DF 13: Nano- and microstructured dielectrics/thin films (DF with KR)

Time: Thursday 9:30–12:30 Location: H26

DF 13.1 Thu 9:30 H26

Fabrication of periodically patterned domain structures in x-cut thin film $LiNbO_3$ — Peter Mackwitz[1], Michael Rüsing[1], Gerhard Berth[1,2], and •Artur Zrenner[1,2] — [1]1Department Physik, Universität Paderborn, 33098 Paderborn, Germany — [2]2Center for Optoelectronics and Photonics Paderborn (CeOPP), 33098 Paderborn, Germany

Within the field of nonlinear optics $LiNbO_3$ represents an important material with outstanding nonlinear optical properties. It is possible to achieve a highly efficient frequency conversion in $LiNbO_3$ with periodic poled structures which preserve the quasi phase matching condition. Bulk $LiNbO_3$ represents one of the major materials for frequency conversion with periodically poled pattern. Concerning the different scattering geometries of $LiNbO_3$ x-cut samples offer favorable properties regarding the fabrication of periodically pattern and the frequency conversion. For example the most intense tensor element d_{33} can directly be triggered. Scores of previous works [1] have shown the fabrication and application of periodically poled domain pattern in bulk $LiNbO_3$. In this work we have processed x-cut thin film $LiNbO_3$ samples in order to create a periodically poled pattern. The transferred domain structures were studied with nonlinear microscopy. Concerning the nonlinear measurements the domain structures could clearly be resolved and the poling process was successful. These results hint to the possibility of homogeneous poled domains allowing novel applications in the framework of photonics and integrated optics. [1] L. Gui, H. Hu et al., Opt. Exp. 17, 3923 (2009)

DF 13.2 Thu 9:50 H26

Nanostructuring of dielectric surfaces using nanosecond laser radiation assisted by metallic absorber layer — •Pierre Lorenz[1], Michael Klöppel[1,2], Christoph Grüner[1], Frank Frost[1], Joachim Zajadacz[1], Martin Ehrhardt[1], and Klaus Zimmer[1] — [1]Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany — [2]Institute of Scientific Computing, Department of Mathematics, TU Dresden, 01062 Dresden, Germany

The laser-induce structuring of different dielectrics assisted by self-organisation of a molten thin metal layer during laser heating with a 248 nm, 25 ns KrF excimer laser was studied. The nanopattern formation at low laser fluence is caused by instabilities of thin molten metal layer on dielectric surfaces within the laser pulse driven by the surface tension of the liquid metal layer. As dielectric substrate and metallic absorber film SiO_2, Al_2O_3, and diamond as well as Cr and Mo were used, respectively. Homogenous and pre-structured metal film were irradiated and specific features of the self-organization process found. For instance, the high laser fluence irradiation of the pre-structured films can result in forming different structures. The resultant structures o the film or in the substrate were investigated by atomic force (AFM) and scanning electron microscopy (SEM). These laser-induced nanoholes were imaged by SEM after cross sectioning by focussed ion beam (FIB). The hole-forming process was simulated using a heat equation to describe the laser-heating of the solid and a kind of Navier-Stokes equation to describe the mass transport in the liquid.

DF 13.3 Thu 10:10 H26

Production yield of rare-earth ions implanted into an optical crystal — •Thomas Kornher[1], Kangwei Xia[1], Roman Kolesov[1], Nadezhda Kukharchyk[2], Hans-Werner Becker[3], Bruno Villa[1], Rolf Reuter[1], Andreas D. Wieck[2], and Jörg Wrachtrup[1] — [1]3. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart, Germany — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany — [3]RUBION, Ruhr-Universität Bochum, 44780 Bochum, Germany

Rare-earth (RE) ions doped into desired locations of optical crystals might enable a range of novel integrated photonic devices for quantum applications. With this aim, we have investigated the production yield of cerium and praseodymium by means of ion implantation. As a measure, the collected fluorescence intensity from both, implanted samples and single centers was used. With a tailored annealing procedure for cerium, a yield up to 53% was estimated. Praseodymium yield amounts up to 91%. Such high implantation yield indicates a feasibility of creation of nanopatterned rare-earth doping and suggests strong potential of RE species for on-chip photonic devices. Additionally, the potential of evanescently coupling RE ions in YAG to photonic structures is investigated.

DF 13.4 Thu 10:30 H26

Circular dichroism of the distorted Gyroid photonic crystal — •Johannes Hielscher[1], Sebastian C. Kapfer[1], Caroline Pouya[2], Peter Vukusic[2], and Gerd E. Schröder-Turk[3] — [1]FAU Erlangen-Nürnberg, Institut für Theoretische Physik — [2]University of Exeter, School of Physics — [3]Murdoch University, School of Engineering & IT, Maths & Stats

The single Gyroid is a bi-continuous triply-periodic network with chiral $I4_132$ cubic symmetry. When realised with two phases of dielectric contrast, it acts as a photonic crystal. As a such, it has been found in butterfly wings. Due to its chirality, it exhibits circular dichroism in reflectance.

We show that the introduction of a long-wavelength variation of the lattice constant ("sinusoidal chirp") tunes the coupling of light waves at the interface of the photonic crystal differently depending on circular polarisation, i. e. changes the circular dichroism [1]. Reflectance spectra are gathered from numerical electrodynamics simulations, and are in good agreement with microwave optics measurements on selected 3D-printed replicas. Studying model systems, as the tetragonally distorted Gyroid and its photonic band structure, contributes to our understanding of the intricate geometrical contributions on the reflectance properties of photonic crystals, beyond the unit-cell scale.

[1] J. Hielscher; C. Pouya; P. Vukusic & G. E. Schröder-Turk: Harmonic long-range distortions of Gyroid photonic materials enhance circular dichroism. *In preparation, 2016*

DF 13.5 Thu 10:50 H26

Flexible formation of coupled active polymeric whispering gallery mode cavities on an elastomer substrate — •Stefan Schierle[1], Tobias Siegle[1], Sarah Krämmer[1], Benjamin Richter[2], Sentayehu Wondimu[3], Peter Schuch[3], Christian Koos[4], and Heinz Kalt[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany — [2]Zoological Institute, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany — [3]Institute of Microstructure Technology, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany — [4]Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany

Optical modes in whispering gallery resonators are classified in analogy to electronic orbitals in atoms. Coupling between multiple resonators allows a photon exchange among them and leads to the formation of so-called photonic molecules.
Dye (pyrromethene 597)-doped active micro disk and goblet cavities are structured in a linear configuration by direct laser writing on a flexible elastomer substrate. Stretching the substrate and using its lateral contraction allows a fine tuning of the inter-cavity gaps. This enables the formation of photonic molecules consisting of two and three micro cavities. Spatially resolved spectroscopy demonstrated both the localization of super-modes, e.g. modes being resonant in the coupled system, and also the extinction of non-resonant modes in the photonic molecules. Relaxation of the substrate shows a change back to the uncoupled modal spectrum.

20 min. break

DF 13.6 Thu 11:30 H26

Electrospun dye-doped polymeric fiber networks for alcohol vapor detection — •Sarah Krämmer[1], Fabrice Laye[1], Christoph Vannahme[2], Minh Tran[1], Pascal Kiefer[1], Felix Friedrich[1], Cameron L. C. Smith[2], Ana C. Mendes[3], Ioannis S. Chronakis[3], Anders Kristensen[2], and Heinz Kalt[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany — [2]Department of Micro- and Nanotechnology, Technical University of Denmark (DTU), 2800 Kgs., Lyngby, Denmark — [3]Nano-BioScience Research Group, DTU-Food, Technical University of Denmark (DTU), 2800 Kgs., Lyngby, Denmark

Recently we have shown that random resonators within dye-doped elec-

trospun polymeric fiber networks lead to lasing emission [1]. Here, we demonstrate that the narrow laser emission lines can be used as sensor signal. When the fiber networks are exposed to alcohol vapors, the alcohol molecules diffuse into the polymer and cause swelling of the fibers. This swelling process changes the effective refractive index of the fiber resonator and thus causes a spectral shift of the laser mode. In various sensing experiments we analyzed the spectral shift of the lasing modes for different concentrations of ethanol and methanol. For the investigated concentration range we found a linear dependency of the shift on the alcohol concentration. The time resolved signal reveals different saturation times for the different alcohols which are related to the different diffusion constants and allow a differentation of ethanol and methanol.

[1] Krämmer et al., Adv. Mater., 26, 8096-8100, 2014

DF 13.7 Thu 11:50 H26

Implanted Strontium Titanate Single Crystals for Energy Storage Applications — •Max Stöber[1], Charaf Cherkouk[1], Juliane Walter[1], Matthias Schelter[2], Jens Zosel[2], Ralph Strohmeyer[1], Slawomir Prucnal[3], Tilmann Leisegang[1], and Dirk Carl Meyer[1] — [1]TU Bergakademie Freiberg — [2]Kurt Schwabe Institute Meinsberg — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf,

A rapid increase of the demand on efficient energy storage solutions requires new approaches beyond the Li-ion technology. In particular, metal-air batteries as well as solid-state fuel cells offer a great potential for high-energy-density storage devices. Since the efficiency of such devices is significantly limited by the activation of both the oxygen reduction reaction (ORR) and the ionic and electronic conductivities, an adequate porosity as well as a controlled doping are required. The ion implantation is a key technology to achieve this goal. In this work, p- and n-doped strontium titanate ($SrTiO_3$) single crystals were used as oxidic materials. The oxygen exchange kinetics as well as the structural changes of the $SrTiO_3$ crystal surface induced by the ion implantation were investigated. On one hand, the depth profile of dopant concentration and dopant valence state were determined using sputtered X-ray photoelectron spectroscopy (XPS). On the other hand, the overall oxygen exchange kinetic of the implanted $SrTiO_3$ crystal was quantitatively described by means of coulometric titration using Zirox system (ZIROX GmbH, Germany). Furthermore, the surface morphology of the samples was investigated using atomic force microscopy (AFM).

DF 13.8 Thu 12:10 H26

Die wahre Definition der Lichtgeschwindigkeit — •Adolf Bablitzka — 88682 Salem Baden, Alpenblick 6

Der Vortrag beschreibt den mathematischen Weg vom cosinusquadrat des sog. "Magic Angle" bzw. "Zauberwinkel" (1/3) zur Lichtgeschwindigkeit. Bekanntlich spielt dieser Winkel bei Versuchen mit magnetischen Momenten eines Festkörpers eine wichtige Rolle.