Q 60: Photonics III

Time: Friday 10:30–12:30 Location: F 128

Q 60.1 Fr 10:30 F 128

Nanophotonic Interactions of Resonant Cesium Atoms with 3D Opal Photonic Crystals — •Pepijn Pinkse[1], Philip Harding[1], Allard Mosk[1], and Willem Vos[1,2] — [1]Mesa+ Institute for Nanotechnology, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands — [2]FOM-AMOLF, Amsterdam, The Netherlands

We have introduced hot Cs vapor in a silica opal photonic crystal to observe novel nanophotonic properties. In comparison to dyes and quantum dots, gaseous alkali atoms are better understood and have strong and very narrow resonances $\omega/d\omega = 10^7$. As the temperature is increased, we observe shifts of the opals reflectivity peak in excess of 20%, which is attributed to the reduction of the silica to SiOx. This shift tunes the frequency of the photonic bands relative to the near-infrared Cs D1 transition. Simultaneously, the Cs resonances undergo dramatic changes in strength, off-resonance reflectivity, and shape. The results are in good agreement with a transfer-matrix model including the dispersion and absorption of two of the Cs hyperfine transitions.

Q 60.2 Fr 10:45 F 128

Applications of Selectively Filled Photonic Crystal Fibers — •Marius Vieweg, Timo Gissibl, and Harald Giessen — 4th Physics Institute, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Filling the holes of a photonic crystal fiber with different media has gained a lot of interest in the recent past for several different optical applications. With our method we are now able to close and fill the fibers selectively with different liquids. There are numerous possible applications for this new optical device. As two examples we present first a single-strand structure embedded in a standard photonic crystal fiber. Here we could measure spectral broadening due to self-phase modulation. As a second example we present a more complex structure. Several single holes infiltrated with a liquid form a liquid waveguide array, in which the waveguides are separated from each other by unfilled holes. We present here the linear propagation as well as coupling effects. For further applications it is possible to tailor the dispersion properties, the nonlinearity, as well as the spatial arrangement of the waveguides for nonlinear light propagation in two-dimensional discrete optical systems.

Q 60.3 Fr 11:00 F 128

Broadband electro-optic modulation in hybrid silicon-organic photonic crystals — •Stefan Prorok[1], Jan Hendrik Wülbern[1], Jan Hampe[1], Alexander Petrov[1], Manfred Eich[1], Jingdong Luo[2], Alex K.-Y. Jen[2], Andrea Di Falco[3], and Thomas F. Krauss[3] — [1]Hamburg University of Technology, Eissendorfer Str. 38, D-21073 Hamburg, Germany — [2]Department of Materials Science and Engineering, University of Washington, Seattle, Washington 98194-2120, USA — [3]School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews KY16 9AJ, Scotland

Electrically driven modulation of the optical properties of silicon based photonic devices so far relies on the refractive index change resulting from the modulation of carrier density in silicon either by carrier depletion, injection or accumulation. The achievable modulation speeds using these methods is limited by the time constants by which the carriers can be injected into or removed from the area of the optical mode. In nonlinear optical (NLO) polymers however, the electro-optic effect originates from the electronic hyperpolarisability of the organic molecules, which allows extremely high modulation speeds. Photonic devices based on a hybrid material system merging silicon and polymer are therefore attractive since they combine the strong light confining abilities of silicon with the superior NLO properties of polymers. Here we present a compact and ultra fast electro-optic modulator based on slotted photonic crystal waveguide that can be realized in two dimensional slabs of silicon as core material employing a nonlinear optical polymer as infiltration and cladding material. A Klopfenstein-taper like electrode structure is used to provide an external modulation signal to the slotted waveguide. The taper like structure yields an increased field strength of the modulation signal. The optical field enhancement in the slotted region increases the nonlinear interaction with the external electric field. Using this kind of setup we demonstrate electro-optic modulation up to 40 GHz at a driving voltage of approximately 1 Volt.

Q 60.4 Fr 11:15 F 128

Simulation analysis of one-dimensional photonic crystal Fabry-Perot filters — •Aws Al-Saadi[1], Bülent A. Franke[1], Shaimaa Mahdi[1], Sigurd Schrader[2], Viachaslau Ksianzou[2], Harald Richter[2], Stefan Meister[1], and Hans J. Eichler[1] — [1]Technische Universität Berlin, Institut für Optik und Atomare Physik, Berlin, Germany — [2]Technische Fachhochschule Wildau, Institut für Plasma- und Lasertechnik, Wildau, Germany

We present 3-D FDTD simulation results to specify the relevant parameters of photonic bandgap (PBG) structures in asymmetric strip waveguide. These mandatory simulations act as pre-processing step before CMOS fabricating of a one-dimensional photonic crystal (PhC) Fabry-Perot filters on a Silicon-on-Insulator (SOI) wafer. The microcavity filters were formed by holes inside of the stripe waveguide. Tuning the Fabry-Perot filter parameters (holes diameter, holes number and cavity length) which make effects on the transmission characteristics (center wavelength, spectral bandwidth, maximum transmission) were investigated. Influence of first and higher order cavity length as well as the number of cavities on the filter spectral shape was analyzed. Finally, in order to achieve the desired spectral shape of the filter function for several applications, a number of different cavities were designed and investigated. Simulation spectral results of the designed filters will be compared to the measurement results.

Q 60.5 Fr 11:30 F 128

Low temperature studies of near-infrared single-photon emitters in nanodimonds — •Petr Siyushev[1], Vincent Jacques[1], Igor Aharonovich[2], Florian Kaiser[1], Tina Müller[3], Laurent Lombez[3], Mete Atatüre[3], Stefania Castelletto[2], Steven Prawer[2], Fedor Jelezko[1], and Jörg Wrachtrup[1] — [1]3.Physikalisches Institut, Universität Stuttgart, D-70550 Stuttgart, Germany — [2]School of Physics, University of Melbourne, VA 3010, Australia — [3]Cavendish Laboratory, University of Cambridge, Cambridge CB3 0HE, UK

Source of indistinguishable single photons is a key requirement for the development of the linear quantum computing and large distance entanglement protocols. Such sources have been already demonstrated using molecules, single atoms, semiconductor quantum dots, and PDC.

Most of the color centers in diamond, including NV defects, have the strong disadvantage: their spectrally broad emission band. In contrast to them, the near-infrared defects in nanodiamonds under consideration emit light concentrated in the zero-phonon line. Beside that, the radiative lifetime is in the nanosecond range and the emission is perfectly linearly polarized. The spectral stability of infrared defects is then investigated using resonant excitation at the zero-phonon line. Although Fourier-transform emission was not achieved, our results show that it might be possible to use consecutive photons emitted by infrared defects in diamond nanocrystals to perform two photon interference experiments, which is at the heart of linear quantum computing protocols.

Q 60.6 Fr 11:45 F 128

Confocal microscopy and magneto-optical properties of cerium-doped YAG nanoparticles — •Roman Kolesov, Rolf Reuter, Fedor Jelezko, and Jörg Wrachtrup — 3. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, Stuttgart, D-70569

Fluorescent and magneto-optical properties of cerium-doped yttrium aluminium garnet (YAG) nanoparticles are studied by means of confocal microscopy under ambient conditions. It is shown that Ce:YAG nanoparticles exhibit very bright fluorescence which makes them perfect photostable fluorescent biomarkers. In addition, all-optical manupulation and detection of cerium electron spin is confirmed by measuring optically-induced magnetization and fluorescence quantum beats. Photon correlation measurements show that creation of a single emitting cerium center is feasible, therefore, making it a good candidate for all-optically addressable spin qubit.

Q 60.7 Fr 12:00 F 128

Single-Photon Imaging and Efficient Far Field Coupling to

Single Plasmons — •Robert Lettow, Philipp Kukura, Michele Celebrano, Mario Agio, Stephan Goetzinger, and Vahid Sandoghdar — Laboratory of Physical Chemistry and optETH, ETH Zurich, CH-8093 Zurich, Switzerland

Coupling of light to a dipolar radiator is one of the most fundamental problems of light-matter interaction. Recent theoretical studies have predicted more than 80% extinction of a focused classical Gaussian beam by a single dipolar radiator [1]. In this talk, we show that single photons can be efficiently coupled to a dipole, realized by a single silver nanoparticle. As single photon sources we used dye molecules at cryogenic temperatures, which emit more than one million Fourier-limited photons per second [2, 3]. We used an interferometric technique in a confocal arrangement to image single silver nanoparticles excited by single photons both in transmission and reflection [4]. Since the scattered photons have been produced via an interaction with plasmons in the nanoparticle, our experimental arrangement provides an efficient way to excite and investigate single quantized plasmons. We discuss the prospects of our experimental arrangement for the efficient coupling of single photons to single molecules.

[1] G. Zumofen, et al., Phys. Rev. Lett. 101, 180404 (2008) [2] R. Lettow, et al., Optics Express 15, 15842 (2007). [3] V. Ahtee, et al., J. Mod.Opt. 56, 161-166 (2009) [4] M. Celebrano, R. Lettow, P. Kukura, M. Agio S. Götzinger, V. Sandoghdar, submitted.

Q 60.8 Fr 12:15 F 128

Assembly and coupling of diamond nanocrytsals to photonic- and plasmonic nanostructures — •Andreas Schell, Thomas Aichele, and Oliver Benson — Humboldt-Universität zu Berlin, Institut für Physik, Nanooptik, Berlin, Germany

The controlled assembly of single quantum emitters, metal nanoantennas, and micro-resonators to nano-photonic structures are attractive for quantum-optical building blocks in integrated photonic circuits. Surface plasmon polaritons (SPPs) in metal nanoparticles and -wires can concentrate and guide electromagnetic energy in volumes much smaller than the corresponding wavelength, providing intense interaction between light and matter.

We have prepared samples with gold and silver nanowires (NWs) as SPP waveguides. Diamond nanocrystals including NV defect centers as single-photon sources where first optically characterized on a separate substrate. Using the tip of an AFM, the emitter was transferred to the NW sample and placed next to a selected NW with high precision. After excitation, single photon emission directly from the emitter, as well as from each end of the NW was observed, confirming the excitation of single SPP in the waveguide. In further steps, the same emitter was moved to various locations with respect to the NW, in order to test the local plasmonic coupling. In this way, the behavior of one emitter in variable model configurations could be studied, while excluding effects arising from inhomogeneous distributions when using several emitters. The composition of more complex systems of metal nanostructures and single quantum-emitters will be discussed, as well.