HL 55: Focus Session: Functionalized semiconductor nanowires II (DS, jointly with HL)

Time: Wednesday 11:45–12:45 Location: H8

HL 55.1 Wed 11:45 H8

First-principles calculations of electronic and optical properties of ZnO nanowires — •Michael Lorke, Andreia Luisa da Rosa, and Thomas Frauenheim — Bremen Center for Computational Materials Science, University of Bremen, Germany

Semiconductor nanowires are promising candidates for the next generation of optoelectronic devices. In this work we have investigated the electronic and optical properties of bare and passivated ZnO nanowires with small diameter. We show that density-functional theory using the PBE0 functional can reproduce well the experimental ZnO band gap. Furthermore, by using the GW method in combination with the Bethe-Salpeter equation, we show that excitonic effects are strongly dependent on the nanowire size and surface termination.

HL 55.2 Wed 12:00 H8

BEC relaxation in a multimodal whispering-gallery exciton-polariton system — •Christof P. Dietrich, Tom Michalsky, Chris Sturm, Helena Franke, Martin Lange, Rüdiger Schmidt-Grund, and Marius Grundmann — Universität Leipzig, Inst. für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig

We present one-dimensional Bose-Einstein condensates (BEC) of whispering gallery mode (WGM) exciton-polaritons in ZnO-microwires up to room temperature. We show massive occupation of the bosonic ground state at condensation threshold, its blueshift and the condensate's one-dimensional extension and spatial coherence. We find that the condensation mechanism is different from that observed in common (two-dimensional) Fabry-Perot microcavities since the WGM system provides numerous photonic modes. Its ground state is energetically far below the exciton transition, so the system is multimodal without polariton ground state. This leads to two effects: 1.) At room temperature, the scattering of reservoir polaritons into zero-momentum states is strongly assisted by LO-phonons and very efficient because the energy-momentum conservation can be very easily fulfilled. 2.) At low temperature, a parametric relaxation process of polaritons into lower polariton branches is observed when an occupation of one is reached. States with a fixed energy difference ΔE_R are occupied. As the polariton-branch separation ΔE_P increases for lower mode numbers, the condensate gains kinetic energy when $\Delta E_P > \Delta E_R$. The lowermost state which can be reached is determined by the coupling strength and the lifetimes of exciton and WGM photon.

HL 55.3 Wed 12:15 H8

Oxygen-controlled electron-transfer dynamics under optical exitation in hybrid ZnO nano-/CdSe quantum dot structures — •Stephanie Bley[1], Dongchao Hou[1], Michael Diez[1], Sebastian Resch[2], Siegfried Waldvogel[2], Jürgen Gutowski[1], and Tobias Voss[1] — [1]Institute of Solid State Physics, Semiconductor Optics, University of Bremen, 28359 Bremen, Germany — [2]Institute of Organic Chemistry, Johannes Gutenberg University Mainz, 55128 Mainz, Germany

Due to their optoelectronic properties hybrid ZnO nano-/CdSe quantum dot structures possess a high potential for applications in photovoltaics and sensing. For this, the use of organic linker molecules to selectively attach the quantum dots to specific surfaces is a very versatile technique. We chemically synthesize colloidal CdSe quantum dots and attach them to the surface of ZnO nanostructures via different ω-mercapto alkanoic acids. The electron transfer dynamics of this hybrid systems are studied under illumination with a photon energy below the bandgap of ZnO (argon ion laser: λ=458 nm, E=2.7 eV). A strong enhancement of the photoconductivity has been found, and the experimental results demonstrate efficient electron tunneling from excited states of the quantum dots into the conduction band of the nanostructures. We discuss the influence of the length and electronic structure of the linker molecules on the electron transfer dynamics in the hybrid structures. Furthermore, we analyse the passivation of the ZnO nanostructure surfaces to reduce the influence of oxygen desorption for further studies of luminescence decay dynamics.

HL 55.4 Wed 12:30 H8

Polarization dependent CdS nanowire lasing — •Robert Röder[1], Sebastian Geburt[1], Robert Buschlinger[2], Ulf Peschel[2], and Carsten Ronning[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena — [2]Institut für Optik, Information und Photonik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Haberstraße 9a, 91058 Erlangen

The forthcoming limitations of electronic integrated circuits cause reinforced work in nanophotonics for the development of on-chip optical components. Since semiconductor nanowires offer efficient waveguiding and mark the physical size limit of a photonic laser, they are promising candidates to overcome these limitations via optical data transmission and processing. High quality CdS NWs synthesized via VLS mechanism open up the green spectral range around 2.4 eV acting as Fabry-Pérot laser resonators with a remarkable low threshold of 10 kW/cm^2 at room temperature. Since optical processing is specified by the direct emission of the device, a "head-on" setup was developed for the investigation of the light output originating out of the facet end along the nanowire axis. The slope efficiency of the optically pumped CdS nanolaser was determined with a high value of 5-10 %. The lasing emission as well as the ASE is furthermore highly dependent on the polarization of the optical pumping with polarization ratios around 0.15 for the emission. FDTD simulations reveal, that the increased pumping efficiency for along the nanowire axis polarized excitation is more likely based on the absorption profile than on the absolute absorption.