HL 38: Polaritons and Polariton Lasing

Time: Tuesday 12:00–13:15 Location: FOE Anorg

HL 38.1 Tue 12:00 FOE Anorg

Non-polar III-nitride microcavities for polariton lasing — •Georg Rossbach[1], Jacques Levrat[1], Amélie Dussaigne[1], Henryk Teisseyre[2], Gatien Cosendey[1], Marlene Glauser[1], Munise Cobet[1], Izabella Grzegory[2], Raphaël Butté[1], Tadeusz Suski[2], and Nicolas Grandjean[1] — [1]ICMP, Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland — [2]Institute of High Pressure Physics, Polish Academy of Sciences, 01-142 Warsaw, Poland

Owing to their ultra-low effective mass and bosonic character, exciton-polaritons are promising candidates for a significant reduction of the threshold of electrically driven semiconductor coherent light emitters. In this context polariton lasing at room temperature has been demonstrated recently in III-nitride (MCs) under optical pumping. However, due to the hexagonal symmetry of III-nitrides, heterostructures grown along polar orientation suffer from the presence of the quantum-confined Stark-effect. The latter reduces the oscillator strength and the exciton binding energy in wide quantum wells, which can potentially prevent the formation of polaritons. In order to circumvent these effects the growth of non-polar orientations looks well suited even though the achievement of high crystal quality is challenging.

Here, we present first results obtained on a non-polar III-nitride MC grown by molecular beam epitaxy on m-plane bulk GaN. Photoluminescence and reflectivity studies were carried out (in the temperature range 4 - 300 K) showing linear and non-linear effects in the strong light-matter coupling regime combined with a pronounced optical anisotropy as expected from selection rules.

HL 38.2 Tue 12:15 FOE Anorg

From polariton condensates to highly photonic quantum degenerate states of bosonic matter — •Franziska Veit[1], Marc Assmann[1], Jean-Sebastian Tempel[1], Manfred Bayer[1], Arash Rahimi-Iman[2], Andreas Löffler[2], Sven Höfling[2], Stephan Reitzenstein[2], Lukas Worschech[2], and Alfred Forchel[2] — [1]Experimentelle Physik 2, Technische Universität Dortmund,44221 Dortmund — [2]Technische Physik, Physikalische Institut und Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, 97074 Würzburg

Bose-Einstein condensation (BEC) of exciton-polaritons in microcavities is considered to be a non-equilibrium process of a degenerate polariton gas in self-equilibrium. We are able to show several key signatures of Bose Einstein condensation BEC without fulfilling the self-equilibrium condition in a highly photonic quantum degenerate non-equilibrium system. Using a planar GaAs/GaAlAs microcavity we observe a buildup of a macroscopic ground state occupation, supressed quantum fluctuations and a linearization of the excitation spectrum.

HL 38.3 Tue 12:30 FOE Anorg

Distinguishing photon and polariton lasing from GaAs microcavities by spectral and temporal analysis of the two-threshold behavior — •Lars Erik Kreilkamp[1], Jean-Sebastian Tempel[1], Franziska Veit[1], Marc Assmann[1], Arash Rahimi-Iman[2], Andreas Löffler[2], Sven Höfling[2], Stephan Reitzenstein[2], Lukas Worschech[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 present the excitation-power dependent evolution of the emission of a planar GaAs/GaAlAs microcavity from thermal polariton photoluminescence to polariton lasing and to photon lasing. For the emission from the lower energy-momentum dispersion branch we find a two-threshold behavior of the ground state in the input-output curve where each transition is accompanied by characteristic changes of the in-plane mode dispersion. By studying the second-order correlation function $g^{(2)}(\tau)$ of the emission, using a streak camera set-up with appropriate time resolution, we show in particular, that the thresholds are unambiguously reflected in the photon statistics. Moreover, the evolution of the emission pulse duration confirms the occurence of two distinct transitions.

HL 38.4 Tue 12:45 FOE Anorg

Magnetic Field Interaction of Exciton-Polaritons in GaInAs Quantum Well-Microcavities — •Arash Rahimi-Iman, Christian Schneider, Julian Fischer, Matthias Amthor, Sven Hoefling, Stephan Reitzenstein, Martin Kamp, and Alfred Forchel — Technische Physik, Universität Würzburg, D-97074 Wuerzburg, Germany

Polaritons formed by excitons and photons in strongly coupled quantum well (QW) semiconductor microcavities have initiated intensive studies of multiple particle physics in solids during the last decade. Bose-Einstein condensation of these quasi particles and the so-called polariton-lasing represent very interesting physical phenomena investigated in different material systems (Deng et al. 2002, Kasprzak et al. 2006). Since condensation is not feasible in ideal 2D systems, it only occurs in planar cavities if natural or artificial traps are provided.

We have studied polariton emission from artificial traps in planar cavities in the presence of external magnetic fields up to 5 T, The work focuses on the interaction of the spin-resolved excitonic component of trapped polaritons due to the Zeeman effect. We report on trap-size dependent Zeeman splittings up to 100 μeV and diamagnetic coefficients up to 0.025 meV/T^2 of exciton-polaritons spatially confined by photonic quantum boxes in a planar single GaInAs QW-microcavity at 5 T. Providing a size variation of the traps ranging from 0.5 to 10 μm on a wide detuning range, quantized polariton modes were observed under non-resonant optical pumping.

HL 38.5 Tue 13:00 FOE Anorg

Balistic exciton polariton propagation in CdZnTe crystals — •Tillmann Godde[1], Ilya Akimov[1], Dimitri Yakovlev[1], Henri Mariette[2], and Manfred Bayer[1] — [1]Experimentelle Physik 2a, Technische Universität Dortmund, 44227 Dortmund, Germany — [2]CEA-CNRS group Nanophysique et Semiconductors, Institute Néel, CNRS and Université Joseph Fourier, 25 Avenue des Martyrs, 38042 Grenoble, France

We study the propagation of lower branch exciton polaritons in 200 μm - 800μm thick $Cd_{0.88}Zn_{0.12}Te$ samples using time resolved photoluminescence (PL) and time of flight techniques. The PL spectrum comprises of two peaks consistent with emission from upper and lower polariton branches with a resonance frequency of $\hbar\omega_0 = 1.664$ eV. The lifetimes of the exciton polaritons in the upper and lower branches are 1.5 ns and 3 ns, respectivly.

In time of flight measurements we observe significant delay of 1 ps optical pulses, which increases to 350 ps at $\hbar\omega = 1.661$ eV in a 745 μm thick sample. Femtosecond-pulses get stretched and allow to obtain the dispersion in a single streak camera measurement. We reproduce the measured delays using a single oscillator model for the lower polariton branch dispersion.

The propagation is ballistic, which follows from the observation of reflected replica pulses. Assuming that the exciton polariton scattering on optical and acoustical phonons is mainly inelastic, we conclude that the propagation is coherent. We estimate the coherence time to be about 300 ps.