HL 56: Heterostructures, Interfaces and Surfaces II

Time: Friday 9:30–11:00 Location: EW 561

HL 56.1 Fri 9:30 EW 561

Magneto-optical studies of charge transfer excitons in type-II semiconductor quantum wells — •Johannes Röder[1], Marina Gerhard[1], Cong Ngo[2], Johannes T. Steiner[2], Mikko Wilhelm[1], Christian Fuchs[1], Wolfgang Stolz[1], Stefan W. Koch[1], Torsten Meier[2], Wolfram Heimbrodt[1], and Martin Koch[1] — [1]Department of Physics and Material Sciences Center, Philipps-Universität Marburg, Germany — [2]Department of Physics, Paderborn University, Germany

While charge transfer excitons (CTX) are a well-known phenomenon in so called type-II semiconductors, their study with absorption measurements is very challenging, due to the small overlap between the electron and hole wave functions.

This situation was changed by growing 50 asymmetric double quantum wells (ADQWs) via MOVPE, for which earlier studies have already shown a strong CTX absorption. One ADQW consisted of a layer of Ga(As,Sb) and one layer of (Ga,In)As. Among the different samples the Sb-content was varied and a reference sample without the Ga(As,Sb)-layer was grown as well.

The main focus of this presentation is the CTX absorption behavior in a magnetic field. Here we observed the 1s CTXs shift and the formation of higher order excitons in magnetic fields up to 7 T at 1.8 K.

Theoretical calculations via the semiconductor-Bloch equations with a k.p model agree very well with or experimental results, thus confirming our observation of spatially indirect magneto-excitons.

HL 56.2 Fri 9:45 EW 561

Carbon Nanotubes meet MOF synthesis — •Marvin J. Dzinnik[1], Necmettin E. Akmaz[1], Adrian Hannebauer[2], Andreas Schaate[2], Peter Behrens[2,3], and Rolf J. Haug[1,3] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Institut für Anorganische Chemie, Leibniz Universität Hannover, 30167 Hannover, Germany — [3]Laboratorium für Nano- und Quantenengineering, Leibniz Universität Hannover, 30167 Hannover, Germany

Metal-organic frameworks (MOFs) are highly porous materials made from metallic ion clusters connected by organic linker molecules. The choice of these building blocks strongly affects the physical and chemical properties like pore size and adsorption behaviour. It has been shown that bringing networks of functionalized carbon nanotubes (CNTs) into a MOF synthesis can lead to a conducting, intergrown hybrid material with chemiresistive sensing properties.[1] We found a method to control UiO-66 MOF growth on individual CNTs. By local pretreatment with an electron beam we can define lines on which MOF growth is inhibited, leaving MOF-free spaces on a particular CNT giving a possible way to fabricate miniaturized MOF/CNT devices and exploring the interaction between these materials.

[1] Schulze, H. A., et al. Electrically Conducting Nanocomposites of Carbon Nanotubes and Metal-Organic Frameworks with Strong Interactions between the two Components. ChemNanoMat, 5(9), (2019), 1159-1169.

HL 56.3 Fri 10:00 EW 561

Time-resolved unidirectional propagation of exciton-polariton condensates in a Kagome edge mode — •Christian G. Mayer[1], Tristan H. Harder[1], Philipp Gagel[1], Simon Betzold[1], Monika Emmerling[1], Adriana Wolf[1], Michael D. Fraser[2,3], Sebastian Klembt[1], and Sven Höfling[1] — [1]Julius-Maximilians-Universität Würzburg, Physikalisches Institut and Würzburg-Dresden Cluster of Excellence ct.qmat, Lehrstuhl für Technische Physik, Am Hubland, 97074 Würzburg, Germany — [2]RIKEN Center for Emergent Matter Science Wako-shi, Saitama 351-0198, Japan — [3]Physics & Informatics Laboratories (PHI Lab) NTT Research, Inc. Sunnyvale, CA 94085, USA

Strongly coupled Fabry-Pérot microcavity photons with excitons form hybrid light-matter particles called exciton-polaritons. Surpassing a critical density and inherited by their bosonic statistics, they undergo a phase transition towards a dynamic condensate by stimulated scattering into ground state. Confining the photonic mode in micropillars, an artificial photonic lattice can be created. By implementing this technique, the photonic potential landscape can be shaped to emulate the band structure of a two-dimensional lattice by coupling many pillars.

Here, we utilize a Kagome lattice, in which we observe a site-dependent unidirectional propagation of the polariton condensate along the dense edge due to its intrinsic asymmetric potential. We use a streak camera to time-resolve and visualize the propagation along the edge for multiple lattice sites.

HL 56.4 Fri 10:15 EW 561

Energy states of excitons in finite-size crystals — •Pavel Belov[1], Florian Morawetz[1], Sjard Ole Krüger[1], Stefan Scheel[1], Niklas Scheuler[2], Patric Rommel[2], Jörg Main[2], and Harald Giessen[3] — [1]Institut für Physik, Universität Rostock, 18059 Rostock — [2]Institut für Theoretische Physik II, Universität Stuttgart, 70569 Stuttgart — [3]4th Physics Institute and Research Center SCoPE, Universität Stuttgart, 70569 Stuttgart

Due to quantum confinement, electron-hole pairs in finite-size crystals behave rather differently than in bulk materials: in addition to features of the band structure, in the energy spectrum each quantum-confinement subband produces a proper series of Rydberg levels. The lowest series is attributed to bound electron-hole states, i.e. the exciton states. Moreover, due to the Coulomb coupling of upper subbands to the continuum of lower subbands, electron-hole resonant states appear above the electron-hole scattering threshold. We investigate the dependence of exciton energies on the strength of the quantum confinement. In our study, the energy spectrum of hydrogen-like excitons in Cu_2O-based rectangular quantum wells (QWs) is numerically obtained from the solution of the three-dimensional Schrödinger equation. Various crossings and avoided crossings of energy levels as functions of the QW width are observed and categorized based on the symmetry properties of the exciton wave functions. Particular attention is paid to the limiting cases of narrow and wide QWs. Moreover, energies and linewidths of the electron-hole resonant states are obtained by both the stabilization method and the complex scaling technique.

HL 56.5 Fri 10:30 EW 561

InGaN/GaN nanowires as optical biosensors with dual readout — •Genrietta Steingelb, Hannah Nell, Rudolfo Hötzel, Stephan Figge und Martin Eickhoff — Universität, Bremen, Deutschland

Due to their specific electrochemical properties, group III-nitrides (III-N) and their nanostructures have been shown to provide an excellent material platform for the application in electrochemical and biochemical sensors [1-4]. Here, we demonstrate that simultaneous dual readout of InGaN/GaN NW arrays by photoluminescence and photocurrent at different bias voltages provides optical biosensors with enhanced selectivity. As examples we demonstrate the detection of pH changes and of the presence of ascorbic acid and discuss the main detection mechanisms of InGaN NWs on GaN NW templates as well as of axial InGaN/GaN NW heterostructures.

[1] G. Steinhoff, M. Hermann, W. J. Schaff, L. F. Eastman, M. Stutzmann and M. Eickhoff, Appl. Phys. Lett. 83, 177 (2003).

[2] F. Ren, S. J. Pearton, Phys. Stat. Sol. (C) 9, 393 (2012).

[3] J. Wallys, J. Teubert, F. Furtmayr, D. M. Hofmann, M. Eickhoff, Nano Lett. 12, 6180 (2012).

[4] M. Riedel, S. Hölzel, P. Hille, J. Schörmann, M. Eickhoff, F. Lisdat, Biosens Bioelectron. 94, 298 (2017).

HL 56.6 Fri 10:45 EW 561

Properties of higher order Raman modes in confined carbyne — •Johannes Lechner — Institut für Physik und IRIS Adlershof, Humboldt-Universität zu Berlin

Confined carbyne consists of long linear carbon chains (more than 100 atoms) inside carbon nanotubes and is considered a close, stable analogue to the truly 1-dimensional carbon allotrope carbyne. Here we investigate the higher order modes of the Raman active C-mode of single confined carbyne chains by confocal resonant Raman spectroscopy. We observe large frequency shifts which imply strongly anharmonic properties. Analyzing the relative intensities of Raman peaks of different order, we unravel major fluctuations depending on the excitation wavelength, particularly for the second order. Unexpectedly, the relative intensities of different Raman mode orders also change with the

frequency of the C-mode. These new discoveries enable further insight into the structural and electronic properties of confined carbyne as a material system.