Q 59 Photonische Kristalle IV

Zeit: Donnerstag 11:10–12:55 Raum: HI

Q 59.1 Do 11:10 HI

Nicht-resonante Wechselwirkungen in nichtlinearen Photonischen Kristallen — •Johannes-Geert Hagmann[1], Lasha Tkeshelashvili[2] und Kurt Busch[1,2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe (TH) — [2]Institut für Nanotechnologie (INT), Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

Seit einigen Jahren sind nichtlineare Photonische Kristalle aufgrund ihrer zahlreichen Anwendungsmöglichkeiten Gegenstand vieler theoretischer und experimenteller Untersuchungen. Für Kristalle mit $\chi^{(2)}$-Nichtlinearität standen dabei bisher fast ausschliesslich Effekte im Vordergrund, die auf resonanten Wechselwirkungsprozessen beruhen, so zum Beispiel die Möglichkeit der Frequenzverdopplung.

Wir erweitern einen kürzlich veröffentlichten Formalismus [1] zur Beschreibung von Blochwellen in nichtlinearen Photonischen Kristallen am Beispiel eines $\chi^{(2)}$ Kristalls für den Fall, dass Drei-Wellen Resonanzbedingungen verletzt sind, und diskutieren einfache Wechselwirkungen anhand der vereinfachten dynamischen Gleichungen. Die vorgeschlagene Methode kann gleichsam auf nicht-resonante Prozesse höherer Ordnung angewendet werden.

[1] S.N. Volkov, J.E. Sipe; Phys. Rev. E **70**, 066621 (2004)

Q 59.2 Do 11:25 HI

Evolution of pulses in Kerr-nonlinear photonic crystals — •Sabine Essig[1], Lasha Tkeshelashvili[2,3], and Kurt Busch[1,2,3] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft — [3]DFG Forschungszentrum Center for Functional Nanostructures (CFN), Universität Karlsruhe

One-dimensional photonic crystals with Kerr-nonlinear constituent materials can become transparent for sufficient intense pulses with carrier frequencies in the band gap. In the stationary region, these pulses were numerically discovered by Chen and Mills and are known as gap solitons [1].

We investigate the formation of gap solitons in nonlinear photonic crystals from given initial pulses. The evolution of such pulses are described by the nonlinear coupled mode equations [2], which are non-integrable. In order to obtain insight into the behaviour of pulses in these systems, we extend the variational approach of Anderson for the (integrable) nonlinear Schrödinger equation [3] to the nonlinear coupled mode equations. We compare analytical results with numerical studies of the pulse evolution.

[1] W. Chen and D.L. Mills, Phys.Rev.Lett. **58**, 160 (1987)
[2] C.M. de Sterke and J.E. Sipe, in *Progress in Optics*, vol. XXXIII, p.203, edited by E. Wolf, Elsevier Sience, Amsterdam (1994)
[3] D. Anderson, Phys.Rev.Lett. **27**, 3135 (1983)

Q 59.3 Do 11:40 HI

Dramatic enhancement of nonlinear optical frequency conversion efficiency in one-dimensional photonic crystals — •Christiane Becker[1], Sean Wong[1], Georg von Freymann[1], and Martin Wegener[2] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, 76021 Karlsruhe — [2]Institut für Angewandte Physik, Universität Karlsruhe, 76131 Karlsruhe

Photonic crystals posses optical properties not present in any naturally occuring material. For nonlinear frequency conversion it is essential to have perfect phase matching between pumping and generated beams. In bulk material with normal dispersion the $\chi^{(3)}$-frequency conversion process $\omega_{\text{signal}} = 2\omega_{\text{pump}} - \omega_{\text{seed}}$ usually doesn't fulfill phase matching condition in collinear propagation geometry and thus stays very inefficient. In photonic crystals, however, phase matching can be achieved due to the anomalous dispersion near the photonic stop gap without being accompanied by strong absorption.

We present nonlinear FDTD-simulations using the Bloch equations with two ultrashort optical pulses of frequencies ω_{pump} and ω_{seed}, collinearly propagating through a 80 period dielectric stack. The parameters are chosen to match real experimental conditions. Tuning the strong ω_{pump}-pulse to the low-energy side of the photonic stop gap reveals perfect phase matching. This results in a great enhancement of the generated ω_{signal} beam, over that of a bulk reference sample, by two orders of magnitude.

Q 59.4 Do 11:55 HI

Photonic crystal waveguides in the IOSOI-material-system — •Daniel Pergande[1], Torsten M. Geppert[2], Alexey Milenin[2], Cecile Jamois[3], and Ralf B. Wehrspohn[1] — [1]Universität Paderborn, Dept. Physik, D-33095 Paderborn — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle — [3]Advanced Technology Institute, University of Surrey, Guildford, Surrey, GU2 7XH, UK

Optical waveguides are a basic elements of any kind of photonic devices. One of the major advantages of the IOSOI system is its compatibility with standard Si processes, allowing for the simultaneous integration of photonic and electronic devices on the same chip. The IOSOI-material system consists of a symmetrical slab-structure made of a thin silicon layer embedded in between two silica layers.

Photonic crystal waveguides are realized by RIE/ICP-etching of IOSOI. For a W1 waveguide, guided modes lying below the lightline exist. As a consequence, in theory nearly lossless propagation of light in the form of Blochmodes is possible.

First transmission measurements at 1.55 um on conventional ridge waveguides as well as corresponding PhC waveguides sucessfully realized in the IOSOI material system show very low losses. Furthermore, first broadband measurements were performed on the PhC waveguides and show PhC properties, such as a stopgap and a bandedge.

Q 59.5 Do 12:10 HI

FEM Investigation of Light Propagation in Hollow Core Photonic Crystal Fibers — •Jan Pomplun[1], Sven Burger[1], Ronald Holzlöhner[2], Roland Klose[1], Lin Zschiedrich[1], and Frank Schmidt[1] — [1]Zuse Institute Berlin, Takustraße 7, D - 14195 Berlin — [2]European Southern Observatory, Karl - Schwarzschild - Straße 2, D - 85748 Garching

Hollow core holey fibers are promising candidates for low-loss guidance of light in various applications, e.g., for the use in laser guide star adaptive optics systems in optical astronomy. We present an accurate and fast method for the computation of light modes in arbitrarily shaped waveguides. Maxwell's equations are discretized using vectorial finite elements (FEM). We discuss how we utilize concepts like adaptive grid refinement and higher order finite elements, and we investigate the convergence behavior of our methods. Further, appropriate transparent boundary conditions for the computation of leaky modes in photonic crystal fibers will be discussed.

Q 59.6 Do 12:25 HI

Supercontinuum generation in planar rib waveguides — •Anton Husakou[1], Olga Fedotova[2], and Joachim Herrmann[1] — [1]Max Born Institute, Max Born Str. 2a, 12489 Berlin, Germany — [2]Institute of Solid State and Semiconductor Physics, Brovki str. 17, 220072 Minsk, Belarus

Many applications in research and engineering require sources of coherent broadband radiation, so-called supercontinuum (SC). Here we study the perspectives for generating supercontinuum spectra in planar rib waveguide structures, which can enable simple SC source in the framework of integrated optics. We calculate the dispersion of the rib waveguide by the effective refractive index method. The propagation of the pulse in the rib waveguide is described numerically using first-order forward Maxwell equation without slowly-varying-envelope approximation and accounting for dispersion to all orders. In microstructure fibers, the supercontinuum generation in the anomalous dispersion range is connected with the splitting of the input pulse into several fundamental solitons, which emit phase-matched non-solitonic radiation. We show that this mechanism of SC generation is also effective in rib waveguides, because waveguide contribution to dispersion yields a broad range of anomalous dispersion. Due to the presence of two zero-dispersion wavelengths, non-solitonic radiation is emitted at both red- and blue-shifted wavelengths. As a result of our study we predict that for certain waveguides and input pulse parameters a 2-octaves-broad supercontinuum can be achieved in a planar rib waveguide.

Q 59.7 Do 12:40 HI

Mode interaction in coupled photonic crystal waveguides
— •Nico Schorr[1], Helmut Scherer[1], Martin Kamp[1], Alfred Forchel[1], Klemens Janiak[2], and Helmut Heidrich[2] — [1]Technische Physik, Am Hubland, D-97074 Würzburg, Germany — [2]Heinrich-Hertz-Institut, Einsteinufer 37, D-10587 Berlin, Germany

The intricate mode structure of photonic crystal (PhC) waveguides makes them versatile building blocks for applications such as spectral filters, power splitters and similar devices. We have investigated the interaction of modes in coupled PhC waveguides. The photonic crystal is realized as a hexagonal lattice of air holes etched into a planar waveguide layer. The waveguides are defined by three missing rows of holes from this lattice. They have a length of 30 lattice periods and are separated by PhC blocks with varying thickness (one to three rows of holes).

The structures are fabricated from passive InP/InGaAsP slab waveguides, which consist of a 420 nm thick quaternary waveguide core grown on an InP substrate and capped by a 200 nm thick InP cladding layer. The PhC patterns with periods in the range of 350 to 420 nm are etched to a depth of more than $3.5\mu m$ into the semiconductor. A tunable laser source ($\lambda = 1480 - 1580nm$) is used to probe the structures.

The power at the end of the original waveguide shows a clear drop in certain spectral regions, whereas the power in the coupled waveguide increases. This is caused by coupling of light from the fundamental waveguide mode to a higher order mode, which in turn transfers the light to the coupled waveguide.