Strong light-matter interaction in quantum dot micropillar cavities — Stepahn Rezenei, Christian Kistner, Michael Münch, Christian Schneider, Michla Strausa, Philipp Frankei, Arash Rahimi-Iman, Tobias Henei, Sven Höfling, Lukas Worschei, and Alfred Forschel — Technische Physik, Universität Würzburg, Würzburg, Germany

Following the first demonstration of strongly coupled quantum dot (QD)-microware systems enormous effort has been devoted to this field of cavity quantum electrodynamics (QED). For applications and for fundamental cQED studies it is crucial to control the light-matter coupling strength by external parameters. To date most experimental studies involving strong coupling in QD-microware systems have relied on temperature tuning while electric anc magnetic fields are required to fully explore their potential in terms of switching speed, record tuning anc in-situ control of the interaction strength.

In this contribution, we will address recent progress in the field of strongly coupled QD-microwave systems controlled by external parameters. For instance, it will be demonstrated that electrically contacted high-Q microwares with large, high oscillator strength $\text{In}_{0.3}\text{Ga}_{0.7}$As QDs in the active layer allow for electro-optical resonance tuning in the strong coupling regime. Besides, we will show that external magnetic fields can induce a transition from the strong to the weak coupling regime and provide a means to access the spin degree of freedom in magneto-optical studies.

Strong light matter coupling in GaN based semiconductors — Nicolas Grandjean — EPFL, Switzerland

III-V nitride semiconductors are well suited for short-wavelength optoelectronic devices such as blue light emitting diodes and laser diodes. On the other hand, III-V nitrides are quite promising for the physics of cavity-polaritons. Indeed, GaN possesses intrinsic properties like oscillator strength 10x larger than that of GaAs and exciton binding energy as large as 50 meV in ultra-thin quantum wells (QWs). As a consequence, the light matter interaction is enhanced allowing the strong coupling regime (SCR) to be sustained at room temperature (RT). Such characteristics have led to the first demonstration of polariton lasing at 300K.

Optical pumping experiments performed on GaN bulk MCs have already shown the potential of III-V nitride semiconductors for polariton condensation. Recent results obtained on QW-MC indicate polariton condensation at 300K with a very low threshold. As expected, the threshold is dependent on both the temperature and the detuning of the cavity mode with respect to the excitation mode.

Another interesting feature is concerned with the polarization behavior, which increases with the pump power above threshold. A depinning of the polarization is observed resulting in a progressive decrease of the polarization degree of the emitted light.

Finally, we will discuss the perspectives of GaN cavity-polaritons for device applications.

Invited Talk HL 18.3 Tue 10:30 H13

Higher Order Photon Bunching in a Semiconductor Microcavity — Franziaka Veit, Marc Assmann, Manfred Bayer, Mike van der Poel, and John M. Hvam — Experimentelle Physik II, TU Dortmund, D-44221 Dortmund, Germany — DTU Fotonik, Technical University of Denmark, DK-2800 Kongens Lyngby, Denmark

We were able to show the statistical behaviour of photons in the single mode emission of a semiconductor microcavity by determining the correlation function $g^{(n)}(\tau)\,\tau$ of the emitted light up to fourth order. We studied the photon correlation in the weak as well as in the strong coupling regime. Our setup using a modified streak camera allowed us to directly record the photon counting statistics with picosecond time resolution. Therefore, we had the possibility to perform measurements of the photon bunching with a time resolution comparable to the coherence time of the light, allowing us to address $g^{(n)}(\tau)\,\tau$ inside the light pulses instead of just between them.

We can illustrate bunching behaviour in the strong coupling regime whereas in the weak coupling regime the cavity starts lasing and therefore the photon bunching vanishes leading to statistically independent photon emission. For the first time the $n!$ prediction for the zero delay correlation function $g^{(n)}(\tau = 0)$ of $n$ thermal light photons could be verified.
The combination of distributed Bragg mirrors and pillar fabrication leads to photonic devices with efficient three-dimensional photon confinement for applications as low-threshold lasers and single-photon sources. However, the quality of the optical mode confinement is reduced by fabrication imperfections of the underlying structure. For a Al(Ga)N/GaN micropillar system high resolution TEM investigations reveal layer-thickness gradients and fluctuations. The experimentally determined true layer profile as well as dispersion measurements for the low and high-index material are used as input for numerical calculations of the three-dimensional mode structure based on a vectorial transfer matrix approach. We determine the influence of various types of structural imperfections on the reduction of the mode confinement in terms of the cavity quality factor. Furthermore, theoretical and experimental mode spectra are compared, that exhibit various confined transverse modes.


**Invited Talk**

**HL 18.9 Tue 12:30 H13**

**Novel polariton-based devices: Room temperature polariton laser and electrically controlled polariton parametric amplifier**

Gabriel Christmann, Stavros Christopoulos, Christopher Coulson, and Jeremy J. Baumberg — NanoPhotonics Centre, Department of Physics, University of Cambridge, CB3 0HE, UK

Semiconductor microcavities (MCs) offer a unique system for producing novel types of non linear devices. In such systems polariton parametric amplification as well as polariton lasers can be obtained. These properties combined with the recent demonstration of electrical injection of polaritons offer a great potential for device realization.

Room temperature polariton lasers will be first presented. Here such systems are fabricated from lattice-matched monolithic GaN-based multilayers, including both bulk and QW microcavities. Coherent emission with a threshold below exciton saturation density is demonstrated in both types of structures. These devices offer a new route to robust long-lived GaN lasers and also provide a new prototype system for the study of macroscopic coherent states.

Then, recent results on a biased GaAs polariton light emitting diode structure will be presented. Pump probe experiments in the parametric amplifier geometry have been performed exhibiting up to 100 fold gains. By varying the electric field across the cavity, a very strong (>90%) quenching of the optical gain is observed for a sharp resonance. This effect is ascribed to competition between the rate of Rabi-coupling and of electronic tunnelling between adjacent quantum wells and is of high potential for the realization of novel light modulators.

**HL 18.7 Tue 12:00 H13**

**Growth and characterization of II-VI-based Bragg reflectors for the blue-violet spectral region**

Sebastian Klemmt, Carsten Kruse, and Detlef Hommel — Institute of Solid State Physics, Semiconductor Epitaxy, University of Bremen, Otto-Hahn-Allee NW1, 28359 Bremen, Germany

The objective is to realize surface emitters for the blue to violet spectral range from 400 to 460 nm using II-VI materials. For this purpose, highly reflective distributed Bragg reflectors (DBRs) are necessary. Since the standard high index material ZnSSe is absorbing at 460 nm, it has to be alloyed to achieve a higher bandgap. The investigated structures consist of ZnMgSSe layers for the high refractive index material and MgS/ZnCdSe superlattices for the low index material. One main challenge is to achieve sharp DBR interfaces when the Mg content of the quaternary ZnMgSSe layers is higher than 20%. Furthermore, the requirement of lattice matching to the GaAs substrate needs precise control of deposition parameters during the DBR growth run. High-resolution X-ray diffraction (HRXRD) measurements were performed for calibration of the composition. In order to determine the exact quarterwave thickness of each layer, the use of in-situ reflectometry turned out to be crucial.

A 16 pairs DBR with a stopband centered at 460 nm reaches a reflectivity exceeding 98%, while the stopband width is about 35 nm. Vertical resonators formed by two DBR mirrors and a cavity containing binary ZnSe quantum wells will also be discussed.

**HL 18.8 Tue 12:15 H13**

**Influence of growth imperfections on optical properties of nitride pillar VCSEL microcavities**

Matthias Florian, Frank Jahnke, Angelika Pretorius, Andreas Rosenauer, Heiko Dartsch, Carsten Kruse, and Detlef Hommel — Institute for Solid State Physics, University of Bremen, Germany

The combination of distributed Bragg mirrors and pillar fabrication leads to photonic devices with efficient three-dimensional photon confinement for applications as low-threshold lasers and single-photon sources. However, the quality of the optical mode confinement is reduced by fabrication imperfections of the underlying structure. For a Al(Ga)N/GaN micropillar system high resolution TEM investigations reveal layer-thickness gradients and fluctuations. The experimentally determined true layer profile as well as dispersion measurements for the low and high-index material are used as input for numerical calculations of the three-dimensional mode structure based on a vectorial transfer matrix approach. We determine the influence of various types of structural imperfections on the reduction of the mode confinement in terms of the cavity quality factor. Furthermore, theoretical and experimental mode spectra are compared, that exhibit various confined transverse modes.