Q 20 Photonische Kristalle I

Zeit: Dienstag 10:40–12:55 Raum: HI

Q 20.1 Di 10:40 HI

Bloch-mode Formation and Disorder in Coupled-Cavity Chains — •Björn M. Möller[1], Ulrike Woggon[1], and Mikhail V. Artemyev[1,2] — [1]Department of Physics, University of Dortmund — [2]Institute for Physico-Chemical Problems of Belarussian State University

The coupled-microresonator model is an important concept to describe loss-less waveguiding, photonic circuits, and slowing down light [1-3].

In this work, we discuss a coupled oscillator model for photon states in finite 1D-periodic structures. Experimentally, we explore the coherent photon coupling in linear chains of up to 14 spherical microcavities. Coherent coupling is evidenced by (i) collapse of individual whispering gallery modes, (ii) splitting of modes into a fine structure, (iii) the strong variation of the field intensity and splitting features between adjacent spheres in a chain.

We demonstrate how intensity modifications along the coupled resonator chain can originate from two different phenomena: The observed intensity variations are explained using a coupled oscillator model predicting locally varying oscillator strengths. Both Bloch-mode formation and size disorder can lead to significant field variations in a coupled resonator structure. The transition between both effects are transparently explored in terms of this coupled-oscillator model.

[1] A. Yariv *et al.*, Opt. Lett. **24** (11), 711 (1999)
[2] B. M. Möller, *et al.*, Opt. Lett. **30** (16), 2116 (2005)
[3] B. M. Möller, *et al.*, J. Appl. Opt. A, in press (2006)

Q 20.2 Di 10:55 HI

Near field studies of resonances in multistep photonic crystal heterostructure nanocavities. — •Sushil Mujumdar[1], A. Femius Koenderink[2], and Vahid Sandoghdar[1] — [1]Laboratory of Physical Chemistry, ETH Zurich, CH-8093 Zurich, Switzerland. — [2]FOM-Institute for Atomic and Molecular Physics (AMOLF), Kruislaan 407, 1098 SJ Amsterdam, The Netherlands.

We report on near-field studies of resonances in photonic crystal nanocavities realized in thin GaAs membranes. The nanocavities were created under a multistep photonic heterostructure design, wherein five crystal slabs, with lattice constants a_1, a_2, a_1, a_2 and a_1 respectively ($a_1 > a_2$) were seamlessly welded together[1]. A collinear $W1$ waveguide created through the structure exhibits an offset in the band diagram for the guided mode in the regions with different lattice constants. The confinement in the spatially narrow (width $2a_1$) region yields resonances of quality factors $\sim 10^4$, depending on the width of the a_2 region. An optical fiber tip mounted in a shear-force setup explored the near-field distribution of light in the nanocavity on and off resonance frequencies. The high-resolution (< 100 nm) intensity map in the nanocavity at the resonant frequency shows excellent agreement with 3D finite difference time domain simulations. Furthermore, the pre-resonant evolution of light intensity in the nanocavity shows an interesting behaviour as the mode-gap is scanned in frequency.

[1] Samples were fabricated by the Nanodevices for Photonics and Electronics group, Institute of Experimental Physics, University of Würzburg.

Q 20.3 Di 11:10 HI

Interaction of Nanoscopic Particles with the Near Field of Photonic Crystal Structures — •Michael Barth and Oliver Benson — Nano Optics, Institute of Physics, Humboldt University Berlin

Nanostructured dielectric materials provide new ways of guiding and manipulating light, most prominently realized in photonic crystal waveguides and cavities. The specific optical properties of these structures make them promising candidates for novel sensing techniques, as small changes in the dielectric environment can significantly alter the propagation of light. For this purpose we have studied the interaction of nanoscopic dielectric particles with the near field of various photonic crystal structures by means of numerical simulations. We investigate the resulting changes in the optical properties of the photonic crystals as well as the mechanical forces acting on the particles. Both effects turn out to be strongest for cavity-like defect structures, which exhibit sharp resonances and large field enhancements, thereby ensuring intense matter-light interaction. These results will be exploited in experimental studies, which are currently in progress, using an optical tweezer to position and manipulate dielectric particles on planar photonic crystals.

Q 20.4 Di 11:25 HI

Lauebeugung von sichtbarem Licht an periodischen Strukturen mit endlicher Ausdehnung — •Oliver Henneberg[1], Ullrich Pietsch[2] und Norbert Lauinger[3] — [1]Universität Potsdam — [2]Universität Siegen — [3]Corrsys-Datron

v.Laue-Beugung mit Röntgenstrahlung wird seit langem zur Charakterisierung von Einkristallen eingesetzt. Lauespots entstehen, wenn eine Netzebene hkl mit dem Netzebenenabstand d(hkl) die Braggbedingung für eine spezielle Wellenlänge λ aus dem einfallendem weissen Röntgenlicht erfüllt. Das selbe Prinzip kann angewendet werden, um aus weissem sichtbaren Licht, Spots verschiedene Farbe zu selektieren. Die dazu nötigen Kristalle mit Gitterkonstanten im Micrometer Bereich sind im Prinzip als Photonische Kristalle verfügbar. Im Gegensatz zu den Röntgenobjekten sind diese aber in ihrer räumlichen Ausdehnung begrenzt was die Energieunschärfe der möglichen Reflexe begrenzt.

Im folgenden stellen wir ein Experiment vor, mit dem man Lauebilder eines Kristalls mit Mikrometer Gitterkonstante nach Beugung mit sichtbarem Licht auswerten kann. Mit Hilfe eines Computerprogramms läßt sich die Streuung am endlichen Kristall simulieren. Numerischen Ergebnisse werden mit gemessenen Lauebeugungsaufnahmen verglichen.

Q 20.5 Di 11:40 HI

Unconditionally stable time-domain simulations using Krylov-subspace methods — •Jens Niegemann[1,2], Martin Pototschnig[1], Lasha Tkeshlashvili[3,2], and Kurt Busch[1,3,2] — [1]Institut für theoretische Festkörperphysik, Universität Karlsruhe — [2]DFG Forschungszentrum Center for Functional Nanostructures (CFN), Universität Karlsruhe — [3]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

Over the past decades, many numerical methods have been developed to solve the time-dependent Maxwell equations. The most popular one is the so-called Finite-Difference Time-Domain (FDTD) method. While FDTD is very easy to implement and relatively fast, it exhibits some inherent problems. In particular, it is only of second order in time and only conditionally stable. Therefore, to obtain accurate results one has to take very small timesteps. We propose to solve Maxwell's equations with an unconditionally stable and more accurate method based on operator exponentials using Krylov-subspace techniques. We compare the performance of our method with standard FDTD and other methods. In addition, we demonstrate how to include absorbing boundary conditions and sources into this method while still maintaining the unconditional stability. Furthermore, we show how this method can be extended to nonlinear and coupled systems, by using nonlinear exponential integrators.

Q 20.6 Di 11:55 HI

Characterization of macroporous silicon devices for Photonic Crystal-based spectroscopic gas sensors — •Stefan L. Schweizer[1], Torsten Geppert[2], Andreas von Rhein[1], Daniel Pergande[1], and Ralf B. Wehrspohn[1] — [1]Dept. Physik, Universität Paderborn, 33095 Paderborn — [2]MPI Halle, 06120 Halle

Photonic crystals (PhC) offer the potential to allow the realization of compact spectroscopic gas sensors. The working principle is based on low group velocities. However, the fabrication of corresponding PhC structures is demanding. We improved the macroporous Si fabrication process to fabricate promising structures. Growth of deep (450 μm) trenches next to ordered macropore arrays was successfully achieved during photoelectrochemical etching. In addition, this approach allows in-situ realization of an efficient coupling scheme of low group velocity modes as well as manual separating of the gas sensor devices with sub-μm precision. Transmission through macroporous Si PhCs of several hundred pore rows has been achieved. Homogeneity issues related to this are also discussed.

Q 20.7 Di 12:10 HI

Tunable photonic crystal laser with integrated wavelength monitor — •Christian Ulzhöfer, Helmut Scherer, Martin Kamp, and Alfred Forchel — Technische Physik, Am Hubland, D-97074 Würzburg, Germany

We have investigated the integration of tunable photonic crystal (PhC) lasers with a wavelength monitor. The tunable lasers are based on two coupled PhC waveguides with slightly different length. PhC mirrors are