K 4: Poster

Time: Tuesday 16:30–18:30 Location: f428

K 4.1 Tue 16:30 f428

High-power OPCPAs at 1.45 - 2.4 μm wavelength — Ivanka Grguras[1], Jan-Heye Buss[1], Torsten Golz[1], Mark Prandolini[1,2], Michael Schulz[1], and •Robert Riedel[1] — [1]Class 5 Photonics GmbH, Notkestrasse 85, 22607 Hamburg, Germany — [2]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

High power and high repetition rate femtosecond lasers at 1.45 - 2.40 μm wavelength are critical for many applications in the physical, chemical, and biological sciences. Previously, such systems have been realized by optical parametric amplification from Ti:Sapphire lasers at 800 nm with limited power levels. A novel optical parametric chirped-pulse amplifier (OPCPA), pumped by high-power Yb-doped solid state lasers, and combined with bulk crystal white-light-generation seeding (WLG) is demonstrated. The laser system features tunable and broadband operation in the 1.45 - 2.40 μm spectral range, requiring no complex cooling with a compact footprint. Such systems have recently become commercially available from Class 5 Photonics and allow for scalability up to millijoule pulse energies at 100 W average power with a tunable range from 1.45 - 2.45 μm.

K 4.2 Tue 16:30 f428

An XUV and soft x-ray split-and-delay unit for FLASH2 — •Matthias Dreimann[1], Sebastian Roling[1], Ivan Zadyraka[3], Marion Kuhlmann[2], Elke Plönjes-Palm[2], Frank Wahlert[3], Felix Rosenthal[1], Michael Wöstmann[1], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience, Münster, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]Westfälische Wilhelms-Universität, Münster, Germany

An XUV and soft x-ray split-and-delay unit is built that enables time-resolved pump-probe experiments covering the whole spectral range of FLASH2 from hv = 30 eV up to 1500 eV. With wavefront beam splitting and grazing incidence angles sub-fs resolution with a maximum delay of -6 ps $<$ t $<$ +18 ps will be achieved. Two different coatings are required to cover the complete spectral range. Therefore, a design that is based on a three dimensional beam path allows to choose the propagation via two sets of mirrors with these coatings. A Ni coating will allow a total transmission on the order of T = 55 % for photon energies between hv = 30 eV and 600 eV at a grazing angle of w = 1.8° in the variable delay line. With a Pt coating a transmission of T $>$ 13 % will be possible for photon energies up to hv = 1500 eV. In the fixed beam path at a grazing angle of w = 1.3° a transmission of T $>$ 62 % with a Ni coating and T $>$ 28 % with a Pt coating will be possible. For a future upgrade of FLASH2 the Ni coating can be used at a grazing angle of w = 1.3° to cover a range up to hv = 2500 eV.

K 4.3 Tue 16:30 f428

The HeH^+ ion in intense asymmetric field — •Saurabh Mhatre and Stefanie Gräfe — Institut für Physikalische Chemie, Friedrich-Schiller-Universität Jena, Helmholtzweg 4, 07743 Jena, Deutschland

We investigate the dynamics of dissociation and ionization of highly asymmetric HeH^+ ion. The large mass and electronic asymmetry in the HeH^+ ion makes it an ideal candidate for the dynamics in few-cycle intense laser pulses. We employ our recently developed semi-classical dressed surface hopping model to simulate all possible fragmentation pathways such as dissociation, single and double ionization. These pathways can be accessed in multiphoton as well as tunnelling regime. By using specifically tailored femtosecond pulses, we aim to control these fragmentation pathways.

K 4.4 Tue 16:30 f428

AOM shaper-based D-Scan in the mid-infrared region — •Florian Nicolai, Niklas Müller, and Tiago Buckup — Physikalisch-Chemisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany

Pulse duration and phase characterization play a central role in ultrafast time-resolved spectroscopy. One method to determine the pulse's spectral amplitude and phase is dispersion scan (d-scan). In this technique, a known amount of dispersion is added to the pulse and its effect on the second harmonic spectrum is observed. The d-scan method has already shown its success in the visible and near infrared spectral region. However, implementing a d-scan setup for mid infrared (MIR) pulses is quite challenging, especially due to the lack of suitable materials to imprint the desired amount of dispersion on the pulse. We show the successful realization of a d-scan setup for pulses in the MIR region at about 5.0 μm with an acousto-optic modulator (AOM). In this way we implemented a compact setup to determine the spectral phase of a MIR pulse. Furthermore, the AOM shaper has the potential to add an arbitrary phase and thus to compress the pulse.

K 4.5 Tue 16:30 f428

Terahertz radiation in tailored two-color laser fields with nanostructure semiconductor — •Han Rao[1,2], Ihar Babushkin[1,2], Christian Markus Dietrich[1,2], Jose Ricardo Cardoso de Andrade[1,2], and Uwe Morgner[1,2] — [1]Leibniz University Hannover, Institute for Quantum Optics, Hannover, Germany — [2]Cluster of Excellence PhoenixD, Hannover, Germany

Terahertz (THz) technology has attracted much attention due to its potential in various applications such as: remote sensing, biology and medicine, security scanning, information and wireless communication technology. THz sources based on two-color ionizing femtosecond (fs) pulses in gases stand out because of absence of damage threshold, absence of phonon absorption and zero interface reflection. Such approach, based on ionization, was up to now not realized in solids. In our case, we use the semiconductor nanodots for THz generation which can be fabricated with tunable band gap. Here, we present a concept of THz pulse generation in semiconductor nanodots with two color pulses, which, as we believe, can generate THz radiation with much higher efficiency than in gases. The two-color driver will be delivered with 40 MHz a doubly resonant optical parametric oscillator (DROPO) which can generate 2060 nm light in the fs region. The DROPO pump source is a home-built Kerr-lens mode-locked Yb:YAG thin disk laser, emitting pulses at a wavelength of 1030 nm with a pulse duration of 250 fs, and 40 W output power and 40 MHz repetition rate.

K 4.6 Tue 16:30 f428

High-Order Harmonic Generation in Liquids — •Jan Heine, Christoph Jusko, Elisa Appi, Uwe Morgner, and Milutin Kovacev — Institut für Quantenoptik, Cluster of Excellence PhoenixD, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

High-order Harmonic generation (HHG) is a well established technology for probing ultrafast processes, allowing researchers to generate ultra-short optical pulses in the attosecond regime through nonlinear frequency conversion. While the generation process in gas-phase targets is well understood, there is still ongoing investigation on the interaction of ultrashort laser pulses with high-density media such as liquids [1] and solids [2]. Here, we present a HHG source using liquid droplets, with which we can investigate the impact of different target geometries (e. g. water sheet/droplet) and possible additives on the generation process. We are currently working on reducing the target size to be comparable to the wavelength of our driving pulse. This way we expect to see interesting dynamics, similar to the interaction of laser pulses with solid nanostructures and nanoantennas.

[1] T. T. Luu *et al.*, Nature Commun. 9, 3723 (2018)
[2] S. Ghimire *et al.*, Nature Phys. 15, 10-16 (2019)

K 4.7 Tue 16:30 f428

Detection and safety precautions of generated X-ray during laser material processing — •Zulqarnain Sheikh[1,2], Uwe Morgner[1,2], and Milutin Kovacev[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering - Innovation AcrossDisciplines), Hannover, Germany

The global market for laser material processing systems is rapidly increasing over the past few years[1]. From laser cutting to laser drilling and laser marking, high power ultrashort pulse lasers are versatile tool for production. Plasma generation during laser processing with ultrashort laser pulses puts the risk of unwanted X-ray radiation in the range of several kilo electron volts. We performed experiments to detect the generated X-rays(soft and hard X-rays between 200eV to 10,000eV) using X-ray camera while processing different solid materials and investigate the exposure safety limits[1,2].

[1] Legall *et al.*, (2018) Applied Physics A, 124(6), 407.

[2] De Bruijn *et al.*, U.S. Patent No. 7,755,070. 13 Jul. 2010.

K 4.8 Tue 16:30 f428

A semiclassical Two Temperature-Hydrodynamic Model for surface plasmons-polaritons assisted nanostructuring of metals using ultrafast laser pulses — •Othmane Benhayoun — Department of Theoretical Physics II, University of Kassel

We propose a semiclassical Two Temperature-Hydrodynamic Model (TTH) based on field equations to investigate the role of electrons and surface plasmons-polaritons on the energy exchange with the lattice, which can lead to the creation of laser induced periodic surface structures (LIPSS) in metals subject to ultrashort laser pulse excitation. The TTH equations are constructed by applying perturbation theory on the energy-, momentum- and density conservation equations of the electronic system. We consider three subsystems: the lattice, the thermalized electrons and the surface plasmons, all of which are coupled to each other by collision terms, and coupled to an external laser field. A numerical analysis is then performed on gold, where we compare our results with the classical TTM for different laser fluences, and show the emergence of an oscillation pattern in the electronic and lattice temperature distribution, in both single and multi-pulse regimes, which can be responsible for the formation of ripples on the surface of the material.

K 4.9 Tue 16:30 f428

Correlation between lasers induced carbonization and LIBS on leather — •Dominic Bergmeister[1], Alexander Feist[2], Ali Hachimi[2], Mareike Schäfer[2], Johannes L'huillier[2], and Peter Schultheis[1] — [1]Prüf- und Forschungsinstitut Pirmasens e.V., 66953 Pirmasens, Germany — [2]Photonik-Zentrum Kaiserslautern e.V. and Research Center OPTIMAS, 67633 Kaiserslautern, Germany

The industry 4.0 sets the shoe industry for great challenges, automation is due to the large use of leather very problematic. To bond leather to the sole, it is necessary to remove the finish from leather. In shoe industry this roughening process is still often done by hand. Investigations showed the potential of ultra-short pulse lasers for the roughening process. However, it is required to adapt the laser parameters to the respective leather type in order to avoid carbonization on the surface, which reduce the adhesive strength. Our approach is to regulate the laser output power, which is critical for the carbonization, through laser induced breakdown spectroscopy (LIBS). Due to the thermal process of the carbonization during laser processing of leather, it is possible to detect the broad emission spectrum by LIBS. To establish a control, it is necessary to correlate the spectra with the carbonization. For this, the carbonization is also quantified with a sample speckled on the processed leather area and analyzed of residue on the surface. The results show the correlation between the spectrum, the speckle tests and the adhesive tests on leather according to DIN 1392. Based on these results we are able to establish an automatic control for the laser processing of leather samples.

K 4.10 Tue 16:30 f428

LIPSS guided by photolithographic pre-structured polymer films — •Martin Ehrhardt[1], Shengying Lai[1,2], Pierre Lorenz[1], and Klaus Zimmer[1] — [1]Leibniz Institute of Surface Engineering (IOM), Permoserstr. 15, 04318 Leipzig, Germany — [2]School of Science, Nanjing University of Science & Technology, Xiaolingwei 200, Nanjing 210094, China

The formation of LIPSS (Laser induced periodic surface structures) was discussed and investigated in detail in the last decades. However, only few studies were published dealing with the guiding of LIPSS on pre-structured substrates. In the present study, LIPSS formation on polymer dot and line structures is presented. The LIPSS are induced by a partial polarized excimer laser radiation (t=25ns, λ=248nm). The degree of order of the LIPSS are influenced by the shape and geometry of the polymer pre-structures as well as the alignment of the laser polarization to the pre-structure direction. Several hundred micrometers long LIPSS were observed using an optimized adjustment of the alignment as well as an adapted laser parameter set (fluence and laser pulse number). The highly ordered LIPSS formation process can accept alignment mismatches up to 10 °. The LIPSS are induced at the top and the side wall of the pre-structured polymer dependent on the applied laser parameters, respectively.

K 4.11 Tue 16:30 f428

Time Resolved X-ray Holography of Cavitation Dynamics at European XFEL — •Hannes P. Hoeppe[1], Malte Vassholz[1], Juan M. Rosselló[2], Robert Mettin[2], Johannes Hagemann[3], Markus Osterhoff[1], Andreas Schropp[3], Christian G. Schroer[3], Johannes Möller[4], Anders Madsen[4], and Tim Salditt[1] — [1]Institut für Röntgenphysik, Universität Göttingen, Germany — [2]3. Phys. Institut, Universität Göttingen, Germany — [3]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [4]European XFEL GmbH, Schenefeld, Germany

High-resolution X-ray Holography with Free Electron Laser radiation enables imaging of fast and ultrafast processes, based on illumination with single X-ray pulses with durations less than 100 fs. We present an investigation of laser-induced Cavitation dynamics in water by X-ray Holography in an optical pump- x-ray probe experimental scheme. Two experiments have been performed in June and October 2019 at the MID Instrument of European XFEL. Cavitation dynamics was studied in three geometries: undisturbed seeding in a flow-through chamber, surface-near seeding and cavitation in a free water jet. We have in particular imaged the fast transition from plasma to vapour, leading to shock wave emission and bubble formation. By iterative phase retrieval or forward modeling, the radial density profiles of early state plasma distribution and cavitation bubbles are obtained. In unique ways, this gives insight to the phase transition and energy balance of the seeding process, as well as volumetric information about the shape and density distribution of later states of the cavitation bubbles.

K 4.12 Tue 16:30 f428

Femtosecond noncollinear optical parametric oscillator in the visible spectral range — •Robin Mevert[1], Christian Markus Dietrich[1,2], José R.C. Andrade[1,2], Luise Beichert[1,2], and Uwe Morgner[1,2] — [1]Leibniz University Hannover, Institute for Quantum Optics, Hannover, Germany — [2]Cluster of Excellence PhoenixD, Hannover, Germany

We present a widely-tunable non-collinear optical parametric oscillator (NOPO) in the visible spectral range. NOPOs are very interesting for spectroscopic applications due to their ability to create frequency tunable ultrashort laser pulses at wavelengths unreachable for most available lasers. This is especially important for the visible spectral range. By changing the resonator length the center wavelength of the signal can be tuned from 430 nm to 690 nm. The NOPO is pumped by the third harmonic (343 nm) of a two-stage fiber amplifier seeded by a nonlinear polarization rotating fiber oscillator at 1030 nm and a repitition rate of 50.2 MHz. An average power of 3W UV-pump-light is used to create average output powers up to 485 mW at 605 nm.

K 4.13 Tue 16:30 f428

Quantitative coherent diffraction imaging via deep learning: from simulation to reconstruction — •Alessandro Colombo[1], Julian Zimmermann[2], and Daniela Rupp[1] — [1]ETH Zürich, 8093 Zürich, Switzerland — [2]Max-Born-Institut, 12489 Berlin, Germany

Coherent Diffraction Imaging (CDI) is a lens-less technique that exploits the 2D measured diffraction pattern $I(\vec{k})$, produced by short-wavelength coherent radiation illuminating e.g. an individual nanoscale structure, to retrieve its electron density distribution $\rho(\vec{x})$. The use of Deep Learning for classifying diffraction patterns already proved to outperform standard approaches [1]. Here we present an approach based on Deep Convolutional Neural Networks for regression, to directly retrieve the electron density structure $\rho(\vec{x})$ when classical reconstruction algorithms do not apply, as, for example, in the wide-angle scattering regime. The generation of a sufficently large training dataset for the supervised learning of the network is done by simulating diffraction data. A model representation of the particle shapes, that enables parametrization, has to be found, with the goal of retrieving the optimized parameters from the neural network for each CDI pattern. The simulation software and the neural network are described, along with a first comparison with experimental data, showing that such a simulation-reconstruction scheme may provide a quick and quantitative insight into large CDI datasets.

[1] Zimmermann et al. *Physical Review E* 99.6 (2019): 063309.