HL 95: Polaritons

Time: Thursday 11:30–13:00 Location: POT 051

HL 95.1 Thu 11:30 POT 051

Influence of disorder on polariton BEC — •Martin Thunert[1], Alexander Janot[2], Chris Sturm[1], Helena Franke[1], Bernd Rosenow[2], Rüdiger Schmidt-Grund[1], and Marius Grundmann[1] — [1]Universität Leipzig, Fakultät für Experimentelle Physik II, Linnestr. 5, 04103 Leipzig — [2]Universität Leipzig, Fakultät für Theoretische Physik, Brüderstr. 16, 04103 Leipzig

We discuss the impact of disorder effects on the dynamics of exciton-polariton Bose-Einstein condensates (BEC) in a ZnO-based bulk planar microcavity. In contrast to previous experimental work [1], we do not observe significant stabilization of the condensate with increasing polariton density and find even at high excitation powers strong traces of disorder effects in the momentum space intensity distributions. Recent theoretical work shows that disorder destroys the spatial long-range order of a driven quantum condensate [2]. Moreover, the superfluid stiffness of a driven condensate vanishes in the thermodynamic limit and a rigid behaviour is expected over finite length scales only. This indicates that disorder has a significantly pronounced impact on a polariton condensate compared to an equilibrium condensate. We simulate the polariton emission in the momentum space for a large number of disorder realisations. For a condensate phase fluctuation length comparable to the condensate size, our simulations allow us to understand the experimental findings and reproduce its qualitative behaviour for increasing excitation power.

[1] A. Baas *et al.*, Phys. Rev. Lett. **100**, 170401 (2008); [2] A. Janot *et al.*, arXiv:1307.1407 (2013)

HL 95.2 Thu 11:45 POT 051

An electrically driven polariton laser — •Matthias Amthor[1], Arash Rahimi-Iman[1], Na Young Kim[2,3], Julian Fischer[1], Lukas Worschech[1], Martin Kamp[1], Christian Schneider[1], Alfred Forchel[1], Yoshihisa Yamamoto[2,4], and Sven Höfling[1,5] — [1]Technische Physik and Wilhelm-Conrad-Röntgen-Research Center for Complex Material Systems, Universität Würzburg, D-97074 Würzburg, Am Hubland, Germany. — [2]E.L. Ginzton Laboratory, Stanford University, Stanford CA, 94305, USA. — [3]Institute of Industrial Science, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan. — [4]National Institute of Informatics, Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan. — [5]SUPA, School of Physics and Astronomy, University of St Andrews, St Andrews, KY16 9SS, United Kingdom

We report on magneto-optical measurements of an electrically driven GaAs based exciton-polariton light-emitting diode. While using direct current excitation at a temperature of 8K three different regimes occur in the energy-momentum dispersion characteristics. Subject to an applied magnetic field in Faraday configuration, we observe two distinct nonlinearities in the excitation power dependent output characteristics and a characteristic shift of the emission energy. Furthermore the linewidth shows a drop at the first threshold, which is a sign for the buildup of temporal coherence, and continously decreases to the resolution limit in the photonic regime. Additionally, we prove the conservation of the strong coupling regime above the first threshold and its loss above the second threshold by investigating the Zeeman splitting.

HL 95.3 Thu 12:00 POT 051

Determination of operating parameters for a GaAs-based polariton laser — •Johannes Schmutzler[1], Franziska Wishahi[1], Marc Assmann[1], Jean-Sebastian Tempel[1], Sven Höfling[2], Martin Kamp[2], Alfred Forchel[2], and Manfred Bayer[1] — [1]Experimentelle Physik 2, Technische Universität Dortmund, D-44221 Dortmund, Germany — [2]Technische Physik, Physikalisches Institut, Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, D-97074 Würzburg, Germany

We report on a systematic study of the phase transitions to polariton condensation and further to cavity lasing in a GaAs-based microcavity with respect to exciton-cavity detuning and lattice temperature. Using far field and time-resolved spectroscopy we identify two different modes which are attributed to polariton condensation and cavity lasing, respectively. Thereby we can determine the parameterspace in which polariton condensation can be achieved and the corresponding variation of threshold power. For the investigated sample, we found a lower bound of -12 meV for the exciton-cavity detuning and an upper bound of 90 K for the lattice temperature.[1]

[1] J. Schmutzler et al., Applied Physics Letters 102, 081115 (2013)

HL 95.4 Thu 12:15 POT 051

Textured microcavity trapped polaritons — •Karol Winkler[1], Anne Schade[1], Julian Fischer[1], Martin Kamp[1], Christian Schneider[1], and Sven Höfling[1,2] — [1]Technische Physik and Wilhelm Conrad Röntgen Center for Complex Material Systems, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]School of Physics and Astronomy, University of St Andrews, St Andrews, United Kingdom

Trapping of microcavity exciton polaritons by introducing an additional lateral confinement has been shown to support condensation into the bosonic ground state of the system. These 0D polariton traps then, for example, allow the investigation of interacting polariton condensates by enabling arbitrary configurations into advanced lattice structures.

We will focus here on the trapping technique of an elongated textured microcavity. Through an etch-and-overgrowth step a three-dimensional confinement potential for photons and therefore polaritons is introduced. In devices based on a single GaInAs QW in a GaAs λ-cavity, optical and electrical injection of 0D-polaritons has been demonstrated. We will present resonant photocurrent measurements to probe density dependent energy shift of the ground state in such an electrical device.

These systems undergo a transition into weak coupling by further pumping. We will further present a textured microcavity platform that enables arbitrary lattice configurations with deep confinement while condensation in the ground state is possible.

HL 95.5 Thu 12:30 POT 051

Magnetic field properties of zero- and two-dimensional polariton-condensates — •Julian Fischer[1], Sebastian Brodbeck[1], Bo Zhang[2], Alexander Chernenko[3], Steffen Holzinger[1], Matthias Amthor[1], Vladimir D. Kulakovskii[3], Lukas Worschech[1], Mikhail Durnev[4], Hui Deng[2], Martin Kamp[1], Christian Schneider[1], Alexey V. Kavokin[4], and Sven Höfling[1,5] — [1]Technische Physik, Physikalisches Institut, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]Department of Physics, University of Michigan, Ann Arbor, Michigan, 48109, USA — [3]Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, 142432, Russia — [4]Ioffe Physical-Technical Institute of RAS, 194021 St.-Petersburg, Russia — [5]SUPA, School of Physics and Astronomy, University of St Andrews, UK

We discuss magnetic field properties of zero- (0D) and two-dimensional (2D) polariton-condensates in GaAs microcavities. For the 2D polariton-condensate we observe a sign reversal of the Zeeman-splitting above a critical magnetic field. This experimental result is explained by a nonequilibrium spin Meissner effect. In the second part we investigate the magnetic field response of 0D microcavity structure, where the three-dimensional photonic confinement is archieved by replacing the top distributed Bragg reflector by a sub-wavelength high index contrast grating. The emission characteristics are dominated by discrete, zero-dimensional resonances. Magnetic field investigations allow us to prove the matter part of the polariton-emission above the threshold by directly measuring the polariton's diamagnetic shift.

HL 95.6 Thu 12:45 POT 051

Low dimensional GaAs/Air vertical microcavity lasers — •Jonas Gessler[1], Theresa Steinl[1], Arkadiusz Mika[1,2], Julian Fischer[1], Jan Misiewic[2], Sven Höfling[1], Christian Schneider[1], and Martin Kamp[1] — [1]Technische Physik, Universität Würzburg, Am Hubland, D-97074, Würzburg, Germany — [2]Wroclaw University of Technology, 27 Wybrzeze Wyspiańskiego St, 50-370 Wrocław, Poland

Microcavities consisting of gallium arsenide (GaAs)/ aluminum gallium arsenide (AlGaAs) distributed Bragg reflectors have been the platform for many pioneering light matter interaction studies in semiconductors. GaAs/air microcavities that can be fabricated by selective etching of layers with high Al-content have the major advantage that they show a very large index contrast. This enables smaller mode volume by decreasing the effective cavity length and to obtain the same quality factors with a notably smaller number of mirror pairs. Our cavity design is promising to reach the strong coupling regime and demonstrate polariton formation in the GaAs/ air microresonator.

We report on the fabrication of GaAs/ air distributed Bragg reflector microresonators with indium gallium arsenide quantum wells. The structures are studied via momentum resolved photoluminescence spectroscopy which allows us to investigate a pronounced optical mode quantization of the photonic dispersion. Via analytical simulations we extract the lateral physical extensions of our microcavity from the energetic distance between the discrete states. Power dependent investigations of our structures revealed clear evidence of photon lasing.