probes for the study of the optical properties of photonic crystals. As an example, anisotropic light propagation in photonic crystals is measured by imaging a single quantum dot with defocused fluorescence microscopy. A numerical fitting procedure is applied to invert the obtained experimental results to the angular dependence of the photonic stop band. Models are presented how a fractional local optical density of states can be defined and how it influences the emission of single chromophores inside photonic crystals.

HL 22.7 Tue 15:45 H13

Thickness dependence of the optical properties of split ring resonator metamaterials — •Hongcang Guo[1], Na Liu[1], Liwei Fu[1], Heinz Schweizer[1], Stefan Kaiser[2], and Harald Giessen[1] — [1]4th Physics Institute, University of Stuttgart, Pfaffenwaldring 57, D-70550 Stuttgart, Germany — [2]1st Physics Institute, University of Stuttgart, Pfaffenwaldring 57, D-70550 Stuttgart, Germany

We study the thickness dependence of the resonant properties of split-ring-resonators (SRRs) in the optical regime using experiments and numerical simulations. It is shown that the so-called LC resonance frequency of an SRR increases with its thickness, rather than being constant as indicated by the inductor-capacitor (LC) circuit model. An equivalent cut-wire model based on plasmonic interpretation is applied to analyze the resonant behavior of SRRs, and good agreement between experiment and numerical simulation is obtained. It is proven that the plasmonic interpretation of metamaterials resonances is an appropriate model when studying SRR optical behavior.

[1]. C. Rockstuhl, F. Lederer, C. Etrich, T. Zentgraf, J. Kuhl, and H. Giessen, Optics Express 14, 8827 (2006). [2]. H. C. Guo, N. Liu, L. W. Fu, H. Schweizer, S. Kaiser, and H. Giessen, accepted in Phys. stat. sol. (b).

HL 22.8 Tue 16:00 H13

Phase-matched nondegenerate four-wave mixing in one-dimensional photonic crystals — •Christiane Becker[1,2], Martin Wegener[1,2], Sean Wong[1,2], and Georg von Freymann[1,2] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Postfach 3640, D-76021 Karlsruhe — [2]DFG-Center for Functional Nanostructures, Universität Karlsruhe (TH), D-76128 Karlsruhe

Photonic crystals are a promising class of materials for nonlinear optics. They posses an effective material dispersion relation of light that differs strongly from the dispersion of bulk material. Hence, the important phase matching condition for efficient frequency conversion can be achieved using photonic crystals while it is not possible using bulk material. We report on nondegenerate four-wave mixing in the near infrared using a one-dimensional chalcogenide-glass based photonic crystal. For 76 lattice constants, we find a 3.5-fold enhancement of the mixing signal with respect to the optimum-thickness bulk chalcogenide film. The key is the ability to tailor the dispersion relation of light in the photonic crystal, allowing for phase matching. Numerical calculations agree well with the experiments.

HL 22.9 Tue 16:15 H13

Novel photonic bio-sensors based on silicon nanostructures — •Dominic Dorfner, Ulrich Rant, Jonathan Finley, and Gerhard Abstreiter — Walter Schottky Institute, Garching, Germany

Silicon photonic nanostructures are of widespread interest for applications in integrated photonics. In particular, photonic crystal resonators confine light to ultra small volumes and exhibit cavity modes with high optical finesse. We take advantage of these properties to investigate bio-sensor applications based on the linear optical response of the system.

We use a silicon-on-insulator material system to establish 250nm thick freestanding membrane structures perforated with a triangular pattern of air-holes separated by 400nm. By decreasing the diameter of one hole, a cavity with an extremely small mode volume ($V < \frac{1}{2}(\frac{\lambda}{n})^3 \approx 0.01\mu m^3$) is formed. We characterized these structures with μ-photo-luminescence spectroscopy by covering the surface with colloidal PbSe quantum dots embedded in a polymer matrix. First experiments lead to a quality-factor $Q \approx 800$ and the dependence on geometric parameters is in excellent agreement to our calculations. Simulations predict a sensitivity of $\Delta n/n = 0.001$ to surface refractive index variation in aqueous environment upon covering 10nm of the membrane surface with bio-molecules. Since the sensitive area is in the range of μm^2 we predict a sensitivity approaching the single molecule regime.

Photonic crystal waveguide resonators enable bio-functionalization techniques on the surface and offer a unique possibility to carry out research on the interaction of photons with single bio-molecules.

HL 22.10 Tue 16:30 H13

Characterization of metamaterials based on split-ring-resonators — •Pia Weinmann, Martin Kamp, and Alfred Forchel — Technische Physik, Am Hubland, D-97074 Würzburg

Negative index materials are materials which have a negative permeability and permittivity in a certain frequency range. These metamaterials have recently attracted considerable attention due to their fascinating optical properties and potential applications. The challenge in realizing such metamaterials is to achieve a negative magnetic response. One possible approach is based on U-shaped Split-Ring-Resonators (SRR), which effectively operate as small LC-oscillators. The resonance of these structures leads to a negative effective permeability. In order to act as an effective medium, the spacing of the resonators has to be much smaller (usually a tenth) of the desired resonance wavelength. The resonace wavelength can be controlled by adjusting the dimensions of the Split-Ring-Resonators. We have investigated different resonator structures with magnetic resonances in the mid IR region. The structures were fabricated on silicon substrates by E-beam lithography, evaporation of gold and lift-off. The transmission of the samples in the range from 1.5 to 8μm was measured using a Fourier-Transform Infrared Spectrometer. Measurements on SRRs with different sizes and geometries show a clear dependence of the LC-resonance on structural dimensions. We have also investigated structures consisting of two gold wires separated by an insulating layer, which also provide the desired magnetic resonance.

HL 23: Spin controlled transport II

Time: Tuesday 14:00–16:00 Location: H14

HL 23.1 Tue 14:00 H14

Electrical detection of donor Rabi flops — •Hans Huebl[1], Andre Stegner[1], Felix Hoehne[1], Christoph Boehme[2], Klaus Lips[3], Martin Stutzmann[1], and Martin Brandt[1] — [1]Walter Schottky Institut, Garching, Germany — [2]University of Utah, Salt Lake City, USA — [3]Hahn Meitner Institut, Berlin,Germany

Due to its potential compatibility with existing microelectronics, the proposal for a silicon based quantum computer by Kane is being pursued intensively. In this concept, the nuclear spins of single ^{31}P donors serve as qubits. Exchange coupling between donor-bound electrons, whose spins experience hyperfine interaction with their nuclei enables two and more qubit operations. An experimentally unsolved key issue is the readout of the ^{31}P quantum state. We demonstrate the measurement of the spin state of ^{31}P donor electrons in silicon and the observation of Rabi flops by purely electric means, carrying out pulsed electrically detected magnetic resonance experiments (pEDMR). Resonant microwave pulses are used to induce coherent manipulation of an ensemble of ^{31}P electron spins by electron spin resonance. The resulting change of spin-dependent charge-carrier recombination between the ^{31}P donor and paramagnetic localized states at the silicon surface is then detected by a transient photoconductivity measurement after the coherent excitation is turned off. The electron spin information is shown to be coupled through the hyperfine interaction to the phosphorus nucleus, suggesting that recombination-based readout of nuclear spins is feasible.

HL 23.2 Tue 14:15 H14

Fast polarization switching in room temperature Spin-VCSEL — •Stephan Hövel[1], Nils Gerhardt[1], Martin Hofmann[1], Fang-Yuh Lo[2], Dirk Reuter[2], and Andreas Wieck[2] — [1]Optoelectronic Devices and Materials, Ruhr-University Bochum, IC2/133, Universitätsstr. 150, 44780 Bochum, Germany — [2]Applied