# HL 58: Photonic Crystals: Experiment

Time: Thursday 16:00–17:45 Location: H13

HL 58.1 Thu 16:00 H13

**Liquid crystal infiltrated photonic crystal fibers** — •Alexander Lorenz, Heinz Kitzerow, and Rolf Schuhmann — University of Paderborn, Warburger Str. 100, 33098 Paderborn

Experimental results obtained by means of a cut back technique indicate low attenuations (< 1 dB/cm) for a solid core photonic crystal fiber filled with the nematic liquid crystal E7. These results observed in the visible wavelength range are compared with electromagnetic field simulations. The latter are carried out with a full vectorial finite element algorithm. Based on the modal properties under the condition of perpendicular anchoring of the liquid crystal molecules, the wavelength dependent attenuation is estimated using a power loss model considering the turbidity of the nematic liquid crystal. The results indicate that the scattering properties of this type of materials make them extremely interesting for fiber optical filters in the visible wavelength range and that filling materials with a relatively high turbidity are in general potentially useful as filling materials for solid core photonic crystal fibers.

HL 58.2 Thu 16:15 H13

**Photonic crystal resonators with electrical contacts** — •Martin Kamp, Benedikt Friess, Thomas Schlereth, Sven Höfling, and Lukas Worschech — Technische Physik, Am Hubland, 97074 Würzburg

Photonic crystal (PhC) resonators with embedded quantum dots have become an intensively studied solid state system for experiments on cavity quantum electrodynamics. Contacts that allow carrier injection/extraction or the possibility to apply an electric field to the quantum dots provide an additional degree of control over these structures.

We have investigated PhC resonators fabricated in GaAs membranes with embedded InGaAs quantum dots. The upper and lower half of the GaAs membrane were doped, thus forming a pn junction. After definition of the contact metallization to the front and back side of the sample, photonic cystal resonators based on three missing holes in a PhC lattice were fabricated. The structures were measured by low temperature photo- and electroluminescence. The latter was observed when operating the structures in forward bias. A reverse bias allowed to tune the emission wavelength of quantum dots in the cavity by the quantum confined Stark effect. In addition, photocurrent spectroscopy was performed by scanning a tunable laser over the resonance of the cavity and detecting the photocurrent. The resonance of the PhC cavity is clearly observed, with a quality factor comparable to that observed in the photoluminescence.

HL 58.3 Thu 16:30 H13

**Angle-resolved fluorescence detection by defocused wide-field imaging** — •Rebecca Wagner, Georg Kropat, and Frank Cichos — Molecular Nanophotonics Group, University of Leipzig, Linnéstraße 5, 04103 Leipzig

Photonic Crystals (PCs) are materials where the dielectric constant varies periodically. Multiple scattering of light on this spatially modulated refractive index leads to the formation of a photonic band structure including photonic band gaps where light can not propagate through the material. This band structure can for example be probed by angle resolved reflection spectroscopy. However, for every angle of incidence the detection angle has to be varied since reflections can occur on different lattice plane families, which makes this method very time consuming. A faster method is angle resolved fluorescence spectroscopy of internal emitters where only the angle of detection has to be varied. Still the problem remains to make sure that one measures always at the same position, otherwise one averages over different crystal domains and defects. We are developing a way to collect light emitted in all directions in one measurement, based on defocused imaging of single emitters in 3D PCs. Since these images result from the diffraction of electromagnetic waves from the aperture of the microscope objective, the diffraction patterns change when light emission in certain directions is inhibited by the PC. We observe this modification for example in a threefold symmetry of the image, which we attribute to reflections on different lattice plane families of the PC.

HL 58.4 Thu 16:45 H13

**Optical Microresonators Fabricated by Epitaxial DBR Overgrowth of Pyramidal GaAs Cavities** — •Daniel Rülke, Matthias Karl, Dongzhi Hu, Daniel M. Schaadt, Heinz Kalt, and Michael Hetterich — Institut für Angewandte Physik and DFG Center for Functional Nanostructures (CFN), Karlsruher Institut für Technologie (KIT), 76131 Karlsruhe, Germany

Based on the fabrication technique of recently investigated pyramidal GaAs microresonators, we have developed a method to create microcavities with the shape of truncated pyramids sandwiched between two distributed Bragg reflectors (DBRs). To this end, an AlAs sacrificial layer is utilized for facet formation in a wet-chemical etching process. The sacrificial layer is then removed in a selective etching step and, after a further selective etching step, truncated pyramids with a DBR underneath are obtained. Overgrown with a second DBR on top, these cavities serve as high-quality ($Q$) resonators with observed $Q$-factors of optical modes up to 8000. Compared to conventional cylindric pillar-resonators their smooth facet angle of about 20° promises reduced scattering losses at the edges of the cavity and a reduced density of leaky modes.

HL 58.5 Thu 17:00 H13

**Optical properties of waveguide circuits in GaAs-based photonic crystals** — •Rebecca Saive, Norman Hauke, Alexander W. Holleitner, and Jonathan J. Finley — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, D-85748 Garching, Germany

We present micro-photoluminescence measurements on GaAs photonic crystal waveguides, designed with transmission bands between 875 nm and 950 nm. The photonic waveguide properties were simulated using RSOFTs CAD, FullWave and BandSolve modules which operate with finite-difference time-domain and planewave expansion methods, respectively. The structures were defined by electron-beam lithography and then, transferred to the GaAs matrix with reactive ion etching. In a final step, we underetched the waveguide structures with hydrofluoric acid to obtain a freestanding membrane. Light was coupled into the waveguide via a tapered optical fiber, while the transmitted, out-of-plane scattered light, at the end of the waveguide was collected with a microscope objective and detected with a Si-photodiode. The transmission bands in simulation and experiment are in good agreement.

HL 58.6 Thu 17:15 H13

**Long living surface acoustiv wafes in a phononic-photonic crystal** — Alexey S. Salasyuk[1], Alexey V. Scherbakov[1], Dmitriy R. Yakovlev[1,3], Andrey V. Akimov[1,3], Alexander A. Kaplyanskii[1], Saveliy F. Kaplan[1], Sergey A. Grudinkin[1], Alexey V. Nashekin[1], Alexander B. Pevtsov[1], Valeriy G. Golubev[1], Thorsten Berstermann[2], Christian Brüggemann[2], •Michael Bombeck[2], and Manfred Bayer[2] — [1]Ioffe Physical-Technical Institute of the Russian Academy of Sciences, 194021 St.Petersburg, Russia — [2]Experimentelle Physik 2, Technische Universität Dortmund, D-44227 Dortmund, Germany — [3]School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, UK

The time evolution of bulk and surface acoustic wafes in synthetic opals with different sintering is detected by the changes of reflectivity. The opal system is a three dimensional array of close packed silica spheres with approximately 350nm diameter. It is known to provide a photonic stopband in the near infra red and also posses a full three dimensional phononic band gap in the GHz range. An acoustic puls is injected into the opal by a thermo-elastic transducer from a 800nm 150fs Ti:Sa laser puls. The changes of the reflectivity due to acoustic excitation of the opal are sampled by a probe pulse from the same laser. The main result of our measurments is the observation of a long-living acoustic mode corresponding to the first band gap of the phononic crystal with weak sintering. There is no observation of a long living mode in an opal with stronger sintering according to theory predictions.

HL 58.7 Thu 17:30 H13

**Strain dependence of second harmonic generation in silicon** — •Clemens Schriever[1], Christian Bohley[1], Jörg Schilling[1], and Ralf Wehrspohn[2] — [1]ZIK "Sili-nano", Martin-Luther-University Halle — [2]Martin-Luther-University Halle Wittenberg

In recent years, silicon has become a favored material in photonics, mainly due to its highly optimized CMOS processing technology and its suitable optical properties at telecommunication wavelengths. Here it has proven itself as passive optical component. The difficulty of integrating silicon into active optoelectronics, where electrical and optical functionalities are combined in a monolithic device is due to its limited active optical properties. Generally, second order nonlinear optical effects like second harmonic generation are forbidden in silicon because of its inversion symmetry. However, an induced inhomogeneous strain can reduce the symmetry of the crystal and therefore give rise to a second order nonlinear susceptibility. This opens the possibility to create silicon based active optical devices, e.g. electro-optical modulators and switches. Here we determine experimentally the strain dependence of the second order nonlinear susceptibility on the applied strain by means of second harmonic generation in a reflecting geometry. The components of the second order nonlinear susceptibility are determined and compared to the unstrained case. The results agree well with theoretical predictions that take into account the applied strain. There, an analytical dependence of the second order nonlinear susceptibility on the strain is derived from an $sp^3$-orbital concept.