DF 10: Optical and nonlinear optical properties, photonic

Time: Tuesday 9:30–12:20 Location: H11

DF 10.1 Tue 9:30 H11

Transient gratings based on small polarons in nominally undoped, thermally reduced $LiNbO_3$ — •Hauke Bruening[1], Holger Badorreck[1], Kay-Michael Voit[1], Volker Dieckmann[1], Gabor Corradi[2], Christoph Merschjann[3], and Mirco Imlau[1] — [1]Department of Physics, University of Osnabrück, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary — [3]Helmholtz-Zentrum für Materialien und Energie, Berlin, Germany

We studied a new type of hologram recording in nominally undoped, thermally reduced $LiNbO_3$ by means of single intense ns-laser pulses ($\lambda = 532$ nm) yielding short-lived volume phase-gratings with high diffraction efficiencies η. The gratings are probed in the blue-green spectral range ($\lambda = 488$ nm) [1] and the NIR spectral range ($\lambda = 785$ nm) [2]. They show unique features like a stretched-exponential relaxation behavior with a lifetime in the ms-range at room temperature, an accelerated decay with increased temperature and a pronounced dependence of η on the orientation of the grating vector with respect to the polar c-axis. These properties can be explained comprehensively by taking an optically generated, spatial modulated density of small polarons into account. Therefor, this new recording mechanism is of particular interest for the field of nonlinear and ultrafast photonics because of the fast small polaron generation on the fs-scale.

*Financial support by the DFG (IM37/5 and INST190/137-1) and DAAD (50445542) is gratefully acknowledged.

[1] H. Bruening et al., Optics Express 20, 13326 (2012)
[2] M. Imlau et al., Optics Express 19, 15322 (2011)

DF 10.2 Tue 9:50 H11

Lithiumniobat und Lithiumtantalat unter Beschuss: Die Auswirkungen von hochenergetischen Alphas und ihren leichteren Kollegen — •Niels L. Raeth, Johannes Goetze, Konrad Peithmann und Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Der künstliche Kristall Lithiumniobat ($LiNbO_3$) ist für viele Anwendungsfälle der nichtlinearen Optik sehr gut geeignet. Mittels Durchstrahlung hochenergetischer, leichter Ionen können entscheidende Materialparameter wie Brechungsindex, Leitfähigkeit oder das Verhalten ferroelektrischer Domänen gezielt beeinflusst werden. Begleitet wird dies jedoch von einer eher störenden nuklearen Aktivierung. Auch für das kristallographisch isomorphe Material Lithumtantalat ($LiTaO_3$) lassen sich ähnliche Modifikationen nach Ionenbeschuss nachweisen.

Wir präsentieren Unterschiede und Gemeinsamkeiten der gemessenen Effekte in beiden Kristallen für alle vier leichten Projektile (^{4}He, ^{3}He, ^{2}D, ^{1}H). Anschließend interpretieren wir die Ergebnisse zur weiteren Erklärung der ablaufenden Prozesse, sowie in Hinblick auf eine Optimierung für Anwendungen.

DF 10.3 Tue 10:10 H11

Three-dimensional ferroelectric domain mapping in lithium niobate — •Thomas Kämpfe[1], Mathias Schröder[1], Philipp Reichenbach[1], Alexander Haussmann[1], Theo Woike[2], and Lukas M. Eng[1] — [1]Institute of Applied Photophysics, Technical University Dresden, 01062 Dresden — [2]Institute of Structural Physics, Technical University Dresden, 01062 Dresden

Ferroelectric domain walls (DWs) are an elegant new approach towards nanoelectric circuitry, as they intrinsically exhibit DW conduction within an insulating volume. The DW conductivity in Mg:$LiNbO_3$ single crystals depends on the inclination [1], which is related to the poling conditions and doping concentration, effectively altering the wall pinning. For three-dimensional investigations of conductive DWs, we apply Cerenkov second-harmonic generation (CSHG) with adjustable fundamental wavelength in a range of 800 – 990 nm. This technique enables the noninvasive DW characterization throughout the whole crystals. Here, we report that conductive DWs have constant inclination throughout the whole crystal. The extracted inclination angles are in agreement with surface-sensitive PFM measurements in [1]. Besides this, the visualization of topological defects, e.g. the merging of two domains within the crystal or domains being completely embedded within the bulk, are shown.

[1] M. Schröder et al., Adv. Funct. Mater., 22: 3936–3944 (2012)

DF 10.4 Tue 10:30 H11

Linear and nonlinear optical properties of congruent LiNbO3 — •Arthur Riefer, Simone Sanna, and Wolf Gero Schmidt — Theoretische Physik, Universität Paderborn, Warburger Str. 100, 33100 Paderborn, Germany

Lithium niobate (LN) is one of the most important ferroelectric materials and the most important optical material. Recently, the linear [1,2,3] and nonlinear [3,4] optical properties of highly ordered stoichiometric LN have been investigated theoretically. However, the technologically relevant material is the congruently melting LN (CLN), containing up to 6% empty Li sites. In this work, we have investigated the linear and the nonlinear optical properties of congruent LN from first-principles. Thereby CLN is simulated both within the established Li and the Nb site vacancy models [5]. Our approach allows us to calculate the dielectric function as well as the second harmonic generation spectra within the independent particle approximation. The influence of the intrinsic defects on the optical and electronic properties of LN is discussed. The results are compared with experimental measurements [6].

[1] W. G. Schmidt *et al.*, Phys. Rev. B **77**, 035106 (2008)
[2] C. Thierfelder *et al.*, phys. stat. sol. (c) **7**, 362 (2010)
[3] A. Riefer *et al.*, IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control **59**, 1929 (2012).
[4] S. Cabuk, Central European Journal of Physics **10**, 239 (2012)
[5] T. Volk *et al.*, *Lithium Niobate*, Berlin Springer, 2008
[6] D.A. Roberts, IEEE J. of Quantum Electronics **28**, 2057 (1992)

10 min. break

DF 10.5 Tue 11:00 H11

Near-field optical microscopy of femtosecond laser reshaped silver nanoparticles in dielectric matrix — •Moritz Beleites[1], Christian Matyssek[2,3], Hans-Helmuth Blaschek[4], and Gerhard Seifert[1] — [1]Zentrum für Innovationskompetenz SiLinano, Martin-Luther-Universität Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, D-06120 Halle (Saale) — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale) — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale) — [4]Fraunhofer-Institut für Werkstoffmechanik IWM Halle, Walter-Hülse-Str. 1, D-06120 Halle (Saale), Germany

Near-field scanning optical microscopy (NSOM) and microscope spectrometry have been utilized to detect and evaluate shape transformation of individual silver nanoparticles embedded in a thin dielectric layer (40 nm Al_2O_3). Shape modification was previously executed by femtosecond laser irradiation of samples containing spherical nanoparticles. The NSOM measurements were performed with several optical wavelengths of unpolarized and linearly polarized light on different regions of the samples containing spherical and transformed nanoparticles. We were able to unambiguously identify reshaped, spheroidal nanoparticles by polarization dependent switching of the NSOM contrast at individual particles. In combination with microsope spectrometry, this allows analyzing orientation and aspect ratio of single metal nanoparticles.

DF 10.6 Tue 11:20 H11

Hopping transport in crystalline insulators and semiconductors: the effects of site-correlation and trap saturation in 1, 2 and 3 dimensions — •Christoph Merschjann — Helmholtz-Zentrum-Berlin für Materialien und Energie

Hopping transport of particles and quasiparticles (e.g., electrons, small polarons, or excitons) in otherwise perfectly crystalline insulators and semiconductors is often (vaguely) mentioned in possible explanations for experimental findings in optical and electrical spectroscopy.
Typical problems include transient absorption and luminescence measurements in bulk crystals and lower dimensional systems like monolayers or polymer strands.

A random-walk approach is applied to address the effects of site-correlation (e.g. after excitation out of traps) and trap-saturation (e.g. due to recombination of electrons and holes after band-band excitation). It is found that both effects lead to characteristic deviations from Debye-like monoexponential relaxation and give means to deduce the dimensionality of the investigated problem from spectroscopic measurements.

DF 10.7 Tue 11:40 H11

Phase matching for efficient nonlinear frequency generation in hybrid Si/Chalcogenide glass slot waveguides — Peter W. Nolte, Christian Bohley, and •Joerg Schilling — ZIK SiLinano, Martin-Luther-University Halle-Wittenberg, Germany

To circumvent the limitation of strong two photon absorption in nonlinear silicon photonics, hybrid photonic structures have to be used, in which silicon is combined with other materials.

We theoretically investigated the situation for degenerate four wave mixing in silicon slot waveguides which are infiltrated by a chalcogenide glass (e.g. As_2S_3) promising efficient frequency generation within the vicinity of the pump wavelength.

Varying waveguide height, width and slot width we optimized the waveguide cross section to achieve a maximum effective mode area and modes which are well confined to the slot resulting in a figure of merit of 1.3. Furthermore a new phase matching scheme for degenerate four wave mixing in these waveguides was investigated by introducing a periodic index variation along the waveguide. This leads to a photonic band gap and strong band bending in its vicinity allowing the desired group velocity dispersion (GVD) of zero. The usable bandwith is above 40nm for waveguide lengths up to 5mm. With this scheme the phase matching condition can be independently fulfilled from the wave guide cross section and the GVD = 0 condition can be easily tuned to the wavelength of interest allowing a flexible design of the hybrid photonic components.

DF 10.8 Tue 12:00 H11

Room-Temperature Lasing from Tamm Plasmon-Polaritons in an Organic Microcavity — •Andreas Mischok[1], Robert Brückner[1], Reinhard Scholz[1], Vadim G. Lyssenko[1], Markas Sudzius[1], Susanne I. Hintschich[1], Alexander A. Zakhidov[2], Hartmut Fröb[1], and Karl Leo[1] — [1]Institut für Angewandte Photophysik, George-Bähr-Str. 1, 01062 Dresden — [2]Fraunhofer COMEDD, Maria-Reiche-Str. 2, 01109 Dresden

Organic solid state lasers combine a tunable emission spectrum and room-temperature operation with a comparably easy fabrication. In order to drive such devices electrically, high current densities must be transported, calling for highly conductive - and highly absorptive - metal electrodes.

In this work, we report stimulated emission in an organic-dielectric surface emitting microcavity with an embedded continuous silver layer of 40nm thickness, under non-resonant optical excitation. Despite the absorption introduced by the silver, the quality factor of the sample and the gain provided by the Alq3:DCM Host:Guest emitter system suffice to reach lasing from Tamm plasmon-polariton states. Knowledgeable design of the cavity multilayer stack minimizes the metal-induced absorption via a shift of the resonant cavity mode. Above the laser threshold, the excitation intensity can be increased at least 20 times without damage to the device. These results pave the way to an electrical contacting of the emitter and are essential for the future realisation of an electrically driven organic solid state laser.