Q 63: Photonics IV

Time: Friday 14:00–16:00 Location: F 128

Q 63.1 Fri 14:00 F 128

On-chip optical isolation based on non-reciprocal resonant delocalization effects — •Ramy El-ganainy[1], Pradeep Kumar[2], and Miguel Levy[2] — [1]Max Planck Institute for the Physics of Complex Systems, Nothnitzer street 38, 01187 Dresden, Germany — [2]Department of Physics, Michigan Technological University, Houghton, Michigan 49931

Optical isolators are very essential components in most optical systems. These devices operate as optical diodes- allowing light to propagate only in one direction and block any reflected signal. We propose a novel optical isolator device design that is based on integrated optics waveguide technology. The proposed device consists a modulated optical Bloch lattice that exhibits a refractive index ramp and periodic coupling constants between next neighbor optical channels along the propagation direction. Non-reciprocal resonant delocalization effects are introduced in these structures by depositing magnetic cover layer on top of the waveguides. Our analytical and numerical results show that large bandwidth high isolation ratios of -45 dB can be achieved at the telecommunication wavelength

Q 63.2 Fri 14:15 F 128

High Aspect Ratio Micro-Rod Arrays as 2D Photonic Crystal Structures — •Christian Kraeh[1], Markus Schieber[2], Alexandru Popescu[2], Harry Hedler[2], Martin Zeitlmair[1], and Jonathan Finley[1] — [1]Walter Schottky Institut, Technische Universität München, 85748 Garching — [2]Siemens AG, Corporate Technology, 81739 München

We are developing novel photonic crystal structures made of high aspect ratio micro-rod arrays. The fabrication of these rods is based on the creation of macroporous Si by a wet-chemical etching technique and subsequent filling of the pores and selective etching of the Si substrate. Due to their high aspect ratio the rods exhibit almost ideal 2D optical properties. Simulations show that they can be used as optical bandgap materials.

A potential application of these structures is a photonic crystal based gas detection system in which the photonic crystal is used to reduce the optical absorption path.

Q 63.3 Fri 14:30 F 128

Photonic Crystals for Improved Light Extraction from Scintillators: Impact of Scintillator Parameters — •Christof Thalhammer[1], Alexandru Popescu[2], Harry Hedler[2], and Thoralf Niendorf[1] — [1]Berlin Ultrahigh Field Facility (B.U.F.F.), Max-Delbrueck Center für Molekulare Medizin, Berlin — [2]Corporate Technology, Siemens AG, München

Photonic crystals bear the potential to improve the light extraction from scintillator crystals used in high energy physics and medical imaging applications. Because of their periodic structure with dimensions in the range of the wavelength of incident light, photonic crystals can manipulate photon propagation in a significant way. In this study, Rigorous Coupled Wave Analysis has been used in conjunction with Monte Carlo simulations to investigate the performance of two-dimensional photonic crystal coatings for various scintillator configurations, including different geometries and crystal wrappings. Their impact on the detector performance is discussed and preparations of the experimental verification are presented.

Q 63.4 Fri 14:45 F 128

Effect of Domain Shape on Noncollinear Second-Harmonic Emission in Disordered Quadratic Media — •Markus Passlick[1], Mousa Ayoub[1], Philip Roedig[1], Kaloian Koynov[2], Jörg Imbrock[1], and Cornelia Denz[1] — [1]Institut für Angewandte Physik Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany — [2]Max Planck Institut für Polymerforschung, 55128 Mainz, Germany

Nonlinear parametric processes are known to depend critically on phase matching between the phase velocities of the interacting waves. Phase matching is mostly achieved using conventional methods like crystal birefringence in homogeneous nonlinear optical media, or quasi-phase matching technique in periodically poled media. Recently, randomly structured multi-domain media have attracted a lot of interest for frequency conversion, because they allow a tunable phase-matched second-harmonic generation (SHG) practically in the whole transparency range of the crystal. However, these applications require adapted methods of phase matching. In this contribution, we study the role of the individual ferroelectric domain shape in SH emission in strontium barium niobate (SBN). The noncollinearly emitted SH signal is scanned in the far-field at different incident angles for different domain size distributions. This offers a possibility to retrieve the distribution of the Fourier coefficients, corresponding to the spatial domain distribution and the domain shape. Based on microscopic images of domain structures in SBN, domain patterns are simulated, the SH intensities are calculated, and finally compared with the measurements.

Q 63.5 Fri 15:00 F 128

Polarization of Random-Lasing Modes under Weak Localization — •Sebastian Knitter, Michael Kues, Michael Haidl, and Carsten Fallnich — Westfälische Wilhelms-Universität Münster

When the diffusive losses induced by strong scattering in a random optical medium are compensated by gain, a recurrent stimulated amplification can arise. The resulting coherent light field is often referred to as "Random-Lasing" (RL) and is associated with narrow peaks atop the regular fluorescence spectrum of the amplifying component [1].

By using a novel single-shot spectro-polarimetric technique [2], we have shown earlier how the emission polarization of weakly scattering organic-dye RL can be manipulated [3] (mean free path $l_t > 100$ μm). Our most recent study however, is concerned with RL modes in the weakly-localized regime (l_t of a few μm). Here a static assembly of Zinc oxide nanoparticles was used to provide strong scattering and amplification at the same time.

An excitation of the medium with ps-pulses at 355 nm lead to sharp RL modes, which reproduced very well in spectrum and polarization over more than 2000 pump-laser shots. The exact shape of the emission spectra was characteristic to any given sample position. Also the RL mode-polarization and spectrum were strongly affected by the pump polarization, as expected from FDTD-simulations.

[1] H. Cao et al., Journal of Physics A, 38 (2005)
[2] S. Knitter et al., Opt. Lett., 36, 16 (2011)
[3] S. Knitter et al., Opt. Lett., 37, 17 (2012)

Q 63.6 Fri 15:15 F 128

Numerische Untersuchungen zu anisotrop verstärkten laseraktiven randomisierten Medien — •Michael Haidl, Michael Kues, Sebastian Knitter und Carsten Fallnich — Instititut für Angewandte Physik, Westfälische Wilhelms-Universität, Münster, Deutschland

In konventionellen Lasern formen Spiegel zur optischen Rückkopplung einen Resonator, der durch optische Verstärkung aufgrund von stimulierter Emission entdämpft und zur Oszillation angeregt wird. Bei Random Lasern erfolgt die Rückkopplung z.B. durch streuende Partikel.

Mittels einer dreidimensionalen numerischen Simulation konnte erstmals der Einfluss anisotroper Verstärkung, wie sie etwa in flüssigen Farbstoffen [1] oder Halbleitermaterialien wie Zink-Oxid [2] existiert, auf Emissionsspektren sowie die Polarisation spektraler Moden von Random Lasern berechnet werden. Die Spektren zeigen eine Abhängigkeit von der Anisotropie der Verstärkung, die im Experiment über die Polarisation der Pumpstrahlung eingeht und eingestellt werden kann. Experimentelle Ergebnisse [1] konnten mit Hilfe der numerischen Untersuchungen bestätigt werden. Darüber hinaus wurden klare Unterschiede im Verhalten der Polarisation spektraler Moden zwischen dem diffusiven und dem schwach lokalisierten Regime festgestellt.

[1] S. Knitter *et al.*, Optics Letters **37**, 17 (2012)
[2] R. Klucker *et al.*, Phys. Stat. Sol. (b) **45**, 265 (1971)

Q 63.7 Fri 15:30 F 128

Anderson localization in optically induced photonic random structures — •Sebastian Brake, Martin Boguslawski, Patrick Rose, and Cornelia Denz — Institut für Angewandte Physik and Center for Nonlinear Science (CeNoS), Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Anderson localization is one of the most intriguing effects in solid state physics where an electron may be localized in dependence on the disorder of the surrounding crystal lattice. Since the effect is based on wave phenomena, Anderson localization has recently been discovered for light waves in several systems as e.g. random granular media.

In this contribution, we demonstrate light localization in optically induced two-dimensional photonic random lattice structures. Using the so-called optical induction technique, we are able to create reconfigurable refractive index patterns in a nonlinear optical medium. In contrast to previous realizations, our approach is based on a computer-controlled spatial light modulator that is used to generate structured nondiffracting beams with a tremendous flexibility. This class of beams that provides complex transverse intensity structures while being invariant in the direction of propagation is the foundation of our flexible approach for the generation of complex random structures.

We report our results on the experimental observation of Anderson localization in these structures and show how the localization can be controlled. We find that the localization length depends both on the strength of the refractive index modulation as well as on the structural size of the induced photonic random structure.

Q 63.8 Fri 15:45 F 128

3D Photonic Crystals from Rolled Membranes — •Silvia Giudicatti, Matthew R. Jorgensen, and Oliver G. Schmidt — Institute for Integrative Nanosciences, IFW-Dresden, Helmholtzstrasse 20, D-01069 Dresden, Germany

Photonic crystals are periodically patterned dielectric materials which allow the control of light thanks to forbidden frequencies ranges (photonic band gaps). Their properties make them interesting candidates for a large number of applications, such as the control of spontaneous emission for light amplification, lasing, quantum information, photovoltaics and photocatalysis. In particular, 3D photonic crystals promise to offer unprecedented opportunities. However, their fabrication requires sophisticated methods that mainly allow the preparation of devices suitable for applications in the near infrared and longer wavelengths. Regarding visible frequencies, examples are limited to partial band gap materials and those templated from biological samples.

We propose 3D photonic crystals achieved by applying rolled-up technology to pre-patterned 2D membranes. A combined control of the structural parameters such as the membrane thickness and composition, the geometry of the 2D lattice and the rolling direction makes a variety of crystal families accessible. Among them, the diamond structure can also be obtained. A theoretical investigation has been carried out to identify the structural parameters resulting in the best band gap. The effects of the finite size as well as the bending have been also considered. The results of the theoretical analysis will be presented together with some preliminary tests for the system fabrication.