HL 53: Photonic crystals

Time: Wednesday 15:00–16:00 Location: EW 015

HL 53.1 Wed 15:00 EW 015

Transport in three-dimensional aperiodic structures: Experiments and calculations — •Michael Renner[1] und Georg von Freymann[1,2] — [1]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern — [2]Fraunhofer-Institute for Physical Measurement Techniques (IPM), Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany

To explore the mechanism of light transport in three-dimensional aperiodic structures we perform finite-difference time-domain (FDTD) simulations closely resembling our experimental geometry [1]. By incoherently adding individual mode profiles after excitation with Cassegrain-type point spread functions and taking into account the given collection optics we are able to reproduce experimental results obtained by an focal plane array (FPA) connected to a Fourier transform infrared spectrometer (FTIR). We confirm the experimentally observed sub-diffusive transport behavior in direct laser written polymer samples with different aperiodic spatial correlations. Structures based on the Rudin-Shapiro sequence show the strongest mode localization, in good agreement with the experiment. Comparisons with two-dimensional representations reveal less pronounced localization highlighting the importance of the aperiodic structuring in three dimensions.

[1] Renner, M. & von Freymann, G. Transverse Mode Localization in Three-Dimensional Deterministic Aperiodic Structures. Adv. Opt. Mater. 2, 226-230 (2014).

HL 53.2 Wed 15:15 EW 015

Fabrication of photonic crystal circuits based on GaN ultrathin membranes by maskless lithography — •Olesea Volciuc[1], Tudor Braniste[2], Veaceslav Sergentu[3], and Jürgen Gutowski[1] — [1]Institute of Solid State Physics, University of Bremen, Bremen 28334, Germany — [2]National Center for Materials Study and Testing, Technical University of Moldova, Chisinau 2004, Moldova — [3]Institute of Applied Physics, Academy of Sciences of Moldova, Chisinau 2028, Moldova

We report on maskless fabrication of photonic crystal (PhC) circuits based on ultrathin (d ~ 15 nm) nanoperforated GaN membranes exhibiting a triangular lattice arrangement of holes with diameters of 150 nm. In recent years, we have proposed and developed a cost-effective technology for GaN micro- and nano-structuring, the so-called surface charge lithography (SCL), which opened wide possibilities for a controlled fabrication of GaN ultrathin membranes. SCL is a maskless approach based on direct writing of negative charges on the surface of a semiconductor by a focused ion beam (FIB). These charges shield the material against photo-electrochemical (PEC) etching. Ultrathin GaN membranes suspended on specially designed GaN microstructures have been fabricated using a technological route based on SCL with two selected doses of ion beam treatment.

HL 53.3 Wed 15:30 EW 015

Fabrication of two dimensional photonic crystal membranes in cubic AlN/GaN — •Sarah Blumenthal[1], Matthias Buerger[1], Donat J. As[1], Andre Hildebrandt[2], and Jens Förstner[2] — [1]University of Paderborn, Faculty of Physics, Department of Optoelectronic Semiconductors — [2]University of Paderborn, Faculty of Physics, Department of Theoretical Electrical Engineering

Group III-Nitrides attracted much attention in the development of optical and quantum optical devices, operating in the UV spectral range. Microresonators enable to control the spontaneous emission of light and to realize an efficient single photon emitter (SPE). Promising candidates for such devices are 2D photonic crystal (PhC) nanocavities. Recently, SPE of hexagonal GaN quantum dots (QD) were already reported. However, h-GaN QDs exhibit strong internal electrical fields causing long radiative lifetimes. This can be overcome by the growth of cubic GaN QDs where no polarisation fields are present. We implemented a process to fabricate freestanding c-AlN/GaN membrane with a 2D hexagonal array of holes. This configuration leads to a large photonic band gap. The free standing membrane ensures an inplane light propagation. This PhC cavity processing is realized by electron beam lithography and different steps of reactive ion etching. Simulations were carried out to optimize the size of the holes, the distance between the holes and the thickness of the membrane. Furthermore, various cavities were fabricated by omitting three holes in a row (L3-cavity) and five holes in a row (L5-cavity).

HL 53.4 Wed 15:45 EW 015

GaAs-based photonic crystal microcavities with metallic contacts — Wadim Quiring[1], •Björn Jonas[1], Dirk Reuter[1], Andreas D. Wieck[2], and Artur Zrenner[1] — [1]Center for Optoelectronics and Photonics Paderborn (CeOPP), Universität Paderborn, Paderborn, Germany — [2]Ruhr-Universität Bochum, Bochum, Germany

An elegant method to perform coherent control on a quantum dot two level system is to make use of an optical clock signal together with a synchronous electric HF-signal [1]. The application of this concept requires electrically contacted microcavities. To achieve this, we use MBE-grown membrans, which are designed as n-i-Schottky structures with an InGaAs quantum well as active layer in the intrinsic region. From this we have fabricated GaAs-based photonic crystal cavities with narrow electrodes, which provide an electric connection to the defect. Metalic contacts offer low sheet resistance and enable the transmission of high frequency signals, which are required for coherent optoelectronic manipulation. They also allow for electric tuning via the quantum confined Stark effect and for photocurrent (PC) readout. On those electrically contacted cavities we have performed PC spectroscopy under resonant excitation within a temperature range of 4 K - 310 K. We find strong cavity resonances in the PC spectrum and surprisingly high Q-factors up to 6000. Temperature increase results in an exponential enhancement of the PC and in an external quantum efficiency of 0.26 at room temperature. [1] S. Michaelis de Vasconcellos et. al, Nat. Photon., 4, 548 (2010)