HL 28: Optical properties

Time: Wednesday 14:15–16:30 Location: H14

HL 28.1 Wed 14:15 H14

Localized Optical Modes in Microtube Resonators containing InGaAs Quantum Wells — •Christian Strelow, Hagen Rehberg, Christoph Matthias Schultz, Holger Welsch, Christian Heyn, Detlef Heitmann, and Tobias Kipp — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg

We report on optical modes in semiconductor microtube resonators containing InGaAs quantum wells. Self-supporting microtubes were fabricated by optical lithography and wet etching processes utilizing the self-rolling mechanism of a strained InAlGaAs/AlGaAs bilayer. On the low energy side of the quantum well emission we observe a signal of sharp modes ($Q \sim 2000$) which is about 10 times stronger than the background. Modes on the high energy side show much smaller Q-factors ($Q \sim 280$) caused by reabsorption of light. The modes are localized due to a confinement along the axis of the tube. We study the spatial intensity distributions. A theoretical model considering the tube as a rolled-up waveguide yields mode energies, which agree very well to the experimental results.

We acknowledge financial support from the Deutsche Forschungsgesellschaft via SFB 508 and the Graduiertenkolleg 1286.

HL 28.2 Wed 14:30 H14

Quantum kinetic theory of the electron-phonon-interaction in semiconductor intersubband systems — •Stefan Declair, Stefan Butscher, and Anreas Knorr — Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

The effect of quantum kinetic (non-Markovian) electron-phonon interaction for semiconductor intersubband transitions is investigated for acoustical and optical phonons. We discuss their influence to line width at low temperature. In this regime, even in weakly coupled systems, we find that electron-phonon interaction can lead to suppression of Coulomb binding effects (1).

(1) S.Butscher and A. Knorr, Phys. Rev. Lett. 97, 197401 (2006).

HL 28.3 Wed 14:45 H14

Microscopic investigations of luminescence from multiple quantum-well structures — •Marco Werchner, Martin Schafer, Walter Hoyer, Mackillo Kira, and Stephan W. Koch — Department of Physics and Material Sciences Center, Philipps-University, Renthof 5, D-35032 Marburg, Germany

Multiple quantum-well (QW) structures provide one-dimensional realizations of resonant photonic crystals where the periodic arrangement of emitters can drastically influence the photonic modes. As a consequence, luminescence from multiple QWs can be considerably different from the single QW case. The theoretical modeling of such non-classical light emission of multiple QWs requires a consistent treatment by a microscopic theory for the quantum-well electrons and the quantized light field.

It is shown that the radiative coupling between the periodically spaced QWs yields a strong reduction of the normalized light emission. This incoherent subradiant effect is shown to increase with increasing QW number. It is present for all QW spacings but strongest for Bragg structures. Clearly, the suppression of the radiative decay results in an enhancement of the exciton lifetime. Moreover, the direct creation of ground-state excitons is shown to be possible via the radiative coupling between the QWs.

HL 28.4 Wed 15:00 H14

Optical Deep Level Transient Spectroscopy on ZnO — •R. Weirauch, R. Pickenhain, H. v. Wenckstern, M. Lorenz, G. Biehne, and M. Grundmann — Institut für Experimentelle Physik II,Universität Leipzig, Linnéstraße 5, 04103 Leipzig, Germany

We investigate the optical activity of deep defects in ZnO thin films grown by pulsed laser deposition on sapphire substrates using Optical Deep Level Transient Spectroscopy (ODLTS). The high quality Schottky diodes [1] are investigated by CV, IV, photocurrent spectroscopy and DLTS [2] prior to the ODLTS measurements. Measurements at the low temperature side of the thermal DLTS peak and utilizing a lock-in correlation function are necessary conditions to assure that thermal emission rates from the traps can be neglected [3]. We observe optical induced carrier emission and absorption processes and determine the optical cross sections of deep levels within the space charge region of a Schottky barrier.

[1] H. v. Wenckstern, G. Biehne, R. A. Rahman, H. Hochmuth, M. Lorenz, M. Grundmann, Appl. Phys. Lett. **88**, 092102 (2006).
[2] H. v. Wenckstern, S. Weinhold, G. Biehne, R. Pickenhain, H. Schmidt, H. Hochmuth, and M. Grundmann Adv. in Sol. Stat. Phys., Vol. **45**, 263, (2005).
[3] R. Pickenhain, H. Schmidt, V. Gottschalch, J. Appl. Phys. **88** 2, 948, (2000).

HL 28.5 Wed 15:15 H14

Carrier Capture by Ionized Impurities in ZnO Epilayers — •Frank Bertram, Juergen Christen, Armin Dadgar, and Alois Krost — Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Universitaetsplatz 2, 39106 Magdeburg

The kinetics of relaxation and recombination processes of excitons in an epitaxial-grown thick ZnO layer has been examined using time-resolved cathodoluminescence. The unique feature of this technique allows the full analysis of excitation from thermal equilibrium into true steady state condition and the subsequent relaxation back into thermal equilibrium. The high quality 8 μm thick ZnO epi-layer under study was grown by MOVPE on an optimized ZnO/GaN/sapphire template. At T = 4 K the luminescence is dominated by the impurity bound exciton (BE) I_8. The free exciton X_A, the BEs I_1, I_2, and I_6, as well as I_9 are clearly visible. No spectral shift with time is observed for all excitons - neither during onset nor during decay. However, a distinct change in intensity ratio of I_8 and I_9 as compared to I_1 and I_2 is found in time delayed spectra. The excitons bound to a neutral impurity I_8 and I_9 exhibit a delayed, strictly mono-exponential decay over three orders of magnitude which is initially fed by the capture of the free exciton X_A ($\tau_{loc} \geq 95ps$). In complete contrast, the ionized impurity bound excitons I_1 and I_2 show a non-exponential decay starting with a very fast initial decay followed by a slower component exhibiting strong persistence. The fast initial drop results from the carrier capture by the ionized donors ($\tau_{capture}(I_{1,2}) \geq 300ps$) resulting in their neutralization - thus feeding the neutral bound excitons.

HL 28.6 Wed 15:30 H14

Cathodoluminescence spectroscopy of point defects in AlN — •Barbara Bastek[1], Frank Bertram[1], Thomas Hempel[1], Juergen Christen[1], Armin Dadgar[1,2], and Alois Krost[1,2] — [1]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Germany — [2]AZZURRO Semiconductors AG, Magdeburg, Germany

A set of AlN layers MOVPE grown on (111) Si-substrate is characterized by spectrally resolved cathodoluminescence (CL) microscopy at temperatures from 5K to 300K. The growth conditions were systematically changed: III-V-ratio, growth temperature (T_G) and pressure. A clear correlation between the growth conditions and the luminescence intensity of four different defects in the samples is found and their thermalization is analyzed. In all samples a broad band occurs at 3.28eV which is assigned to the oxygen-DX-center. We observe a strong thermal activation of this defect, perfectly described by an Arrhenius-function yielding an activation energy of 9meV and a quenching energy of 85meV, respectively. For growth under extensive N-supply, this band competes with (D^0, X) and a second defect band shows up at 4.6eV which we assign to the Al-vacancy. The intensity of V_{AL} decreases monotonously with rising temperature and the Arrhenius-fit yields two quenching energies of 9meV and 55meV. In contrast, for moderate N-supply during growth V_{AL} is completely gone and (D^0, X) dominates the spectrum. At high T_G a weak CL band appears at 3.91eV, which we tentatively assign to a Si-related DX-center accounting for the Si substrate. This defect shows a slight activation with rising temperature, however, the quenching dominates its temperature dependence.

HL 28.7 Wed 15:45 H14

Micro-Photoluminescence studies of individual InP-nanowires grown by low pressure MOVPE — •Steffen Münch[1], Stephan Reitzenstein[1], Carolin Hofmann[1], Alfred

Forchel[1], Shanna Crankshaw[2,3], Linus Chuang[2,3], Michael Moewe[2,3], and Connie Chang-Hasnain[2,3] — [1]Technische Physik, Physikalisches Institut, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Applied Science and Technology group, University of California at Berkeley, Berkeley, California, 94720 — [3]Department of Electrical and Computer Engineering, University of California at Berkeley, Berkeley, California, 94720

Optical studies have been performed on individual InP nanowires grown by low pressure MOCVD on B-doped (100) Si substrates using Gold catalysts. By means of micro photoluminescence experiments at low temperature we determined the radial confinement potential of individual nanowires. Confinement energies between 25 and 56 meV were derived which are related to the radial confinement of the electron and hole wave function in nanowires with diameters between 14 and 21 nm. The high quality of the nanowires is reflected in narrow emission peaks with full width at half maximum of only 2 meV. Temperature dependent investigations reveal that thermally activated nonradiative recombination processes lead to a decrease of photoluminescence intensity above approx. 25 K which is associated with a decrease of the photoluminescence decay time from about 2.5 ns at 4 K down to about 1.4 ns at 27 K.

HL 28.8 Wed 16:00 H14

Fringe field induced modification of the coherent spin dynamics in GaAs — Patric E. Hohage[1], •Jörg Nannen[1], Tilmar Kümmell[1], Gerd Bacher[1], Dirk Reuter[2], and Andreas D. Wieck[2] — [1]Werkstoffe der Elektrotechnik, University Duisburg-Essen, Bismarckstr. 81, 47057 Duisburg, Germany — [2]Angewandte Festkörperphysik, Ruhr-University Bochum, Universitätsstr. 150, 44780 Bochum, Germany

Ferromagnet-semiconductor hybrids are promising candidates for spin manipulation in potential spintronic devices. Using time-resolved Kerr rotation, we studied the coherent evolution of electron spin states in both ferromagnet-GaAs hybrids and pure n-GaAs bulk crystals. The experiments on n-GaAs allow us to extract the oscillation frequency of the electron spin beats up to room temperature, which is controlled by the electron g factor and the external magnetic field. By defining lithographically microscale ferromagnets on top of the semiconductor, we are able to locally manipulate the oscillation frequency of the electron spins due to the influence of the additional ferromagnetic fringe field. Compared to reference measurements in bulk GaAs, we find an enhancement of the electron spin precession frequency e.g. of 1.1 GHz at an external magnetic field of 1 T by using Co wires with a width of 6 μm and an interwire distance of 1 μm. Thus, even tiny fringe fields in the order of several mT result in a measurable change of the precession frequency.

HL 28.9 Wed 16:15 H14

Hochauflösende Spektroskopie an 1S-Paraexzitonen in Cu_2O — •Jan Brandt[1], Dietmar Fröhlich[1], Christian Sandfort[1], Manfred Bayer[1], Heinrich Stolz[2] und Nobuko Naka[3] — [1]Institut für Physik, Universität Dortmund, D-44221 Dortmund, Deutschland — [2]Fachbereich Physik, Universität Rostock, D-18051, Deutschland — [3]Department of Applied Physics, University of Tokyo, Tokyo 113-8656, Japan

Wir präsentieren Ergebnisse zur optischen Resonanz des 1S-Paraexzitons der gelben Serie in Cu_2O. Mittels hochauflösender Laserspektroskopie ($\Delta E <$ 10neV) wurden in Magnetfeldern bis 10T die Temperatur- und Dichteabhängigkeit der Transmission untersucht. Das 1S-Paraexziton ist ein reiner Spin-Triplet-Zustand und hat Γ_2^+-Symmetrie. Daher ist die optischen Anregung in allen Ordnungen verboten. Durch Anlegen eines Magnetfeldes mischt es mit den 1S-Orthoexzitonen und wird quadrupolerlaubt. In spannungsfrei montierten Proben wurden bei 1.2K Linienbreiten bis 80neV gemessen. Aus den Transmissionsexperimenten werden die Kopplung der Paraexzitonen an LA-Phononen abgeleitet und Rückschlüsse zur Exziton-Exziton-Wechselwirkung gezogen und ein entsprechendes Modell präsentiert.