K 3: Laser Systems and Applications

Time: Tuesday 14:00–16:00 Location: MB HS

Invited Talk K 3.1 Tue 14:00 MB HS

Glass joining by ultra-short pulsed lasers — •Kristian Cvecek[1,2], Johannes Heberle[2,3], Isamu Miyamoto[2,4], and Michael Schmidt[1,2,3] — [1]Bayerisches Laserzentrum GmbH, Erlangen, Germany — [2]SAOT - Erlangen Graduate School in Advanced Optical Technologies, Friedrich-Alexander-University of Erlangen-Nuremberg, Germany — [3]Chair of Photonic Technologies, Friedrich-Alexander-University of Erlangen-Nuremberg, Germany — [4]Osaka University, Japan

Glass welding by ultra-short pulsed lasers is a complex and highly dynamic process that is influenced by many parameters such as pulse repetition rate, feed speed, pulse duration or laser wavelength. Despite the complexity the understanding of the underlying processes has progressed far enough to support first industrial applications. In the present work basic mechanisms of the USP glass welding will be described and novel developments of this topic discussed.

K 3.2 Tue 14:30 MB HS

Laser-induced Micro- and Nanostructures on Ti-alloy Cylinders for Reduced Adhesion of Biological Cells — •Peter Fosodeder[1], Johannes Heitz[1], Agnes Weth[2], and Werner Baumgartner[2] — [1]Institute of Applied Physics, Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria — [2]Institute of Biomedical Mechatronics, Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria

Irradiation of cylindrical Ti-alloy samples with a Ti:sapphire fs-laser results in the formation of self-organized micro- and nanostructures, i.e., sharp cones or spikes covered by fine sub-wavelength ripples. The motivation of this work is to create a structured ring on a small cylinder with cell-repellent properties, similar as we demonstrated recently for flat substrates [1]. We aim to create such structures on a miniaturized implantable pacemaker to avoid tissue growth around the device.

[1] J. Heitz, C. Plamadeala, M. Muck, O. Armbruster, W. Baumgartner, A. Weth, C. Steinwender, H. Blessberger, J. Kellermair, S. Kirner, J. Krüger, J. Bonse, A.S. Guntner, A.W. Hassel, Appl. Phys. A 123, 734 (2017)

K 3.3 Tue 14:45 MB HS

Ultrakurzpulslaserinduzierte Nanostrukturen zur Steigerung der Umwandlungseffizienz von Laserstrahlung in Röntgenstrahlung — •Jürgen Imgrunt[1], Alexander A. Andreev[1] und Ulrich Teubner[1,2] — [1]Institut für Laser und Optik, Hochschule Emden/Leer, University of Applied Sciences, 26723 Emden, Deutschland — [2]Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg, Deutschland

Nanostrukturierte Oberflächen haben vielfältige Anwendungen. Sie können diese überall dort finden, wo die Lichtabsorption oder die Lichteinkopplung in ein Material gesteigert werden soll. Hier werden Ultrakurzpulslaserinduzierte periodischen Oberflächenstrukturen untersucht, die die Umwandlungseffizienz von ultrakurz gepulster Laserstrahlung in Röntgenstrahlung erhöhen sollen. Strukturanalysen und Simulationen zeigten, dass diese Strukturen nahezu optimale Parameter für eine maximale Laserabsorption besitzen. Für relativ niedrige Intensitäten erhöhen Nanostrukturen sowohl die Umwandlungseffizienz als auch die Photonenenergie signifikant. In einem ersten Schritt wurde die Targetoberfläche durch Anlegen von etwa zehn Laserpulsen nanostrukturiert, sodass die Nanostrukturen direkt im Anschluss für den Umwandlungsprozess in Röntgenstrahlung genutzt werden können. Diese In-Situ-Laserstrukturierung erlaubt im Prinzip die Entwicklung eines Targetsystems mit hoher Repetitionsrate.

K 3.4 Tue 15:00 MB HS

High fluence femtosecond laser ablation of molybdenum targets — •Julian Wegner[1], Dongye Zhao[2,3], Niels Gierse[3], Marcin Rasinski[3], Sebastijan Brezinsek[3], Georg Pretzler[1], Honging Ding[2], and Christian Linsmeier[3] — [1]Institut für Laser- und Plasmaphysik, Heinrich Heine Universität Düsseldorf, Germany — [2]Key Laboratory of Materials Modification by Laser, Ion, and Electron Beams, Dalian University of Technology, Dalian, P R China — [3]Institut für Energie- und Klimaforschung - Plasmaphysik, Forschungszentrum Jülich GmbH, Germany

We present experimental data on the ablation of molybdenum targets by femtosecond laser pulses over five orders of magnitude in laser fluence. The experiments were performed with a Ti:Sa laser with sub 7 fs (FWHM) laser pulses and a pulse energy of 0.4 mJ illuminating flat Mo targets. The samples were analyzed post mortem by electron microscopy concerning surface morphology and ablation rate. Furthermore, cross-section images in the craters were taken by focused ion beam technique, yielding information on the structure of the remaining bulk. This analysis gives a detailed overview on ablation with laser fluences along many orders of magnitude. Five distinct regimes are identified by this analysis. Four of them – with lower laser fluence – are compared to models in the literature. The fifth regime with laser fluences up to 6000 J/cm^2 has not been described before. We present a new model to explain this new ablation regime.

K 3.5 Tue 15:15 MB HS

Sub-Cycle Optical Parametric Synthesizer — •Roland E. Mainz[1,2], Giulio Maria Rossi[1,2], Fabian Scheiba[1,2], Shih-Hsuan Chia[1,2], Yudong Yang[1,2], Oliver D. Mücke[1,2], Giovanni Cirmi[1,2], and Franz X. Kärtner[1,2] — [1]Center for Free-Electron Laser Science, Notkestrasse 85, 22607 Hamburg, Germany — [2]Physics Department and The Hamburg Centre for Ultrafast Imaging, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Coherent light-field synthesis is a promising route to scale the bandwidth of optical parametric amplifiers beyond one octave. Our vision is to generate custom-tailored sub-cycle optical waveforms opening up unprecedented prospects for precision control of strong-field interactions, for the generation of intense isolated attosecond pulses and for attosecond pump-probe spectroscopy. We present our system based on three OPA spectral channels each featuring a three stage amplification chain. The system delivers a combined bandwidth of more than two octaves (500 nm - 2.2 μm) allowing for sub-cycle electric field transients with pulse durations below 1.9 fs and millijoule-level pulse energies. The sub-cycle pulse duration allows for immediate isolated attosecond pulse generation without gating techniques, and the synthesized non-sinusoidal waveforms are expected to significantly enhance the HHG efficiency for bright isolated attosecond pulses. The challenges of this approach are the CEP-stable ultra-broadband seeds generation, the timing/phase synchronization, the more than two-octave-wide dispersion management and the long term stability of a setup based on more than 28 non-linear conversion stages (WLGs and OPAs).

K 3.6 Tue 15:30 MB HS

Cascaded regime of optical parametric amplification for efficient terahertz generation — •Giovanni Cirmi[1,2], Halil Olgun[1,3], Nicholas Matlis[1], Michael Hemmer[1], Koustuban Ravi[1,4], Ivanka Grguras[1], Yi Hua[1], Anne-Laure Calendron[1], Luis E. Zapata[1], and Franz X. Kärtner[1,2,4] — [1]Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, 22607 Hamburg, Germany — [2]Physics Department and The Hamburg Centre for Ultrafast Imaging, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Helmholtz Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [4]Research Laboratory of Electronics, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, USA

The efficient generation of multi-cycle coherent THz radiation is of primary importance to drive novel table-top FELs. We explore the cascaded OPA, a new regime of OPA. We start from a home-built Yb:YLF amplifier at 1017-1020 nm temporally chirped to 800-ps. We generate intra-band DFG in a PPLN crystal phase matched for 0.5 THz. The interaction of the IR pulses with the THz pulses produces several spectrally cascaded orders, allowing for the generation of THz radiation beyond the Manley-Rowe limit. This technique promises IR-to-THz conversion efficiencies in the order of 1-10%. After studying the system at room temperature, we explored the case of a crystal at 77 K, which provides much lower THz absorption. The experimental results support the theoretical findings, and reveal that improvements in laser bandwidth and dispersion will lead to the calculated efficiencies.

K 3.7 Tue 15:45 MB HS

Optimized pulse characterization from UV to IR by two-dimensional spectral shearing interferometry (2DSI) — •Fabian Scheiba[1,2], Giulio Maria Rossi[1,2], Roland E. Mainz[1,2], Yudong Yang[1,2], Shih-Hsuan Chia[1,2], Oliver D. Mücke[1,2], Giovanni Cirmi[1,2], and Franz X. Kärtner[1,2] — [1]Center for Free-Electron Laser Science, Notkestrasse 85, 22607 Hamburg, Germany — [2]Physics Department and The Hamburg Centre for Ultrafast Imaging, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

To manipulate electron dynamics in their inherent time scale, ultrashort laser sources delivering pulse durations below one optical cycle are under development. Pulse characterization methods have to keep pace with the ultrabroad bandwidth of sub-cycle pulses. We present our simplified and compact version of 2DSI, capable of characterizing a variety of broadband light sources. The ancillary pulses can be derived from the pump laser allowing to measure even low energy pulses quickly. Moreover the possibility to up- or downconvert the fundamental spectrum permits to measure in the visible range a large variety of sources spanning from IR to UV. The two-dimensional data trace allows for direct graphical evaluation of group delay and pulse stability. This gives the opportunity to monitor the spectral phase in real-time for >1 kHz rep.-rate systems. 2DSI measurements of a two-color driven hollow core fibre, an OPA synthesizer and an octave-spanning Ti:sapphire oscillator, demonstrate the capability to characterize ultrabroadband pulses with energies from few nJs to mJs level.