Q 13: Laser Development and Applications (joint session Q/A)

Time: Monday 14:00–15:45 Location: K 0.023

Q 13.1 Mon 14:00 K 0.023

Pump-power scaling of a diode-pumped Alexandrite laser — •Martin Walochnik[1], Hans Huber[1], Bernd Jungbluth[2], Alexander Munk[2], Michael Strotkamp[2], Dieter Hoffmann[2], and Reinhart Poprawe[1,2] — [1]RWTH Aachen University Chair for Laser Technology LLT — [2]Fraunhofer Institute for Laser Technology ILT

The possibility of diode pumping and the tunability between 700 nm and 800 nm make Alexandrite a remarkable laser gain medium. At present the scalability of the pump power and pump brilliance as well as the temporal stability of the laser output remain challenging. We report on our progress of using a red diode laser with spatially symmetrized output for end pumping of an Alexandrite laser rod. We measured the thermal dioptric power of the pumped laser crystal and experimentally identified the induced thermal aberrations as an important limit of the applicable pump power density. We designed a laser resonator with special emphasis on fundamental mode operation for high dioptric powers. We show results of a continuously pumped Alexandrite laser with wavelengths between 740 nm and 785 nm and fundamental mode operation up to 5 W. Future work will address further development of this laser in the field of mode locking and frequency conversion to generate ultrashort pulses and operate in the UV regime, respectively.

Q 13.2 Mon 14:15 K 0.023

Fourier Limited Picosecond Pulses for Laser Cooling of Relativistic Ion Beams — •Daniel Kiefer and Thomas Walther — Technische Universität Darmstadt, Institut für Angewandte Physik, Laser und Quantenoptik, Schlossgartenstr. 7, 64289, Darmstadt

Laser cooling of relativistic ion beams has been shown to be a sophisticated technology [1] and white light cooling has been demonstrated in non-relativistic ion beam cooling [2]. However, the experimental realisation of white-light-cooling of relativistic beams still has to be performed. The necessary laser bandwidth shall be provided by pulsed laser light. Simulations have shown the demanding requirements for these laser pulses [3]. We present a master-oscillator-power-amplifier system supplying laser pulses of 100 to 740 ps length with a centre wavelength of 1029 nm. The system is marked by the Fourier transform limited character of the pulses, the continuously adjustable pulse length and the repetition rate between 500 kHz and 10 MHz. [1] S. Schröder et al, Phys. Rev. Lett. 64, 2901-2904, (1990). [2] S.N.Atutov et al, Phys. Rev. Lett. 80, 2129, (1998). [3] L. Eidam et al, arXiv:1709.03338 [physics.acc-ph], (2017).

Q 13.3 Mon 14:30 K 0.023

Ultra Compact High-Harmonic Cavity Optical Parametric Oscillator for Optical Amplifier Seeding — •Marco Nägele[1], Florian Mörz[1], Heiko Linnenbank[1], Tobias Steinle[2], Andy Steinmann[1], and Harald Giessen[1] — [1]4th Physics Institute, University of Stuttgart, Germany — [2]ICFO, Barcelona, Spain

We present a master oscillator power amplifier (MOPA) scheme, based on a high-harmonic cavity optical parametric oscillator (OPO), emitting tunable light in the near infrared region. Different from conventional OPOs and our previous fiber-feedback OPO, the high-harmonic OPO cavity uses only a fraction of the fundamental conventional OPO cavity length, thus supporting the 15th harmonic and offering a very compact design. Additionally, low pump power values provide high suitability for post-amplification of the OPO output, since the remaining pump power is available for an optical parametric amplifier (OPA). We recorded a pump power threshold between 30-100 mW over the entire OPO tuning range from 2.3-4.1 μm. A high versatility of different pump laser sources with MHz repetition rate is suitable by using the high-harmonic cavity design and direct idler outcoupling. As the signal pulse remains inside the cavity, the ejected idler pulses match the pump laser in repetition rate, pulse duration, and shape. While we use a 450 fs pulsed solid-state pump laser at 1030 nm and 41 MHz, different repetition rate pump sources are usable by several cm cavity length adjustment in order to match a higher pump harmonic. Post amplification of the ejected idler using an (OPA) additionally generates tunable signal light between 1.4-2 μm.

Q 13.4 Mon 14:45 K 0.023

Noncollinear optical parametric oscillator for Raman Spectroscopy of Microplastics — •Luise Beichert[1], Yuliya Binhammer[1], José Ricardo Andrade[1], and Uwe Morgner[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Germany — [2]Hannoversches Zentrum für optische Technologien, Leibniz Universität Hannover, Germany

Meanwhile microplastics can be detected in an increasing rate in our enviroment as well as in our drinking water. We present a broadband and fast tunable light source to detect these particles via stimulated Raman scattering in water circulation.

Noncollinear optical parametric oscillators (NOPOs) provide a good scalability in terms of output power, repetition rate and pulse energy. The instantaneous broadband frequency conversion combined with the special phase matching geometry in the nonlinear crystal enables a fast tunability without readjustment.

We show an IR-NOPO, rapidly tunable in 1 ms from 750 to 950 nm and Ramanspectra in the range of 500-3200 cm^{-1} of different plastic particles.

Q 13.5 Mon 15:00 K 0.023

Monitoring protein configurations in the fingerprint region with micro-FTIR spectroscopy using a 98 fs solid-state laser tunable from 1.33 to 8 μm at 73 MHz repetition rate — •Florian Mörz[1], Rostyslav Semenyshyn[1], Frank Neubrech[2], Tobias Steinle[3], Andy Steinmann[1], and Harald Giessen[1] — [1]4. Physikalisches Institut, Universität Stuttgart — [2]Kirchhoff-Institut für Physik, Universität Heidelberg — [3]ICFO-Institut de Ciencies Fotoniques, Barcelona, Spanien

Configurations of poly-L-lysine proteins using vibrational resonances at 6 μm (1667 cm-1) are monitored by employing a broadband femtosecond laser for micro-FTIR spectroscopy in combination with resonant surface-enhanced infrared absorption (SEIRA) spectroscopy, using a single gold nanoantenna. Our tabletop laser system exceeds the sensitivity of standard FTIR light sources due to an orders of magnitude higher brilliance. Absorption signals as small as 0.5% are detected without averaging, compared to 6.4% using a globar, at 10x10 μm^2 spatial resolution. By pumping a fiber-feedback optical parametric oscillator and a post-amplifier, signal and idler beams spanning from 1.33-2.0 and 2.1-4.6 μm are generated. The tuning range is extended to 8 μm by difference frequency generation between the signal and idler beams. At 7 μm a wavelength stability with fluctuations smaller than 0.1% rms over 9 hours is observed, without applying electronic stabilization. Thus our design is distinctly superior over other systems based on free-space OPOs and applications such as protein sensing using FTIR spectroscopy in combination with SEIRA are enabled.

Q 13.6 Mon 15:15 K 0.023

Systematic refractive index measurements of photo-resists for three-dimensional direct laser writing — •Michael Schmid and Harald Giessen — 4th Physics Institute and Research Center SCoPE, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Femtosecond 3D printing is an important technology for manufacturing of nano- and microscopic devices and elements. Crucial for the design of such structures is the detailed knowledge of the refractive index in the visible and near-infrared spectral range and its dispersion.

We characterize different photoresists that are used with femtosecond 3D direct laser writers, namely IP-S, IP-Dip, IP-L, and OrmoComp with a modified and automized Pulfrich refractometer setup, utilizing critical angles of total internal reflection. Thereby we achieve an accuracy of $5{\cdot}10^{-4}$ and reference our values to a BK-7 glass plate. Their refractive indices are in the 1.49-1.57 range, while their Abbe numbers are in the range between 35 and 51.

Furthermore, we systematically study the effects of UV exposure duration as well as the aging process on the refractive index of the photo resists which are crucial for 3D printed functional devices, especially nano- and microscopic devices. We also deliver the first measurements of refractive index of actual 3D printed samples.

Q 13.7 Mon 15:30 K 0.023

Atom Trap Trace Analysis: Pushing the volume limit for radiometric dating with applied quantum technology — •Lisa

Ringena[1], Zhongyi Feng[1], Sven Ebser[1], Maximilian Schmidt[1], Arne Kersting[2], Emeline Mathouchanh[2], Philip Hopkins[2], Viola Rädle[2], Werner Aeschbach[2], and Markus K. Oberthaler[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg — [2]Institut für Umweltphysik, Universität Heidelberg

Argon Trap Trace Analysis (ArTTA) applies quantum technology to establish an ultra-sensitive detection method for the radioisotope ^{39}Ar. This isotope, with a half-life of 269 years, serves as an unique tracer for dating of environmental samples. The atom of interest is distinguished from the huge background of abundant isotopes by utilizing its shift in optical resonance frequency due to differences in mass and nuclear spin. This selectivity is realized by the multitude of scattering processes in a magneto-optical trap (MOT), where single atoms are captured and detected [1]. Recently the instrument has been upgraded to operate with a minimum of 1mL STP argon gas, degassed from about 2.5L of water, drastically decreasing the effort invested in environmental studies such as ocean depth profiles, and making dating of glacier ice feasible. Paving the way towards routine operation, measures have been taken to increase the stability of the experiment, such as the setup of a new laser system. We will present systematic studies of the apparatus, which show a doubled count rate, leading to shorter measurement times and reduction of statistical errors.

[1] Ritterbusch et al., GRL 2014, DOI: 10.1002/2014GL061120