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Focusing microwaves with a concave lens based on a 2D photonic crystal — •E. Foca[1], S. Frey[1], F. Daschner[1], V.V. Sergentu[2], J. Carstensen[1], R. Knöchel[1], I.M. Tiginyanu[2] und H. Föll[1] — [1]Faculty of Engineering, Christian-Albrechts-University, Kiel, Germany — [2]LLDSP, Technical University of Moldova, Chisinau, Moldova

Photonic crystals (PC) can be considered as optically homogenous materials for the long wave length limit, thus they can be ascribed an effective electric permittivity, and an effective refractive index. However, it is more complicated when the radiation wavelength is comparable with the PC irregularities. Even in this regime there remain frequency regions where the PC can be attributed an effective refractive index.

We present a new method to find the effective refractive index of a PC in non-trivial regimes, especially for the case of $0 < n_{eff} < 1$. We prove the correctness of our calculations by designing and measuring a concave lens with a $0 < n_{eff} < 1$ in the microwave regime. For such a case the lens focuses the radiation and we measured that this is indeed the case. We show a good correlation between the theoretical predictions and measured data and a good focusing quality of the lens. We estimate the focusing power of the lens in terms of the transmission coefficient that reaches values as high as 40 for frequencies close to 7.5 GHz, which is extremely good since nearly no other tool for focussing of microwaves exists.

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Selective Thermal Emitters in 2D Photonic Crystals — •B. Gesemann, M. Milbradt, A. von Rhein, S.L. Schweizer, and R.B. Wehrspohn — Universität Paderborn, Department Physik, Warburger Str. 100, 33098 Paderborn

We study the fabrication and optical properties of thermal emitters placed directly into the holes of a 2D-Photonic Crystal. The influence of the photonic band structure and DOS on the emission characteristics of the emitter is analyzed theoretically. For the realisation, we use Fe_2O_3 nanoparticles as inductive heaters which are selectively infiltrated into 2D macroporous silicon photonic crystals. We present structural and optical characterisation of the infiltration.

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High quality opals from organic-inorganic material — •Jianhui Ye and Rudolf Zentel — Department of Chemistry, University of Mainz, Duesbergweg 10-14, D-55099 Mainz

An attractive feature of synthetic opals, in comparison with their natural counterparts, arises from the possibility to use the lattice of sphere as a template that can be infiltrated with a variety of ferroelectric, nonlinear, and photorefractive materials. This permits the preparation of diverse materials compositions for optoelectronic applications. The photonic crystal properties of such diverse materials compositions are strongly dependent (I) on the quality of the initial opal and (II) on the filling factor of the opaline voids. We use high quality polymer opals as template and infiltrate with an organic-inorganic monomer (ORMOCER). This monomer can be photopolymerized within the opaline voids leading to "perfect" replica structure with filling factor above 90%. This is different from inorganic materials prepared by chemical vapor deposition or a sol-gel process.

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Photonic bandgap in two-dimensional octagonal quasi-periodic lattice — •Dmitry Chigrin and Johann Kroha — Physikalisches Institut, Universität Bonn, Nussallee 12, 53155 Bonn

A systematic study of a photonic bandgap formation in two-dimensional octagonal quasi-periodic lattice of dielectric rods is presented. Photonic bandgap maps are obtained for different dielectric constants and radiuses of rods for both fundamental polarizations. It is shown that for fairly high dielectric constant of rods, complete photonic bandgaps in both fundamental polarizations can overlap leading to a full bandgap. It is also shown, that in the case of TM polarization the first complete photonic bandgap remains open down to very small dielectric constants. The threshold dielectric constant can be as small as $\varepsilon = 1.6$. Possible optoelectronic applications of two-dimensional octagonal photonic quasi-crystals are discussed. The physical mechanisms of the photonic bandgap formation in a quasi-periodic lattice are addressed. Finite-difference time-domain and plane wave expansion methods were used for density of states and band structure calculations, respectively.

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Durchstimmbare Lasertätigkeit in ein- und zweidimensionalen photonischen Kristallen — •Stroisch Marc[1], Gerken Martina[1], Lemmer Uli[1], Forberich Karen[2] und Gombert Andreas[3] — [1]Lichttechnisches Institut, AG Visuelle Informationstechnik und Optoelektronik, Universität Karlsruhe — [2]Freiburger Materialforschungszentrum, Universität Freiburg — [3]Fraunhofer Institut für Solare Energiesysteme ISE, Freiburg

Organische Photonische Kristall-Laser lassen sich durch das Aufbringen von organischen Farbstoffen auf ein mikrostrukturiertes Substrat herstellen. Die Durchstimmbarkeit der Laserwellenlänge erfolgt dabei durch die Variation der Schichtdicke, der chemischen Zusammensetzung und der Gitterperiode des Substrates. Durch die Kombination der drei Elemente ist es mögliche den sichtbaren Spektralbereich abzudecken. Unterschiedliche Lasergitter (Linien-, Kreuz- und Hexagonalgitter) beeinflussen zudem Laserparameter wie die Abstrahlcharakteristik, die Laserschwelle und die Modenform der Laser. Als optisch aktive Materialien werden nach dem Spiro-Konzept verknüpfte organische Farbstoffe (Oligomere) und handelsübliche Laserfarbstoffe verwendet. Die experimentelle Charakterisierung erfolgt durch winkel- und wellenlängenabhängige Detektion der spontanen Emission, der stimulierten Emission und der Transmission.

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Ultraschnelles optisches Schalten in dreidimensionalen Photonischen Kristallen aus Silizium — •C. Becker[1], S. Linden[1], M. Wegener[1,2], N. Tetreault[3], V. Kitaev[3], G. von Freymann[3] und G. A. Ozin[3] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft — [2]Institut für Angewandte Physik, Universität Karlsruhe — [3]Department of Chemistry, University of Toronto

Photonische Kristalle weisen vielversprechende Möglichkeiten zur Realisierung von optischen Schaltelementen auf. Verantwortlich hierfür ist die Existenz einer teilweisen oder kompletten Photonischen Bandlücke, deren spektrale Position vom Brechungsindex abhängt. Eine ultraschnelle optisch induzierte Veränderung des Brechungindex ermöglicht daher interessante Schaltprozesse. Es gab in der Vergangenheit diesbezüglich nur wenige Experimente, die auf resonanter Erzeugung freier Ladungsträger beruhten und daher lange Relaxationszeiten hatten.[1]

Wir haben in einem Anrege-Abfrage-Experiment mit zwei voneinander unabhängigen optisch parametrischen Verstärkern invertierte Silizium-Opale untersucht, deren Bandlücke im nahen Infrarot liegt. Die Variation des Brechungsindex kann jedoch auch durch nichtresonante Effekte verursacht werden. Bei diesen Prozessen, insbesondere beim optischen Kerr-Effekt, sind die Relaxationszeiten wesentlich kürzer. In der Analyse der Daten wurde ein besonderes Augenmerk auf die Unterscheidung der verschiedenen resonanten und nichtresonanten nichtlinearen Effekte gerichtet.

[1] S. W. Leonard et al., PRB, **66**, 161102 (2002)

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Integration of three-dimensional photonic crystals onto structured silicon wafers — •Jianhui Ye[1], Rudolf Zentel[1], Sanna Arpiainen[2], and Jouni Ahopelto[2] — [1]Department of Chemistry, University of Mainz, Duesbergerweg 10-14, D-55099 Mainz — [2]VTT Centre for Microelectronics, P.O. Box 1208, FIN-02044 VTT

The strong research effort devoted to photonic crystals is motivated by their potential to build a generation of optoelectronic devices of reduced size, combining high integration, and high-speed processing. Advanced photonic circuits will need complex architectures, which can be achieved by using structured silicon substrates as a container, onto which high-quality photonic crystals of controlled size and shape have to be grown.

We report on crystallization of silica spheres of diameter 900 nm on structured silicon wafers with the help of a "drawing apparatus". The crystallization can, thereby, be directed exclusively to the lower lying parts. We optimize the conditions of the crystallization and obtain opals of good quality on patterned substrates, i.e.: (I) good infilling of the structures, flat top surface; (II) 3D order; and (III) absence of cracking. The influence of the complex pattern on the quality of the opals will be discussed.