HL 53: Poster II

Topics: Photovoltaics, Transport properties, Preparation and characterization (Quantum dots and wires and others), Optical properties of quantum dots and wires, Transport properties of quantum dots and wires and others, Devices and Semiconductor lasers

Time: Wednesday 9:30–13:30 Location: Poster A

HL 53.1 Wed 9:30 Poster A

Transport experiments on magneto-electric hybrid lattices — •Karoline Gawenda[1], Jakob Schluck[1], Thomas Heinzel[1], Klaus Pierz[2], Hans Werner Schumacher[2], Julien Chaste[3], and Ulf Gennser[3] — [1]Condensed Matter Physics Laboratory, Heinrich-Heine-Universität, Düsseldorf, Germany — [2]PTB, Braunschweig, Germany — [3]CNRS-LPN, Marcoussis, France

Two-dimensional electron gases in $GaAs/Al_xGa_{1-x}As$ heterostructures are exposed to combinations of periodic electric and magnetic fields. These so-called superlattices are realized with customary lithography methods and are composed of a two-dimensional antidot array and a two-dimensional magnetic lattice. The resulting nontrivial electronic trajectories are expected to manifest themselves in novel magnetoresistivity resonances at cryogenic temperatures. To interpret the experimentally obtained results numerical simulations of the electron dynamics within the semiclassical Kubo formalism are used.

HL 53.2 Wed 9:30 Poster A

Electronic transport properties of polycyclic hydrocarbon and TCNQ derivative based charge transfer dimers — •Simon Liebing, Torsten Hahn, and Jens Kortus — TU Bergakademie Freiberg, Institute for Theoretical Physics, Germany

The realization of high rectification ratios in molecular electronics has been challenge for many years, because of strong coupling of the molecules in the material. As a result even very asymmetric molecules or asymmetric coupling to electrodes showed rather symmetric current-voltage characteristic. Recently, we reported that the molecular system picene-F_4TCNQ [1] is able to act as a molecular rectifier [2]. The rectification mechanism has been explained due to charge transfer between the two molecules effectively creating a molecular pn-junction.

Here we report on our investigations on polycyclic hydrocarbons and TCNQ derivatives in order to elucidate if this rectification mechanism applies there too. The theoretical calculations to obtain electronic and transport properties were performed by means of density functional theory and NEGF transport theory [3,4].

[1] Mahns, B. et al. Crystal Growth & Design (2014). [2] Hahn T., Liebing S., and Kortus J., Nanoscale 6, 14508 (2014). [3] Pederson, M. et al., Phys. Status Solidi b 217, 197. (2000). [4] Enkovaara, J. et al., JOP: Condensed Matter 22, 253202 (2010).

HL 53.3 Wed 9:30 Poster A

Commensurability effects of magnetic barriers in 2D electron gases — •Andreas Leuschner, Mihai Cerchez, and Thomas Heinzel — Heinrich Heine University Düsseldorf, Universitätsstr. 1 D-40225 Düsseldorf

Localized magnetic fields (magnetic barriers) in 2D electron gases lead to a magnetoresistance with a number of classical and quantum implications [1,2]. The simultaneous superposition of a variable homogeneous perpendicular magnetic field gives rise in addition to commensurability effects. These are explained in terms of the interplay between transverse snake orbit electrons, with variable cyclotron radii and the finite size of the sample.

[1] S. Hugger, M. Cerchez, H. Xu, and T. Heinzel, Phys. Rev. B 76, 195308 (2007) [2] B. Schüler, M. Cerchez, Hengyi Xu,, J. Schluck, T. Heinzel, and A. D. Wieck, Phys. Rev. B 90, 201111(R) (2014)

HL 53.4 Wed 9:30 Poster A

low temperature magneto-transport behavior in the phase change compound Sn1Sb2Te4 — •Zhe Yang[1,2], Hanno Volker[1], Nicholas P. Breznay[3], and Matthias Wuttig[1] — [1]Department of Physics, RWTH Aachen University, Aachen, Germany — [2]School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, China — [3]Department of Physics, University of California, Berkeley, Berkeley, United States

Disorder is a critical parameter to tailor the transport properties of phase change materials for an improved performance in memory devices. In this work, we have investigated crystalline Sn1Sb2Te4 samples where the disorder is tuned via annealing. Both the temperature dependence of the resistivity and the magnetoresistance have been studied. Hopping transport is observed in the strongly disordered state, while Boltzmann transport is found for the weakly disordered state. Our samples show a metal-insulator transition, which coincides with the divergence of the localization length. From magnetoresistance measurements at low temperature, we calculate the dephasing length induced by electron-electron scattering dephasing processes at the metallic side and derive its evolution near the MIT.

HL 53.5 Wed 9:30 Poster A

low temperature magneto-transport behavior in the phase change compound $Sn_1Sb_2Te_4$ — •Zhe Yang[1,2], Hanno Volker[1], Nicholas P. Breznay[3], and Matthias Wuttig[1] — [1]Department of Physics, RWTH Aachen University, Aachen, Germany — [2]School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, China — [3]Department of Physics, University of California, Berkeley, Berkeley, United States

Disorder is a critical parameter to tailor the transport properties of phase change materials for an improved performance in memory devices. In this work, we have investigated crystalline $Sn_1Sb_2Te_4$ samples where the disorder is tuned via annealing. Both the temperature dependence of the resistivity and the magnetoresistance have been studied. Hopping transport is observed in the strongly disordered state, while Boltzmann transport is found for the weakly disordered state. Our samples show a metal-insulator transition, which coincides with the divergence of the localization length. From magnetoresistance measurements at low temperature, we calculate the dephasing length induced by electron-electron scattering dephasing processes at the metallic side and derive its evolution near the MIT.

HL 53.6 Wed 9:30 Poster A

Electrical transport in γ-CuI crystals and thin films and usage in bipolar γ-CuI/ZnO-heterodiodes with high rectification ratio — •Max Kneiss, Chang Yang, José Barzola-Quiquia, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Exp. Physik II, Germany

The interest in γ-CuI has increased recently, as it is an intrinsically p-conducting transparent semiconductor with a high excitonic binding energy of 62 meV and fairly high hole mobility making it a promising alternative for usage in transparent optoelectronics [1]. We investigated γ-CuI crystals and thin films grown with various techniques via temperature dependent Hall-Effect-, I-V- and magnetoresistance measurements. We modeled the temperature dependent resistance and I-V-curves and found evidence for a tunneling process dominating the transport at low temperature in both crystals and thin films. A change from semiconducting to metallic behaviour with increasing temperature is observable only for thin films, where a power law is characterizing the resistance at higher temperature, which is in agreement with the high carrier concentrations in our thin films ($\approx 10^{19}$-10^{20} cm^{-3}). Magnetoresistance furthermore suggests a weak antilocalization effect for crystals at low temperatures. Finally we were able to grow CuI thin films epitaxially on a ZnO-layer via reactive sputtering thus producing transparent γ-CuI/ZnO-heterodiodes with even higher rectification ratios (up to 9 orders of magnitude) than previously reported [2].

[1] Grundmann et al., Phys. Status Solidi A **210**, 1671 (2013)
[2] Schein et al., Appl. Phys. Lett. **102**, 092109 (2013)

HL 53.7 Wed 9:30 Poster A

The influence of nanopatterning on the electrical conductivity of boron-doped silicon nanowires — •Maximilian Kockert[1], Stefan Weidemann[1], Danny Kojda[1], Zhi Wang[2], Michael Kröner[2], Peter Woias[2], Klaus Rademann[3], Martin Albrecht[4], and Saskia F. Fischer[1] — [1]Novel Materials Group, Humboldt-Universität zu Berlin, D-12489 Berlin — [2]Laboratory for Design of Microsystems, University of Freiburg - IMTEK, D-79110 Freiburg — [3]Institut für Chemie, Humboldt-Universität zu Berlin, D-12489 Berlin — [4]Leibniz-Institut für Kristallzüchtung, D-12489 Berlin

Investigations of silicon nanowires (SiNWs) have shown, that nanopat-

terning affects the thermal conductivity of SiNWs, because of the reduced phonon contribution [1]. In this work, the resistivity ρ of bulk silicon and porous SiNWs was investigated to determine the influence of nanopatterning on the electrical properties. Van der Pauw measurements of bulk silicon show $\rho_{\mathrm{bulk}} = (1.60 \pm 0.01) \cdot 10^{-2}\,\Omega$cm. SiNWs were prepared from that highly boron-doped bulk silicon using the two-step metal-assisted chemical etching method [2]. SiNWs were contacted by means of electron beam-induced deposition. Two-terminal measurements of SiNWs show $\rho_{\mathrm{SiNWs}} = (1.1 \pm 0.2) \cdot 10^{3}\,\Omega$cm. The difference between the resistivity of bulk silicon and silicon nanowires indicates a consumption of the dopant boron during the etching process.

[1] A. I. Hochbaum *et al.*, Nature **451**, 163 (2008).

[2] S. Weidemann *et al.*, Journal of Nanomaterials **2015**, 672305 (2015).

HL 53.8 Wed 9:30 Poster A

Enhancing current-voltage characterisation utilising complementary immittance analysis — •Julian Alexander Amani, Tristan Koppe, Hans Hofsäss, and Ulrich Vetter — II. Physikalisches Institut der Georg-August-Universität Göttingen, Deutschland

Current-voltage characterisation is the standard method of determining underlying conduction mechanisms. Usually performed by measuring the stationary currents under different environmental conditions, mostly at different temperatures, it can be used to identify the conduction processes in single homogeneous pieces of material as well as in heterogeneous systems consisting of multiple materials.

It is almost inevitable that parasitic resistances, e. g. at the contacts, or alternate pathways, for example along surfaces, influence the measurement of the current-voltage characteristics. Identification or removal of the distortions caused by these parasitic contributions, solely using current-voltage measurements, can be complicated.

Complementary immittance spectroscopy can be used to identify and remove the parasitic contributions, often even without the need to understand the specific parasitic processes in detail. We will present a strategy to remove and, if desired, identify parasitic contributions with little overhead. Although not limited to specific contact arrangements, we will show certain geometries that simplify the complementary immittance measurement process. Finally, we discuss whether immittance spectroscopy can replace conventional current-voltage characterisation altogether.

HL 53.9 Wed 9:30 Poster A

Growth of Site-Controlled InAs Quantum Dots by MOVPE — •Marc Sartison, Mauro Bono, Leonard Spira, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Centers SCoPE and IQST, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

In the last decade, it has been demonstrated, that semiconductor quantum dots (QDs) have the potential to be excellent light sources for the application in single-photon devices. Stranski-Krastanov grown QDs with a high optical quality and structrual purity can be obtained self-assembled with a low spatial density. Hence, it is a challenging task to integrate QDs into optical circuits on chip, a precise control of the QD position is essential. It also has been shown, that the surface potential can be locally modified to create sites of higher nucleation probability by prepatterning the substrates. In this contribution, we present two approaches of the site-controlled growth of InAs QDs on prepatterned GaAs substrates. To create nucleation sites, the substrate is structured with a hexagonal hole pattern, which is etched by a combination of wet and dry chemical etching. Afterwards, the templates are overgrown with either GaAs buffer structures or with a burried strain iducing InGaAs layer. The nucleation behavior of the following deposited InAs QDs material is monitored by AFM and SEM measurements. To reveal the optical characteristics, the QDs were capped with a GaAs layer and micro-photoluminescence measurements were carried out.

HL 53.10 Wed 9:30 Poster A

Metamorphic buffer layers on GaAs for the deposition of InGaAs quantum dots — •Julian Kluge, Matthias Paul, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und funktionelle Grenzflächen, University Stuttgart and Research Centers Scope and IQST, Allmandring 3, Universität Stuttgart

The interest in In(Ga)As semiconductor quantum dots (QDs) as sources for entangled or indistinguishable photons has increased in the last years due to a need for non-classical light generation in quantum information or quantum cryptography. For an implementation in fiber-coupled networks, emission wavelengths in the telecommunication bands at 1.31 μm or 1.55 μm are desirable to minimize absorption losses. The high strain in InAs QDs directly deposited on GaAs leads to emission wavelengths below 1 μm. A shift to wavelengths above 1.3 μm is possible by depositing the QDs on InP substrates, thus, decreasing the lattice mismatch. InGaAs metamorphic buffer (MB) layers can substitute InP substrates. We grow MB layers on GaAs substrates for the deposition of In(Ga)As QDs with emission in the range of the telecommunication bands. The Indium content in the MB is increased gradually to adjust the lattice constant and decrease the lattice mismatch between the QDs and the growth surface. In X-ray diffraction experiments, the residual strain on the surface and the Indium content is determined with the help of reciprocal space maps of the symmetrical (004) and asymmetrical (224) reflexes. The surface roughness of the partially relaxed buffers is investigated by atomic force microscopy (AFM). A smooth surface is a prerequisite for the deposition of QDs.

HL 53.11 Wed 9:30 Poster A

Capacitance-Voltage Spectroscopy of InAs Quantum Dots Under External Applied Strain — •Sascha René Valentin[1], Arne Ludwig[1], Andreas D. Wieck[1], and Dirk Reuter[2] — [1]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum — [2]Arbeitsgruppe Optoelektronische Materialien und Bauelemente, Universität Paderborn

Self-assembled InAs quantumdots (QDs) are integrated in a variety of interesting optical and electronical devices and are also highly interesting from a fundamental point of view. Electric fields are often used to tune the optical and electronical properties of QDs. Recently it has been shown that external applied strain can reversibly shift the optical emission energy of QDs. Theoretical calculations indicate that the shift in the emission energy originates in the changed coulomb interaction between the charge carriers as well as in the shift of the energy levels themselves. In this project we want to measure the dependence of the interaction energies of the carriers on externally applied strain using capacitance voltage (CV) spectroscopy. In the device we present, a thin electrically contacted CV-membrane is bonded to a PMNPT-piezoelectric actuator. This allows to apply strain to the QDs and at the same time it enables electrical and optical measurements on a QD ensemble.

HL 53.12 Wed 9:30 Poster A

Huge thermal shift of the excitonic charging featured energy in self-assembled quantum dots — •Fabian Brinks, Patrick Labud, Andreas Wieck, and Arne Ludwig — Ruhr-Universität Bochum, Lehrstuhl für Angewandte Festkörperphysik

It has been shown that excitons of different charge can be detected in self-assembled InAs quantum dots (QD) by means of capacitance-voltage (C(V)) spectroscopy [1]. Above bandgap illumination of QDs embedded in a Schottky diode induces electron hole-pairs, while eventually the built-in electric field separates them before recombining. Electrons flow to the back-contact and holes get trapped in the quantum dots. Reducing the built-in field by applying forward bias to the diode, electrons tunnel from a highly n-doped back contact into the quantum dots and form excitonic complexes before recombining. The associated tunnel current can be measured by C(V)-spectroscopy and light induced, well resolved charging peaks appear at lower gate voltages than by tunnelling into the single electron s-states.

Rising the temperature, these light induced peaks shift to significantly lower voltages, whereas the non-light induced s-peaks charging voltage basically stays unaltered.

In our presentation we will discuss various possible origins of this effect.

[1] P. Labud et al., *Physical Review Letters* **112**, 46803 (2014).

HL 53.13 Wed 9:30 Poster A

Focused ion beam induced growth of single III/V nanowires on arbitrarily arranged sites — •Rüdiger Schott, Sven Scholz, Arne Ludwig, and Arndreas D. Wieck — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum

Semiconductor nanowires (NWs) are used as building blocks for a new generation of advanced devices intended for different applications in the field of nanoelectronics, nanophotonics and nanomechanics. NWs are near one-dimensional structures that typically have a high length-to-width ratio. This is the base of fascinating structural properties. Heterostructures of highly lattice mismatched materials can be com-

bined without dislocations and metastable phases, unattainable in bulk materials like wurtzite GaAs, are feasible. We present focused ion beam (FIB) induced molecular beam epitaxy (MBE) grown single III/V nanowires from site selectively deposited Au seeds [1]. The possibility of maskless patterning makes focused ion beam lithography a powerful tool and an alternative to conventional lithography based methods in semiconductor processing. With an FIB system, equipped with an ExB filter and a liquid metal alloy ion source (LMAIS), most of the elements of the periodic table are accessible for ion implantation and patterning. Structural and optical properties of the nanowires are investigated by secondary electron microscopy, transmission electron microscopy, cathodoluminescence and photoluminescence spectroscopy.

[1] G. Bussone et al., *J. Appl Crystallogr.* **46**, 887-892 (2013).

HL 53.14 Wed 9:30 Poster A

Silicon incorporation in III/V-Nanowires - Comparison of growth and catalyst doping — •Marcel Schmidt, Rüdiger Schott, Sven Scholz, Andreas D. Wieck, and Arne Ludwig — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum

Semiconductor Nanowires (NWs) have a big potential in the aim of further miniaturization of future nanoscale devices. A prerequisite for the fabrication of functional nanowire devices is their electrical doping. We investigate doping of nanowires due to implant doped metal seeds like gold silicon (AuSi) for catalyst assisted molecular beam epitaxy (MBE) growth of GaAs NWs. A focused ion beam system equipped with an ExB filter and a liquid metal alloy ion source (LMAIS) is used to implant the metal seeds. We will present first results, comparing Au and AuSi catalysed GaAs NWs.

HL 53.15 Wed 9:30 Poster A

Fabrication of sub-50 nm silicon nanowires using inductively coupled plasma etching — •Muhammad Bilal Khan, Dipjyoti Deb, Yordan M. Gieorgiev, and Artur Erbe — HZDR, Bautzner Landstraße 400, 01328 Dresden, Germany

Development of an etching process for fabrication of ultrathin silicon nanowires (SiNWs) with inductively coupled plasma (ICP) source and C4F8/SF6 mixed gas recipe at 18 oC is reported. Etch selectivity of silicon (SOI) to hydrogen silsesquioxane (HSQ), a negative tone electron beam resist and selectivity of silicon (SOI) to SiO2 are investigated to identify suitable process window. Effects of ICP power, RF power, chamber pressure, flow rates and ratio of C4F8/SF6 on etch rate, selectivity and surface roughness are examined. Atomic force microscopy (AFM) is used for identifying surface roughness of the plain silicon (SOI) substrates after etching. Thereafter etching of HSQ patterned substrates is performed. Scanning electron microscopy is performed to observe the etch profile. Parameters such as flow rates of C4F8/SF6 are optimized to attain sub-50 nm SiNWs with smooth and vertical sidewalls.

HL 53.16 Wed 9:30 Poster A

Impact of plasma parameters on the growth of InGaN nanowire heterostructures by plasma-assisted molecular beam epitaxy — •Pascal Hille[1], Felix Walther[1], Philip Klement[1], Jörg Schörmann[1], Vanessa Dahmen[2], Nils Rosemann[2], Sangam Chatterjee[2], Philomela Komninou[3], and Martin Eickhoff[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen, Germany — [2]Faculty of Physics and Materials Science Center, Philipps Universität Marburg, Renthof 5, 35032 Marburg, Germany — [3]Physics Department, Aristotle University of Thessaloniki, GR-54124 Thessaloniki, Greece

Its tunable direct bandgap (UV to IR) renders (In,Ga)N nanowires a promising material platform for nano-opto electronic devices. However, the large lattice mismatch between the two binaries as well as the low decomposition temperature of InN compared to GaN leads to structural degradation of the grown material with increasing In content. Preventing InN dissociation during growth by bond stabilization might increase the material quality. For metal rich growth conditions theory predicts that an increase of the nitrogen flux should achieve such a bond stabilization and also yield an increase of the incorporated In fraction [1]. Here, we varied the nitrogen flux and the applied forward plasma power for the growth of InGaN/GaN nanowire heterostructures (NWHs) and studied the influence these variations have on the morphological and optical properties of the NWHs.

[1] Turski et al., J. Cryst. Growth 367, 115–121 (2013)

HL 53.17 Wed 9:30 Poster A

Luminescence and photoconductivity properties of hybrid Carbon-nanodot/ZnO nanostructures — •Kseniia Sergeeva[1], Angelina Vogt[1], Rene Gorny[1], Frank Dissinger[2], Sebastian Resch[2], Siegfried Waldvogel[2], and Tobias Voss[1] — [1]TU Braunschweig, Institut für Halbleitertechnik, Germany — [2]Johannes Gutenberg-Universität Mainz, Institut für Organische Chemie, Germany

Carbon nanodots (C-Dots) have attracted tremendous attention due to their low-cost manufacturing processes, low toxicity, tuneable photoluminescence and absorption properties, and photochemical stability. All these properties make C-Dots well-suited candidates for LED and gas-sensing technologies. In this work, hydrothermally synthesized C-Dots (as-grown or in a reduced state) were attached electrostatically and covalently to the surface of ZnO nanowires. The C-Dots show a strong blue (reduced particles) or green (as-grown particles) luminescence under irradiation with UV-light (365nm). Models which were recently published in the literature suggest that the luminescence properties of C-Dots can be related to different species of polycyclic aromatic molecules (PAH) which form the core of the dot. Their tuneable luminescence and absorption properties may also be related to varying size-distribution of the synthesised C-dots. The structural properties of the C-Dots together with their polymeric shell were characterized with Raman spectroscopy and FTIR. Photoconductivity measurements of ZnO/C-Dot hybrid structures were carried out to study the electron transfer dynamics from the dots to the oxide material.

HL 53.18 Wed 9:30 Poster A

Intense Intrashell Luminescence of Eu-Doped ZnO Nanowires — •Torsten Lindemann[1], Sebastian Geburt[1], Michael Lorke[2], Andreia Luisa da Rosa[2], Thomas Frauenheim[2], Robert Röder[1], Tobias Voss[3], and Carsten Ronning[1] — [1]Institute of Solid State Physics, Friedrich-Schiller-University Jena, Germany — [2]Bremen Center for Computational Materials Science (BCCMS), University of Bremen, Germany — [3]Institute of Semiconductor Technology, University of Technology Braunschweig, Germany

Semiconductor nanowires (NW) have been proposed as route towards the miniaturization of light sources and solid-state lasers. Doping of materials with rare earth (RE) elements enables new optical properties. If these elements are incorporated into host matrices, optical intra-4f transitions become possible, which consequently show long lifetimes and are therefore spectrally very sharp. Successful doping and excellent optical activation of Eu^{3+} ions in single crystalline zinc oxide (ZnO) NWs is realized using the ion implantation approach subsequently to growth. The origin of the intense intra-4f luminescence of Eu^{3+} ions in ZnO is assigned by first-principles calculations to the formation of Eu-Oi complexes within the lattice. These complexes are formed during the nonequilibrium ion implantation process and subsequent annealing at 700 °C in air. Our targeted defect engineering resulted in intense intrashell luminescence of single ZnO:Eu nanowires even at room temperature. The high intensity enabled us to study the luminescence of single ZnO nanowires in detail, their behaviour as a function of excitation power and waveguiding properties.

HL 53.19 Wed 9:30 Poster A

Speeding up a single quantum dot pump-probe experiment — •Gerhard Johannes Schäfer, Christian Dicken, and Markus Lippitz — Experimental Physics III, University of Bayreuth, Germany

We recently showed [1], that it is possible to measure transient reflection on single semiconductor quantum dots in the far field.

Here we show how to improve those measurements. We decrease the integration time by using a high repetition rate laser (1 GHz instead of 76 MHz). At the same time, we also increase the spectral rate to 120 kHz.

[1] *C. Wolpert et al, Nano Lett., 2012, 12 (1), pp 453-457.*

HL 53.20 Wed 9:30 Poster A

Spatio-temporal propagation of nonclassical light in a coupled quantum dot-waveguide system — •Kilian Kuhla and Marten Richter — Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, EW 7-1, Technische Universität Berlin, Hardenbergstrasse 36, 10623 Berlin, Germany

Caused by the need for new quantum technologies, propagation of nonclassical light in an optical waveguide interacting with embedded

semiconductor quantum dots (QDs) constitutes a focus of current experimental and theoretical research.

In this contribution, we study the time- and space-resolved characteristics of the waveguide-QD-system in the few-photon-limit, e.g. for single photon and (entangled) photons pairs.

To describe an open system dynamics, we propose a density matrix formalism, based on spatial dependent photon operators, specifically suitable for the few photon limit.The approach allows to include relevant pumping and dissipation mechanisms in a phenomenological Lindblad formalism. Overall the framework provides a closed set of equation of motion for the excitons in the quantum dot as well as the photon traveling in the waveguide.

HL 53.21 Wed 9:30 Poster A

Hybrid density matrix approach as a factorization scheme for many-body systems — •Sandra Kuhn and Marten Richter — Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, EW 7-1, Germany

Semiconductor quantum dots coupled to an embedding bulk, quantum well or wetting layer carrier reservoir play a significant role in a variety of applications. These structures represent an important example of a hybrid system, which consist of a subsystem with localized, discrete states and a subsystem with quasi continuous states. However, both systems (quantum dot and carrier reservoir) constitute many-body systems with different properties, which requires a description including different approximations. We developed a theoretical factorization scheme to describe interactions between those hybrid many-body systems. The used projection operator technique combines the advantages of conventional correlation expansions and an exact diagonalization scheme. In particular, the approach allows a dynamical treatment of the continuum and is capable of including Non-Markovian effects. Thus, the presented hybrid density matrix approach goes beyond the Markovian approximation typically used in Lindblad formalism to describe scattering processes. The method is illustrated on the example of Coulomb scatterings between quantum dot and surrounding bulk material. However, the approach is also applicable to other systems and interactions mechanisms such as electron-phonon interactions [1].

[1] S.C. Kuhn and M. Richter, PRB **91**, 155309 (2015).

HL 53.22 Wed 9:30 Poster A

Semiconductor quantum dots interfaced with cesium: Mollow triplet and a Faraday filter — •Simone L. Portalupi[1], Matthias Widmann[2], Cornelius Nawrath[1], Sang-Yun Lee[2], Michael Jetter[1], Joerg Wrachtrup[2], Ilja Gerhardt[2], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, University of Stuttgart, Germany — [2]3. Institute of Physics, University of Stuttgart, Germany

Quantum dots (QDs) are nowadays the brightest source of single photons, allowing for high indistinguishability, photonic entanglement generation, and their use as "flying qubits" for quantum communication. A long lasting quantum memory could be realized using the highly coherent properties of atoms. Quantum hybrid systems, which realize spectral superposition of QDs and atoms, have been recently attracting a lot of attention. Atomic vapors have shown their potential in efficient filtering, based on the Faraday rotation. The so called "Faraday anomalous dispersion optical filter" is realized placing an atomic vapor cell in a magnetic field and between two crossed polarizers. It displays the complete rejection of the optical spectrum, except for wavelengths close and on the atomic transitions. Transmission efficiency close to unity makes them ideal filters for practical applications. Here we present the filtering of QDs emission in the vicinity of the Cs D1 line. The QD is resonantly driven in the so called dressed state regime, resulting in the Mollow triplet spectrum. The spectrum can be tuned to have both sidebands resonant with the atomic filter, and hence transmitted, while the Rayleigh peak as well as the scattered laser, is strongly suppressed.

HL 53.23 Wed 9:30 Poster A

Polarization dependent coherent photocurrent spectroscopy of single InAs quantum dots at 1500 nm — •Simon Gordon[1], Matusala Yacob[2], Yves Alexander Leier[1], Mohamed Benyoucef[2], Johann Peter Reithmaier[2], and Artur Zrenner[1] — [1]CeOPP, Universität Paderborn, Paderborn, Germany — [2]INA, Universität Kassel, Kassel, Germany

For long distance quantum communication it is essential to use flying qubits in the telecom wavelength bands. Quantum emitters or detectors in this wavelength regime can be realized with InAs quantum dots (QDs) on InP substrate. In this work, such InAs QDs are investigated by low-temperature photocurrent spectroscopy. Suitable p-i-n diode structures with self-assembled QDs have been grown by molecular beam epitaxy on InP(100) substrates. The layer sequence of the diodes consists of an n-InP back contact, an intrinsic region of lattice-matched InAlGaAs, which contains the QDs – elongated in [0-11] direction –, and a p-InP front contact. The QDs are coherently excited by an optical parametric oscillator. By changing the applied reverse voltage the resonance energy of the QD is tuned by the quantum confined Stark effect to the energy of the light pulse. By increasing the power of the excitation light pulses, we observe a clear signature of Rabi oscillations in the photocurrent. To investigate the fine structure splitting of the exciton, we also performed polarization dependent photocurrent measurements, which reveal a polarization alignment along the [0-11] and the [011] crystal axis. We are further able to estimate the Rabi frequencies of the two ground state transitions.

HL 53.24 Wed 9:30 Poster A

Hybrid approach towards fast electronic control of quantum dot — •Alex Widhalm[1], Amlan Mukherjee[1,2], Nandlal Sharma[1], Dirk Reuter[1,3], Andreas Thiede[2,3], and Artur Zrenner[1,3] — [1]Department Physik, Universität Paderborn, Warburger Str. 100, 33098 Paderborn, Germany — [2]Höchstfrequenzelektronik, Universität Paderborn, Warburger Str. 100, 33098 Paderborn, Germany — [3]Center for Optoelectronics and Photonics Paderborn (CeOPP), Universität Paderborn, Warburger Str. 100, 33098 Paderborn, Germany

A hybrid approach to coherent manipulation of transitions in a quantum dot using combinations of electric and optical pulses promises possibilities of new quantum devices. In this work, we intend to demonstrate a technique for nonlinear and coherent control of transitions within the coherence time in InGaAs quantum dot photodiodes by ultrafast electric fields. The new functional structure comprises of a SiGe hetero-bipolar electronic circuit which generates picosecond electric fields to drives a single quantum dot photodiode. While the amplitude of excited states can be coherently controlled with optical pulses, the coherent phase and resonance conditions for exciton and biexciton transitions can be manipulated by ultrafast Stark effect tuning. Here we present the room temperature characteristics of the first generation picosecond pulse circuit designed. Also, we report the progress in the system integration and design of fast quantum dot photodiode.

HL 53.25 Wed 9:30 Poster A

Improving the indistinguishability of single-photons from resonantly excited single semiconductor quantum dots — •Jonas H. Weber, Eva Schöll, Jan Kettler, Markus Müller, Simone L. Portalupi, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen, Universität Stuttgart, Germany

Single-photons from single semiconductor quantum dots are promising candidates for a number of applications within quantum information technology. As a key feature in various implementations, e.g. linear optical quantum computation, maximum photon indistinguishability is needed and therefore an important goal of on-going research. Two-photon interference in an optimised Hong-Ou-Mandel-like experiment was used to determine the degree of indistinguishability. On the way towards Fourier-limited photons, requirement for perfect indistinguishability, different excitation methods were investigated in order to minimise dephasing mechanisms in the quantum emitter. In contrast to above-band excitation, resonant pumping of the exciton state excites single electron-hole pairs, thereby reducing spectral diffusion. Another promising excitation scheme relies on the use of two-photon excitation to prepare the biexciton state. That simplifies the photon detection due to the spectral separation of pump beam and signal, improving the signal-to-noise ratio. In future experiments, we will focus on several approaches for the stabilisation of the two-level system. With an applied magnetic field, it is possible to compensate for the Overhouser field. Furthermore, an electric field can be applied to stabilise the Fermi level, also enabling slight tuning of the emission line.

HL 53.26 Wed 9:30 Poster A

Analysis of the energy transfer in Mn doped CdS/ZnS quantum dots funtionalized with organic dye molecules — •Mikko Wilhelm[1], Uwe Kaiser[1], Luise Rost[1], Carolina Carrillo-Carrion[1], Nadeem Sabir[1], Pablo Del Pino[2], Wolfgang Parak[1], and Wolfram Heimbrodt[1] — [1]Philipps-University Marburg, Germany — [2]CIC Biomagune, San Sebastian, Spain

The luminescence and energy transfer characteristics of colloidal core shell CdS/ZnS quantum dots doped with manganese in the ZnS shell are investigated. Next to a luminescence band around 430nm from the CdS core a luminescence band typical for the manganese around 580nm can be observed after successful doping. Moreover, the quantum dots are functionalized with an organic dye. Time resolved measurements are used to investigate the Förster resonance energy transfer in the system and show a dye lifetime in the millisecond range, compared to a lifetime of a few nanoseconds for the pure dye. This is due to the quantum dot and manganese states acting as donors for the dye states. These properties are furthermore studied in dependence of the temperature. The quantum dots are therefore transferred from solution via drop casting on a quartz substrate. A change in the intensity and the lifetime of the different luminescence band is observed at low temperatures. Furthermore the manganese ions provide a magnetic moment to the system and the influence of a magnetic field on the luminescence is discussed.

HL 53.27 Wed 9:30 Poster A

Coherence time analysis of long-wavelength InAs quantum dots — •Fabian Olbrich, Jan Kettler, Matthias Paul, Simone Luca Portalupi, Michael Jetter, and Peter Michler — Universität Stuttgart, Institut für Halbleiteroptik und Funktionelle Grenzflächen, Allmandring 3, 70569 Stuttgart

One promising light source for applications in quantum communication, e.g. quantum cryptography or quantum computation is given by semiconductor quantum dots. Since properties like single-photon emission ensuring secure data transfer and indistinguishability providing low error computation are essential requirements for many communication protocols, they have to be deeply investigated and improved.

Dephasing plays an important role for these characteristics and one can gather information about this effect considering linewidth and coherence time studies.

Therefore we compared the PL spectra and coherence times of our MOVPE-grown In(Ga)As/GaAs quantum dots, placed in a planar cavity structure under non-resonant excitation. Their emission wavelengths are varying from 1 micron to the telecom O-band (1.3 micron).

Furthermore, first two-photon interference measurements under non-resonant and (quasi-)resonant excitation will be discussed.

HL 53.28 Wed 9:30 Poster A

Micro-Photoluminescence Spectroscopy and CCD-Imaging of Optically Coupled Microdisk Dimer-Structures — •Simon Seyfferle[1], Fabian Hargart[1], Matthias Paul[1], Michael Jetter[1], Tsung-Li Liu[2], Evelyn Hu[2], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Universität Stuttgart, Allmandring 3, 70569 Stuttgart — [2]School of Engineering and Applied Sciences, Harvard University, 29 Oxford Street, Cambridge, MA 02138

The coupling of optical microcavities forming photonic molecules allows for interesting cQED devices, e.g. low threshold lasers and single-photon sources. Providing high Q-factors and small mode volumes microdisk structures put themselves forward for the investigation of optically coupled photonic molecules.

We investigate two adjacent GaInP-based microdisks coupled via the evanescent field of their whispering-gallery modes. Each 5 μm diameter disk houses an active layer of InP semiconductor quantum dots. Additionally to the already successfully established temperature tuning approach by local laser heating that brings uncoupled modes into resonance, we search for disk pairs displaying already coupled modes by means of μ -PL spectroscopy scans applying a $4f$-setup.

Furthermore, we undertake efforts in real space CCD-imaging of the dimer structures mode profile to obtain additional evidence of optically coupled disk pairs.

HL 53.29 Wed 9:30 Poster A

Electrical Properties of Single As-Grown Semiconductor Core-Shell Nanowires — •Danial Bahrami[1], Genziana Bussone[2], Jovana Colvin[3], Hanno Küpers[4], Ryan B Lewis[4], Rainer Timm[3], Lutz Geelhaar[4], and Ullrich Pietsch[1] — [1]University of Siegen, Solid State Physics department , Siegen, Germany — [2]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [3]Lund University, NanoLund and division of Synchrotron Radiation Research, Lund, Sweden — [4]Paul Drude Institut für Festkörperelektronik, Berlin, Germany

Core-shell nanowire (NW) heterostructures have been employed in device applications including photonics, sensors, and electronics. Understanding and control of electrical properties, e.g. resistivity and mobility, in these NWs is necessary for their integration into the respective devices. For conventional conductivity studies, the NW is removed from the substrate, deposited horizontally and contacted with electrodes in as-called field-effect transistor geometry. Here, we report on conductivity measurements at single NWs in their as-grown geometry onto the substrate by means of FIB/SEM and AFM systems. Using either a tungsten nano-manipulator probe installed inside the FIB/SEM or a sharp metallic tip of a conductive AFM, the I-V characteristics of selected GaAs/InGaAs core-shell NWs grown by MBE onto Silicon (111) have been measured. The I-V characteristic always shows a non-linear behavior with different slope comparing different NWs grown on the same substrate. The data can be analyzed in terms of thermoionic emission theory.

HL 53.30 Wed 9:30 Poster A

Ray Optics with Ballistic Electrons — •Jaan Freudenfeld[1], Sergey Platonov[1,2], Vladimir Umansky[3], and Stefan Ludwig[1,2] — [1]Center for NanoScience & Fakultät für Physik, LMU-Munich, 80539 München, Germany — [2]Paul-Drude-Institut für Festkörperphysik Hausvogteiplatz 5-7 10117 Berlin, Germany — [3]Weizmann Institute of Science, Rehovot 76100, Israel

Precise control of the motion of ballistic electrons on the nanoscale would be a major step towards the realization of integrated electronic quantum circuits. We explore the feasibility of ray optics with ballistic electrons in a high mobility two-dimensional electron system to reach this goal. Our device contains two gate defined quantum point contacts coupled either via parabolic mirrors or an electrostatic lens. A lens for electron diffraction works by modulation of the Fermi velocity just as light is diffracted if its velocity is modulated [1,2]. We present first experiments of the coupled conductance of two QPCs in series, where the QPCs are located in the focus points of a lens in between.

[1] J. Spector et al., Appl. Phys. Lett. 56, 1290 (1990)
[2] U. Sivan et al., Phys. Rev. B 41, 7937(R) (1990)

HL 53.31 Wed 9:30 Poster A

Ambipolar transport in GaAs/InSb core/shell nanowires — •Johanna Janssen[1,3], Patrick Zellekens[1,3], Franz Josef Hackemüller[1,3], Fabian Haas[1,3], Torsten Rieger[1,3], Nataliya Demarina[2,3], Mihail Lepsa[1,3], Detlev Grützmacher[1,3], Hans Lüth[1,3], and Thomas Schäpers[1,3] — [1]Peter Grünberg Institute 9 — [2]Peter Grünberg Institute 2, Forschungszentrum Jülich, 52425 Jülich, Germany — [3]JARA - Fundamentals of Future Information Technologies

Modern epitaxial growth technology of semiconductor nanowires allows the formation of complex axial and radial heterostructures and the combination of materials comprising a large lattice mismatch. In this context, nanowires constituted by a GaAs core and a surrounding InSb shell are very interesting systems. They combine the large g-factor and carrier mobility of InSb and the possibility of band engineering by changing the diameter of the GaAs core.

In this contribution, we present field-effect measurements of GaAs/InSb core/shell nanowires at room temperature. For InSb shells with a thickness smaller or equal to 10 nm, we observe a hole dominated ambipolar transport behavior. By increasing the thickness of the InSb shell, the p-type branch of the gate-dependent conductance is suppressed until the nanowires become purely n-type for shell thicknesses larger than 30 nm. This result agrees well with theoretical calculations which predict a diameter-dependent semiconductor-to-semimetal transition for GaAs/InSb core/shell nanowires due to the formation of a type-III, i.e. broken, band alignment.

HL 53.32 Wed 9:30 Poster A

Imaging of Condensed Quantum States in the Quantum Hall Effect Regime — Josef Oswald[1] and •Rudolf A. Römer[2] — [1]Leoben University, Franz Josef Str. 18, A-8700 Leoben, Austria — [2]University of Warwick, Coventry CV4 7AL, UK

It has been proposed already some time ago that Wigner crystallization in the tails of the Landau levels may play an important role in the quantum Hall regime. Here we use numerical simulations for modelling condensed quantum states and propose real space imaging of such highly correlated electron states by scanning gate microscopy (SGM). The ingredients for our modelling are a many particle model that combines a self-consistent Hartree-Fock calculation for the steady state with a non-equilibrium network model for the electron transport. If there exist condensed many particle quantum states in our electronic model system, our simulations demonstrate that the response pattern of the

total sample current as a function of the SGM tip position delivers detailed information about the geometry of the underlying quantum state. For the case of a ring shaped dot potential in the few electron limit it is possible to find regimes with a rigid (condensed) charge distribution in the ring, where the SGM pattern corresponds to the probability density of the quantum states. The existence of the SGM image can be interpreted as the manifestation of an electron solid, since the pattern generation of the charge distribution requires certain stability against the moving tip potential.

HL 53.33 Wed 9:30 Poster A

Optical and magnetic studies of MBE-grown ferromagnetic CrSe and CrS layers in zincblende structure — •Johannes Röder[1], Nico Hofeditz[1], Richard T Moug[2], Kevin A Prior[2], Dana Vieweg[3], Hans-Albrecht Krug von Nidda[3], Alois Loidl[3], and Wolfram Heimbrodt[1] — [1]Department of Physics and Material Science Center, Philipps University, Marburg, Germany — [2]Institute of Photonics and Quantum Sciences, SUPA, School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, UK — [3]Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, Germany

Theoretical calculations predicted Chromium chalcogenides in the zinc blende (ZB) structure to be promising candidates for half-metallic spin-aligner at room temperature. Unfortunately, the thermodynamically stable phase of CrSe and CrS is the hexagonal NiAs-structure. Different approaches have been tested to stabilize the ZB state. Most promising were CrSe layers grown on GaAs substrates with either ZnSe or ZnSe/MgS as buffer layers and CrS-layers embedded between ZnMgS layers. All samples have been grown by MBE. We investigated the ferromagnetic properties and magnetic phase transitions and the respective optical properties of these films by temperature dependent SQUID and photoluminescence measurements. Ferromagnetic phase transitions have been found. The highest yet observed Curie temperature was at 255 K. Optical measurements revealed excitonic transitions, which will be discussed in detail.

HL 53.34 Wed 9:30 Poster A

Towards bright electrically driven single-photon sources in the red spectral range using In-Situ Lithography — •Marc Sartison, Simone Luca Portalupi, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Centers SCoPE and IQST, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

Semiconductor quantum dots (QDs) have high potential as single-photon light sources in quantum information technologies. Usually, high quality QDs are deposited in Stranski-Krastanov growth mode resulting in a random distribution in position on the sample and in size. Moreover, also the emission energies and the linewidth of single QDs vary due to this deposition scheme. For the fabrication of an efficient bright single-photon source, it is necessary to place the QD at the proper position inside a micro-cavity device. We present a method to find a suitable QD and process the fitted device around the selected QD with an optical lithography method. For this, a sample with resist is placed into the cryostat for optical inspection at 4K. After optical identification of the right QD, the resist is exposed by a green laser to form the mask for the device. Then, the usual semiconductor processing steps including further in-situ lithography form the target electrical resonant cavity LED.

HL 53.35 Wed 9:30 Poster A

Hydrogen sensing with sub-micrometer Pt/TiO2 sensors — Svenja Herbertz, •Mihai Cerchez, and Thomas Heinzel — Heinrich Heine University Düsseldorf, Universitätsstr. 1, D-40225 Düsseldorf

Pt/TiO2 hydrogen sensors are technically well established although the underlying physics is still at debate due to incomplete understanding of the interplay between oxygen vacancies, titanium interstitials, and hydrogen incorporation in disordered systems. In addition, operational voltages required may lead to electroforming effects [1]. Here we present a submicrometer lateral sensor produced by local anodic oxidation of a Ti thin layer evaporated on an insulating layer. A brief Pt evaporation produces clusters of Pt at the TiO2 without shortcutting the lateral contacts [2]. We discuss the sensing and the influence of oxygen and humidity as well as electroforming effects.

[1] M. Strungaru, M. Cerchez, S. Herbertz, T. Heinzel, M. El Achhab, and K. Schierbaum, Appl. Phys. Lett. 106, 143109 (2015) [2] S. Herbertz, M. Cerchez and T. Heinzel, Sensors and Actuators B 221, 401 (2015)

HL 53.36 Wed 9:30 Poster A

GaAs nanowire photodetectors with avalanche multiplication — •Stepan Shvarkov[1], Wadim Quiring[2], Artur Zrenner[2], and Dirk Reuter[1] — [1]Optoelektronische Materialien und Bauelemente, Universität Paderborn, Warburgerstr.100, 33098, Paderborn, Germany — [2]Optoelektronik und Spektroskopie an Nanostrukturen, Universität Paderborn, Warburgerstr.100, 33098, Paderborn, Germany

Efficient single photon detectors (SPD) working at the telecom wavelength (1.5 um) are essential for the establishment of fiber-based quantum communication networks. GaAs-based heterostructures are in principle suited for this task. In this contribution, we present a SPD design based on a lateral p-i-n-junction within a nanowire. This should allow for efficient absorption of the photons and avalanche multiplication of the photo-generated carriers. The GaAs nanowires based detectors are fabricated using combination of optical and electron beam lithography. The formation of n- and p-type regions is realized by ion beam implantation through a hard mask. The non-implanted region of about 10 um separates n- and p-type areas. After post-implantation rapid thermal annealing and contacts fabrication the wires of a different thickness are fabricated using electron beam lithography and reactive ion etching. The devices show rectifying current-voltage characteristics typical for p-i-n junctions. The reverse biased nanowires show very low dark currents and are very sensitive to illumination which is attributed to the avalanche multiplication of the photo-generated electron-hole pairs.

HL 53.37 Wed 9:30 Poster A

Design of single-mode waveguides with integrated quantum dots for on-chip single-photon operations — •Ulrich Rengstl, Mario Schwartz, Thomas Herzog, Matthias Paul, Simone Luca Portalupi, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Research Center SCoPE and IQST, Universität Stuttgart, Allmandring 3, D-70569 Stuttgart

The future use of linear optics quantum computation depends on a miniaturization and therefore a full integration of single-photon sources, beamsplitters and detectors on single chips. III-V semiconductors are promising candidates for the realization of such devices due to the simple implementation of quantum dots (QDs) as single-photon sources.

We present the integration of QDs in rib-type GaAs/AlGaAs waveguides. The design of the waveguides was optimized for the exclusive propagation of the fundamental TE- and TM-mode using frequency-domain simulations to obtain the mode profiles and dispersion diagrams. Time-domain simulations and measurements of propagation losses around 2.6 dB/mm depict the coupling of the QDs to low-loss propagation modes. The single-mode TE operation of our device is shown by the high degree of polarization of the propagating light.

An additional on-chip evanescent field coupler forms a 50:50 beamsplitter as fundamental operation on single photons. The purity of our integrated single-photon source is verified by cross-correlation measurements on the output arms of the beamsplitter.

HL 53.38 Wed 9:30 Poster A

Tunable lasing from hexagonal ZnO micro wires at room temperature — Tom Michalsky, •Marcel Wille, Evgeny Krüger, Helena Franke, Marius Grundmann, and Rüdiger Schmidt-Grund — Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, D-04103 Leipzig, Germany

We demonstrate a hexagonal ZnO micro wire resonator (MW) whose emission wavelength can be finely tuned. Furthermore one can switch between single- or dual mode operation. For that we use a slightly tapered MW with a diameter range (∼resonator length) that allows only one or two whispering gallery modes (WGMs) to be amplified by gain from an electron-hole plasma. The emission wavelength as well as single- or dual mode operation can be set by choosing the matching wire diameter and thus resonator length by slightly changing the position of the excitation spot on the wire in micro photoluminescence experiments. It turnes out that the modes in lasing operation are purely TE polarized. We also present an approach to increase the WGMs' quality factor (∼lifetime) by a factor of five by sandwiching the hexagonal wire resonator between two planar distributed Bragg reflectors.

HL 53.39 Wed 9:30 Poster A

Coexistence of strong and weak coupling in ZnO nanowire cavities — Tom Michalsky[1], Helena Franke[1], •Oliver Herrfurth[1], Robert Buschlinger[2], Ulf Peschel[2], Marius Grundmann[1], and Rüdiger Schmidt-Grund[1] — [1]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, D-04103 Leipzig, Germany — [2]Institut für Festkörpertheorie und -optik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

We present a high quality two dimensional cavity structure based on concentrically Bragg reflector coated ZnO nanowires acting as active material. The spatial mode distribution allows for the simultaneous appearance of the weak and strong exciton-photon coupling regime even at room temperature which is shown experimentally by photoluminescence measurements as well as reproduced by FDTD simulations. The high quality ZnO core nanowires uniquely allow for the observation of middle polariton branches between the A- and B-exciton ground state resonances in ZnO. Further, lasing emission is observed by excitation dependent PL measurements up to room temperature.

HL 53.40 Wed 9:30 Poster A

Sub-Monolayer-Control in Epitactic Growth of Quantum Cascade Lasers — •Michael Kwiatek[1], Negar Hekmat[2], Arne Ludwig[1], Nathan Jukam[2], and Andreas D. Wieck[1] — [1]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum — [2]AG Terahertz-Spektroskopie und Technologie, Ruhr-Universität Bochum

A quantum cascade laser (QCL) consists of multiple vertically stacked semiconductor modules including several well-dimensioned quantum wells. In QCLs intersubband transitions in the conduction band generate the laser light. Due to QCL's cascading structure, one electron generates multiple photons. The production of good QCLs sets high demands on the fabricating process, especially on the layer quality of the quantum wells and barriers, why QCL fabrication is often performed with Molecular Beam Epitaxy (MBE). A known problem in MBE is the shutter transient of the effusion cells (EC). When the EC-shutter is closed, the heat of the EC is reflected back in itself. If the shutter is opened, more power is needed to stabilize the temperature and hence the material flux of the EC. For QCLs very thin material layers of only a few monolayers with high precision are crucial. The time the EC needs to stabilize leads to a change in the growth rate for those thin layers. Our goal is the reduction of the shutter transient effect and other growth related errors on the QCL's layer structure.

HL 53.41 Wed 9:30 Poster A

Towards Nanowire Lasers Integrated onto Silicon Waveguides — •Daniel Ruhstorfer, Thomas Stettner, Bernhard Loitsch, Julian Treu, Benedikt Mayer, Gerhard Abstreiter, Gregor Koblmüller, and Jonathan Finley — Walter Schottky Institut and Physik Department, TU München, Garching, Germany

III-V semiconductor nanowires (NW) have been shown to be a highly promising candidate for the monolithic integration of nanoscale lasers on silicon [1,2]. In this work we present our progress towards the growth and demonstration of III-V NW lasers on low-order mode waveguides.

We investigate the coupling of GaAs/AlGaAs core shell NW lasers with shallow silicon ridge waveguides. Our FDTD simulations show a tunable optical coupling efficiency of up to 20% while at the same time preserving high modal reflectivities required for NW lasing.

In our design we use <111> silicon on insulator (SOI) substrates in which the waveguides are patterned using electron beam lithography and reactive ion etching. The SOI substrates provide the advantage of strong modal confinement by high refractive index contrast while its thick buried oxide also provides a high reflectivity at the substrate interface. By thermal oxidation of the silicon surface, the waveguides are covered with a thin protective layer of silicon oxide. We further delineate the entire fabrication scheme of GaAs/AlGaAs core-shell NW lasers on SOI by employing molecular beam epitaxial growth on predefined nucleation sites directly on the silicon ridge waveguides.

[1] B. Mayer, et al. Nature Comm. 4, 2961 (2013).
[2] B. Mayer, et al. Nano Lett. 15, just accepted (2015).

HL 53.42 Wed 9:30 Poster A

THE INVESTIGATION OF PRESSURE EFFECT ON THE OPTICAL PROPERTIES, SPONTANEOUS POLARIZATION AND EFFECTIVE MASS OF BaHfO3: AB INITIO STUDY — •azahaf chaimae — aculté des Sciences, 4 Avenue Ibn Battouta B.P. 1014 RP, Rabat

Through first principles calculations, the optical properties, spontaneous polarization and the effective mass of the cubic perovskite BaHfO3 under pressure effect have been investigated, using the Full Potential Linearized Augmented Plane Wave (FP-LAPW) method implemented in the WIEN2K code, in connection with the Generalized Gradient Approximation (GGA). During this study, the effect of pressure is seen on the electronic and optical properties such as: The band gap value (Eg) of the perovskite BaHfO3 is reduced and it becomes indirect instead of direct band gap as pressure increased. From the band structure we have also computed the variation of effective masse (m*) which increases to the same effect as the pressure. The results of the optical study, shows that the absorption coefficient increases and the spontaneous polarization (Ps) increases in a quasi-linear behavior as pressure increases. Our conclusion is that BaHfO3 is a piezoelectric material; also this material could be applicable in optoelectronic applications.