedded a layer of InAs/GaAs QDs in an inverted high electron mobility transistor (HEMT) to selectively charge and discharge the QD states with electrons from a tunnel-coupled electron reservoir (2DEG). The 2DEG acts as a sensitive detector for the charge in the QD layer. By using time-resolved transconductance spectroscopy [1] and altering the charging times we can observe the relaxation from the triplet excited state to the singlet ground state. We extract the relaxation time T_1 by applying a rate equation model. While there are already first results for T_1 [2], ongoing questions of interest are its dependency of the strength and orientation of an external magnetic field.

[1] B. Marquardt. et al., Nature Commun. 2, 209 (2011)
[2] K. Eltrudis. et al., Appl. Phys. Lett. 111, 092103 (2017)

HL 14.19 Mon 15:00 Poster F

Investigation of the correlation of optical and electronic properties of O-band quantum dots — •Danial Kohminaei, Nikolai Spitzer, Andreas D. Wieck, and Arne Ludwig — Ruhr-Universität Bochum; Lehrstuhl für angewandte Festkörperphysik, Bochum, Deutschland

For future applications in telecommunications and information technology, quantum dots (QDs) are promising candidates as single photon sources. Optical signals are transmitted over long distances through optical fibers, within which the light is attenuated by Rayleigh scattering and by infrared absorption. However, at the so-called Telecom O-band at 1310nm there is a local minimum of absorption.

We grow self-assembled InAs QDs in InGaAs quantum wells via molecular beam epitaxy; understanding the correlation between growth parameters and the resulting structure defining the optical and electronic properties of the QDs is topic of cutting-edge research.

Therefore, the distribution and properties of QDs on a sample with a pattern defining layer (PDL) [1] underneath the QDs and a InGaAs strain reduction layer above are measured by photoluminescence (PL) and capacitance-voltage C(V) spectroscopy mapping.

[1] BART, N. et al.: Wafer-scale epitaxial modulation of quantum dot density, Nature Communications 13 (2022)

HL 14.20 Mon 15:00 Poster F

Circular gratings for efficient light extraction from InAs quantum dots — •Frederik Ernst[1], Stefan Linden[1], Paul Steinmann[1], and Beata Kardynal[2] — [1]Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn, Germany — [2]PGI-9, Forschungszentrum Jülich, Jülich, Germany

Indium arsenide quantum dots are recognized as high-quality single photon sources. Since the quantum dots are however, embedded in a high refractive index material (GaAs), efficient outcoupling of the photons is challenging. In order to increase the efficiency of light extraction from the GaAs host, we investigate circular gratings (bullseye structure) made from tantalum pentoxide that are positioned on the GaAs surface above individual quantum dots. Our approach involves optimizing the design of these bullseye structures through numerical calculations based on the Finite-Difference-Time-Domain (FDTD) method. The production of these structures, targeted at selected quantum dots, is achieved using electron beam lithography with a positive-tone resist, followed by electron beam evaporation to deposit a 70 nm thick tantalum pentoxide film. Optical experiments conducted at liquid helium temperatures (T=4 K) include exciting the quantum dots with a 785 nm wavelength laser and recording their PL emission before and after bullseye deposition. Preliminary analysis suggests an enhancement in light extraction efficiency, indicating promising applications in quantum dot technologies for improved photonics systems. Ongoing analysis aims to quantify this increase, potentially offering a significant advancement in photon manipulation at the quantum level.

HL 14.21 Mon 15:00 Poster F

Oscillator strength of quantum dots from ensemble photoluminescence — •Yannis Rüggen, Nikolai Spitzer, Arne Ludwig, and Andreas D. Wieck — Ruhr-Universität Bochum; Lehrstuhl für Angewandte Festkörperphysik, Bochum, Germany

A special type of semiconductor heterostructures are so-called quantum dots, which have a potential confinement in all spatial dimensions and therefore have discrete energy levels.

In this project, self-organized InAs quantum dots grown by molecular beam epitaxy are investigated. These quantum dots are In-flushed and gradient-grown and will be examined via power-dependent photoluminescence spectroscopy. Based on the laser power, the lifetime of the excitons will be estimated relatively. Two assumptions are made for this. Firstly, it is assumed that there is a direct correlation between the intensity and the quantum dot density. Furthermore, it is assumed that the lifetime is constant over the entire wafer. The aim of the project is to develop a simple method for estimating the lifetime of excitons. Subsequently, this will be verified by lifetime measurements.

HL 14.22 Mon 15:00 Poster F

Telecom wavelength InP based quantum dots: Growth and optical characterization — •Ranbir Kaur, Mohanad Alkaales, Johann Peter Reithmaier, and Mohamed Benyoucef — Institute of Nanostructure Technologies and Analytics (INA), CINSaT, University of Kassel, Germany

Due to their atomic-like properties such as a size-dependent bandgap and strong quantum confinement, semiconductor quantum dots (QDs) emitting at the telecom wavelengths are promising candidates for quantum communication. InP-based QD material system is one of the possible candidates to achieve this spectral region due to the low lattice mismatch (3.2%) between InP and InAs. [1, 2].

Here, we report molecular beam epitaxy growth optimization of InAs/InP QDs emitting at telecom wavelengths for quantum communication applications. Photoluminescence (PL) and Atomic force microscopy (AFM) were used to study the effects of growth parameters on optical and morphological properties. QDs were grown on high-quality distributed Bragg reflectors (DBRs) with 99% reflectivity and lattice-matched lattices to enhance extraction efficiency. Micro-PL measurements at low temperatures reveal bright single QD emission around 1.55 micrometer with narrow linewidths and small fine-structure splittings. Moreover, we report on the growth and optical analysis of C-band QD molecules.

[1] Benyoucef et al., Appl. Phys. Lett. 103 162101 (2013)
[2] Kors et al., Appl. Phys. Lett. 112, 172102 (2018)

HL 14.23 Mon 15:00 Poster F

Design of a Majorana trijunction — •Juan Torres[1], Sathish Kuppuswamy[2], and Anton Akhmerov[2] — [1]QuTech, Delft, The Netherlands — [2]Kavli Institute of Nanoscience, Delft, The Netherlands

Braiding of Majorana states demonstrates their non-Abelian exchange statistics. One implementation of braiding requires control of the pairwise couplings between all Majorana states in a trijunction device. To have adiabaticity, a trijunction device requires the desired pair coupling to be sufficiently large and the undesired couplings to vanish. In this work, we design and simulate a trijunction device in a two-dimensional electron gas with a focus on the normal region that connects three Majorana states. We use an optimisation approach to find the operational regime of the device in a multi-dimensional voltage space. Using the optimization results, we simulate a braiding experiment by adiabatically coupling different pairs of Majorana states without closing the topological gap. We then evaluate the feasibility of braiding in a trijunction device for different shapes and disorder strengths.

HL 14.24 Mon 15:00 Poster F

Current Induced Magnetization Switching in Vanadium doped $(Bi_xSb_{1-x})_2Te_3$ — •Boris Stanchev, Daniel Rosenbach, Gertjan Lippertz, Anjana Uday, Alexey Taskin, Yoichi Ando, and Erwann Bocquillon — Universität zu Köln, II. Physikalisches Institut, Zülpicher Str. 77, Cologne, Germany

Thin-film quantum anomalous Hall (QAH) insulators host chiral one dimensional edge states when magnetized at mK scale temperatures. The chirality of these edge states corresponds with the direction of the magnetization. Recent experiments have shown that the chirality of edge states and magnetization direction in QAH insulators can also be switched by applying a large current beyond the breakdown threshold at which the QAH effect degrades. However, the precise mechanisms and conditions that lead to this current switching have yet to be elucidated. Thus we present progress towards further studies where we also replicate this effect in Vanadium doped $(Bi_xSb_{1-x})_2Te_3$. Possible applications include the study of ferromagnetic domain walls in QAH insulators, and in particular the coupling of co-propagating edge channels.

HL 14.25 Mon 15:00 Poster F

Real-Space Renormalisation Group Approach to the Quantum Spin-Hall Effect — Syl Shaw and •Rudolf Roemer — University of Warwick, Coventry, United Kingdom, CV4 7AL

The Chalker-Coddington model has been utilised to great success in understanding the plateau transitions in the quantum Hall effect. Since the model's inception, it has been extended to a time-reversal invariant symmetry class to describe the quantum-spin Hall effect. In our work, we extend a previously developed real-space renormalisation group (RSRG) method to study the time-reversal invariant Chalker-Coddington model. The value of the critical exponent of the localisation length in the quantum Hall situation is at present accepted to be $\nu = 2.59 \pm 0.01$. Previous work based on the RSRG approach gives a much lower $\nu = 2.39 \pm 0.01$. We now increase statistics and the accuracy of each RG step to improve the RSRG-based estimate. We find an increased value of $\nu = 2.55 \pm 0.02$. We then generalise the RSRG method to the time-reversal case and determine ν in this symmetry class.

HL 14.26 Mon 15:00 Poster F

Investigation of quantum anomalous Hall edge states using thermal noise measurements — •Alina Rupp, Daniel Rosenbach, Boris Stanchev, Anjana Uday, Gertjan Lippertz, Alexey Taskin, Yoichi Ando, and Erwann Bocquillon — Physics Institute II, University of Cologne, Cologne, Germany

In 3D topological insulators (TIs) transport is governed by 2D topologically protected surface states. By magnetically doping the TI quantum anomalous Hall insulators can be created which exhibit a single chiral edge state and a quantized Hall conductance. Besides the electronic transport, heat transport is also quantized. We aim to observe this using thermal noise measurements.

As a basis for our experiment, we use thin films of V-doped $(Bi_xSb_{1-x})_2Te_3$ grown by molecular beam epitaxy which are etched into a bow tie shape. In the center of the bow tie, we define a metallic island that is heated via the Joule effect through one edge channel while through another edge channel the heat is evacuated. Due to the conductance quantization the Joule power heating the island is well defined, while the quantization of heat transport controls the rate at which this power is evacuated from the island. Thus, by measuring the temperature of the island using thermal noise, insights on the characteristics of the edge states can be gained. In order to detect small changes in the temperature we combine an LC resonator with low-noise amplifiers to enhance the measured signal. This setup has to be calibrated in terms of the amplification chain and the electron temperature to then be able to detect quantized heat transport.

HL 14.27 Mon 15:00 Poster F

A study of Magnetic Topological Insulator $MnSb_2Te_4$ using the *GW* method — •Mohammad Farhan Tanzim and Irene Aguilera Bonet — Science Park 904, 1098 XH Amsterdam

We present *GW* calculations of the magnetic topological insulator $MnSb_2Te_4$ within the all-electron full-potential linearized augmented-plane-wave formalism. Magnetic topological insulators are materials with a narrow band gap, which is often inaccurately predicted by standard Density Functional Theory (DFT) calculations and hence, the comparison with experimental band structures is often unsatisfactory. For this reason a perturbative correction to the Kohn-Sham eigenvalues and eigenstates is necessary. We do this via many-body perturbation theory in the *GW* approximation. Our *GW* calculations show that the band gap of these materials are comparable to the experimental data. However, we do not observe the topological surface states that are characteristic of magnetic topological insulators. For this reason, we are focusing our efforts on the accurate implementation of *GW* calculations including both spin-orbit coupling (SOC) and magnetism. Previously, the SOC was added only as an a posteriori correction. This could be one of the reasons for not obtaining the correct orbital character of the valence and the conduction bands, which might lead to the wrong topological character and thus, account for the missing surface states. We also present progress done in that front so far.

HL 14.28 Mon 15:00 Poster F

Nonlinear Spin to Charge Conversion and Thermopower in an inverted GaAs/AlGaAs 2DEG — •Benedikt Gruenewald, Dieter Schuh, Dominique Bougeard, Dieter Weiss, and Mariusz Ciorga — Universität Regensburg, Regensburg, Germany

Generating and detecting a nonzero spin accumulation in nonmagnetic materials by electrical means is at the heart of spintronics. A typical electrical detection scheme of injected spins involves Silsbee-Johnson spin-charge coupling, where spin accumulation at the ferromagnet-nonmagnet interface is converted into the electromotive-force, linear in the spin accumulation, measured across the junction. In nanoscale devices, an alternative solution was proposed. It was shown, that energy-dependent transmission in quantum point contacts (QPC), narrow constrictions in a two-dimensional electron gas (2DEG), leads to the voltage measured across QPC being quadratic in the spin accumulation. Here we present the results of our experiments on employing a QPC as a nonlinear detector of spin accumulation generated electrically in a 2DEG formed in the inverted GaAs/AlGaAs heterojunction. We employ a Spin Esaki Diode to electrically inject spins from the ferromagnetic semiconductor (Ga,Mn)As into the 2DEG. Both local and nonlocal measurement techniques were employed. However, separating the contribution between spin and thermopower remains a challenge.