Q 64 Photonische Kristalle V

Zeit: Donnerstag 14:00–16:00 Raum: HI

Q 64.1 Do 14:00 HI

3D photonic quasicrystals for near-infrared frequencies — •A. LEDERMANN[1], M. WEGENER[1], L. CADEMARTIRI[2], G. A. OZIN[2], D. WIERSMA[3], and G. VON FREYMANN[4] — [1]Institut für Angewandte Physik, Universität Karlsruhe (TH), 76128 Karlsruhe — [2]Department of Chemistry, University of Toronto, 80 St. George Street, Toronto, Ontario, M5S 3H6, Canada — [3]European Laboratory for Nonlinear Spectroscopy and INFM-Matis, 1.50019-Sesto Fiorentino, Firenze, Italy — [4]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, 76021 Karlsruhe

Photonic quasicrystals (PhQCs) are deterministically generated structures without translational symmetry. As intermediate organization state between random materials and photonic crystals (PhCs) PhQCs are expected to provide yet richer physics than "normal" PhCs. Furthermore, PhQCs are expected to open complete band-gaps for lower index contrasts than expected for conventional PhCs. Besides these properties, which can be probed in microwave model experiments [1], even in perfect PhQCs a mixture of diffusive and ballistic transport channels as well as localized modes are expected. For corresponding experiments with pulsed laser sources, optical properties should lay in the near-infrared. Here we present for the first time PhQCs fabricated via direct laser writing [2] in photoresist. These structures are characterized by optical diffraction measurements. Comparison of these data with theory reveals the ten-fold symmetry expected for three-dimensional icosahedral PhQCs.

[1] W. Man et al., Nature **436**, 993 (2005)
[2] M. Deubel et al., Nature Mater. **3**, 444 (2004)

Q 64.2 Do 14:15 HI

3D-2D-3D photonic crystal heterostructures by direct laser writing — •M. DEUBEL[1], M. WEGENER[1], S. JOHN[2], S. LINDEN[3], and G. VON FREYMANN[3] — [1]Institut für Angewandte Physik, Universität Karlsruhe (TH), 76128 Karlsruhe — [2]Department of Physics, University of Toronto, 60 St. George Street, Toronto, Ontario, M5S 1A7, Canada — [3]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, 76021 Karlsruhe

In 2D photonic crystals, radiation losses into the third dimension pose fundamental performance limitations. These limitations can be overcome in 3D-2D-3D photonic crystal heterostructures, comprising waveguides etc. in the 2D layer. This architecture allows for the incorporation of several parallel 2D layers, leading to a true three-dimensional photonic circuitry.

Here we use direct laser writing [1] for the fabrication of corresponding photoresist templates. Combined with the recent breakthrough of silicon double inversion of polymeric templates [2] leading to the required high-index contrast structures, our work provides a starting point for the realization of the above challenging architectures.

To assess the optical quality of such structures, we have performed normal and oblique incidence transmittance spectroscopy. This reveals a peak related to the Fabry-Perot mode of the 2D structure clad between two 3D photonic crystal "mirrors". A direct comparison with calculated transmittance spectra reveals good agreement.

[1] M. Deubel et al., Nature Mater. **3**, 444 (2004)
[2] N. Tétreault et al., Adv. Mater., DOI:10.1002/adma.200501674

Q 64.3 Do 14:30 HI

Direct-writing of 3D photonic crystals by two-photon polymerization technique — •ALEKSANDR OVSIANIKOV, NIR GROSSMAN und BORIS CHICHKOV — Laser Zentrum Hannover e.V, Hollerithallee 8, 30419 Hannover

In this contribution, we present our recent results on the fabrication of arbitrary shaped 3D photonic crystal using 2PP technique. Flexibility of this technique enables realization of wide range of different 3D topologies, and in contrast to other approaches it is not limited to layer by layer structures. Fabricated woodpile and spiral 3D photonic crystal structures will be demonstrated and investigations of their optical properties will be reported.

Q 64.4 Do 14:45 HI

Herstellung von photonischen Kristallen mit hohem Aspektverhältnis in Lithiumniobat — •HOLGER HARTUNG[1], THOMAS GISCHKAT[2], FRANK SCHREMPEL[2], ERNST-BERNHARD KLEY[1] und ANDREAS TÜNNERMANN[1] — [1]Institut für Angewandte Physik Universität Jena — [2]Institut für Festkörperphysik Universität Jena

Die Herstellung periodischer Strukturen zur Erzeugung einer photonischen Bandlücke erfordert eine gute Kontrollierbarkeit von Periodizität, Größe und Form der Strukturen. Für die Herstellung von photonischen Kristallen in Gläsern liefern herkömmlichen Verfahren wie Trockenätzen ausreichend gute Ergebnisse. Lithiumniobat zeigt gegenüber diesen Verfahren jedoch eine hohe Widerstandsfähigkeit und die Anwendung dieser Verfahren führt zu unbefriedigenden Ergebnissen, insbesondere zu einer schlechten Formtreue. Wir präsentieren ein Verfahren, welches zur Herstellung von photonischen Kristallen in Lithiumniobat verwendet werden kann. Dieses Verfahren zeigt eine hervorragende Formtreue der hergestellten Strukturen. Der Herstellungsprozess teilt sich in eine Amorphisierung des Lithiumniobats durch Ionenbestrahlung und nasschemisches Entfernen der amorphisierten Bereiche.

Q 64.5 Do 15:00 HI

Identifying structural Parameters of 3D laser holographic structures through scattering matrix simulations — •MARCUS DIEM[1,2,3], DANIEL C. MEISEL[3,4], MARTIN WEGENER[3,4], and KURT BUSCH[1,2,3,5] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [2]DFG Forschungszentrum Center for Functional Nanostructures (CFN), Universität Karlsruhe — [3]School of Optics/CREOL & Department of Physics, University of Central Florida, Orlando, USA — [4]Institut für Angewandte Physik, Universität Karlsruhe — [5]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

In the case of laser holographic Photonic Crystals(PC) numerous parameters influence the shape of the structure[2].
We employ a Scattering Matrix approach[1] to calculate the transmission and reflection properties of three-dimensional finite-size PCs. The efficiency of our numerical method enables us to study theoretically the impact of those parameters on angle and frequency resolved transmission properties.
By directly comparing our theoretical results with measurements from recently produced samples[3], we were able to identify deviations in the structural parameters from the desired ones. With this knowledge the fabrication process could be improved.

[1] D.M. Whittaker and I.S. Culshaw, Phys. Rev. B **60**,2610 (1999)
[2] R.C. Rumpf and E.G. Johnson, JOSA **21**, 1704 (2004)
[3] D. C. Meisel et al.,PECS-VI, Aghia Pelaghia (Greece), 2005

Q 64.6 Do 15:15 HI

Preparation and Characterization of Carbon Opals — •BETTINA FRIEDEL and SIEGMUND GREULICH-WEBER — Universität Paderborn, Department Physik, Warburger Str.100, 33098 Paderborn

3D photonic crystals for the visible spectral range are preferably fabricated from silica or plastic submicrospheres via self-assembling. Due to their insufficient refractive index such opals do not reveal complete photonic bandgaps. Therefore contemporarily research is focused on investigation suitable high index materials for infiltration of the interparticle voids of opals, followed by removal of the spheres. Compared to present high interest in these inverted opals, there is relatively low activity in development of new spherical particles. Higher refractive index, thermal resistance or supplementary properties, such as electrical conductivity could result in colloidal crystals, which meet desired requirements. We propose carbon as suitable material, because of its optical, electric and thermal properties. We have prepared monodisperse, smooth surfaced, submicron-sized carbon spheres, via pyrolysis of melamine-formaldehyde. These are stable even above 1200°C, offering a suitable template for inverse opals that require high temperatures, e.g. special ceramics. We will present our results on carbon spheres properties as well as on optical characterization of colloidal crystals.

Q 64.7 Do 15:30 HI

Recent progress in silicon double inversion of three-dimensional polymer photonic crystal templates — •Martin Hermatschweiler[1], Markus Deubel[1,2,3], Martin Wegener[1,2,3], Fabian Pérez-Willard[3], Nicolas Tétreault[4], Geoffrey A. Ozin[4], and Georg von Freymann[3] — [1]Institut für Angewandte Physik, Universität Karlsruhe (TH), 76128 Karlsruhe — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, 76021 Karlsruhe — [3]CFN, Universität Karlsruhe (TH), 76128 Karlsruhe — [4]Department of Chemistry, University of Toronto, Toronto, Ontario M5S 3H6, Canada

We present recent progress in converting polymer templates into 3D silicon (Si) photonic crystals (PCs) by using a silicon-double-inversion procedure [1]. This has led to Si woodpiles with both improved structural and optical quality. In a first step the polymer template is infiltrated with amorphous silica by applying atomic layer deposition (ALD). After removal of the silica cap layer via reactive ion etching (RIE) the polymer is either combusted or etched in air plasma, which results in a silica inverse woodpile. Now, ALD can be repeated in order to fine-tune the filling fraction of the resulting Si PC, thereby allowing optimization of the photonic bandgap. Next the woodpile is infiltrated with Si by chemical vapor deposition with disilane as the precursor. Again, the Si cap layer is removed by RIE. Wet etching with a few drops of 1% HF placed on the structure finally double-inverts the original template into its Si replica. The original substrate is kept during all process steps, thus paving the way for in-plane optical characterization of three-dimensional Si PCs.

[1] N. Tétreault et al., Adv. Mater., DOI: 10.1002/adma.200501674

Q 64.8 Do 15:45 HI

Transparent and high refractive index coatings polymerized by UV lithography and/or two-photon polymerization used for photonic applications — •Pélagie Declerck[1], Ruth Houbertz[1], Carsten Reinhardt[2], and Boris Chichkov[2] — [1]Fraunhofer-Institut für Silicatforschung ISC, Neunerplatz 2, 97082 Würzburg, Germany — [2]Lazer Zentrum Hannover LZH, Hollerithallee 8, 30419 Hannover, Germany

High refractive index inorganic-organic hybrid materials were synthesized by hydrolysis/polycondensation reactions of organoalkoxysilanes and titanium or zirconium alkoxide precursors. The organic moieties used for organically functionalizing the inorganic-oxidic units allow one to polymerize the materials directly either by UV lithography or by two-photon polymerization (2PP) processes. Both processes require a photoinitiator which is added to the resins and absorbs in the UV (λo) and the NIR (2λo), respectively. The materials have to absorb in the UV regime, while for the 2PP process, they have to be highly transparent at the laser wavelength (780 to 840 nm). The parameters influencing the refractive index such as kind and amount of organoalkoxysilanes, amount of hetero element alkoxide, concentration of the catalyst, and the curing temperatures for coatings were investigated. The properties of the synthesized hybrid materials and the resulting layers were characterized by spectroscopic and microscopic methods. Besides, experiments on the technological processing of the resins were carried out in order to determine their ability to be patterned by UV light and by 2PP processes, respectively.