# Q 72: Ultrashort Laser Pulses III

Time: Friday 15:30–16:30 Location: a310

Q 72.1 Fri 15:30 a310

**Line-by-line amplitude and phase modulation of a 10 GHz frequency comb for pump-probe spectroscopy** — •Ali Seer, Oliver Kliebisch, Dirk Heinecke, and Thomas Dekorsy — Department of Physics and Center for Applied Photonics, University of Konstanz, D-78457, Germany

The time-resolved investigation of optically excited nanostructures with tailored pulse sequences is an important technique to study nanomechanical systems [1]. However these techniques are at present limited to 1 GHz or lower due to the lack of high repetition rate femtosecond pulse sources. Here we present a method to generate pulse trains with high repetition rates in the order of fundamental resonance frequencies of nanomechanical systems. Using a 10 GHz Ti:sapphire laser the wide spacing of the frequency comb modes [2] allows us to spatially resolve them using dispersive optics. Independent modulation of phase and amplitude of individual modes is performed using a spatial light modulator to realize line-by-line pulse shaping. Increase of repetition rate is achieved by optimization of modulator phase masks by a genetic algorithm. A tapered semiconductor amplifier is used in a double pass configuration to amplify pulses by factors up to 30 dB [3]. In this way intensity cross correlation measurements are carried out in a pump probe setup employing asynchronous optical sampling (ASOPS) with a second 10 GHz Ti:sapphire laser [4]. [1] Bruchhausen et al., PRL 106, 077401 (2011). [2] Bartels et al., Opt. Lett. 33, 1905 (2008). [3] Bolpasi et al., Rev. Sci. Instrum. 81, 113108 (2010). [4] Gebs et al., Opt. Express 18, 5974-5983 (2010) .

Q 72.2 Fri 15:45 a310

**High-speed stimulated Raman scattering microscopy with an all-optical nonlinear modulator** — •Tobias Steinle, Moritz Floess, Andy Steinmann, and Harald Giessen — 4th Physics Institute and Research Center SCOPE, University of Stuttgart, 70550 Stuttgart, Germany

We introduce a novel technique for high-frequency modulation of femtosecond pulses based on period doubling enabled by nonlinear feedback in an optical parametric oscillator (OPO). We demonstrate the applicability of this technique in a stimulated Raman scattering experiment, where the modulated Raman pump is directly derived from the OPO, while the Stokes is provided by the same Yb:KGW oscillator that pumps the OPO. It is shown that the technique works over a broad spectral range with sufficient modulation depth. With this scheme, the highest possible modulation frequency, namely half the repetition rate, is achieved. Further, the modulation is intrinsically synchronized with the reference pulse train. Hence, it provides optimum performance in any pump-probe scheme. Also, it is scalable to higher modulation frequencies by scaling the repetition rate of the system.

Q 72.3 Fri 16:00 a310

**Broadband supercontinuum generation in high-confinement $Si_3N_4$ integrated optical waveguides** — •Florian Schepers[1], Marco Garcia Porcel[2], Jörn Epping[2], Tim Hellwig[1], Klaus-Jochen Boller[2], and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, Germany — [2]MESA+ Institute of Nanotechnology, University of Twente, The Netherlands

A novel approach for the fabrication of stoichiometric silicon nitride ($Si_3N_4$) waveguides allows the realization of $Si_3N_4$-waveguides with an increased thickness of up to 1.2 $\mu$m[1]. This thickness enables anomalous dispersion in the near-infrared range. In addition the modal confinement for waveguides of such dimensions increases with the size of the waveguides. These two aspects make these waveguides highly desirable for the generation of ultra-broadband supercontinua. The waveguides can be designed such that the zero-dispersion wavelengths are favorable for pumping at multiple common laser wavelengths, importantly, around 1030 nm and 1550 nm where Yb- and Er-fiber lasers are available. Using ultrashort laser pulses at a wavelength of 1064 nm as a pump wave, a supercontinuum with a bandwidth of 495 THz has been obtained[2], spreading from 470 nm up to 2130 nm. This corresponds to the broadest supercontinuum ever generated on a chip. Similarly, using pump pulses in the telecommunication range near 1550 nm, a supercontinuum spanning from 560 nm to more than 2100 nm wavelength has been generated.

[1] Epping J., et al., *Opt. Express* **23**, 642 (2015).
[2] Epping J., et al., *Opt. Express* **23**, 19596 (2015).

Q 72.4 Fri 16:15 a310

**Ultrakurzpuluslaser-Mikrostrukturierung für die Anwendung in Dünnschichtphotovoltaik** — •Jürgen Imgrunt[1], Kambulakwao Chakanga[3], Karsten von Maydell[3] 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 — [3]EWE Forschungszentrum NEXT ENERGY, 26129 Oldenburg, Deutschland

Lichtmanagement in Solarzellen spielt eine wichtige Rolle zur Verbesserung der Lichtabsorption und der Effizienz. Hierzu wurde eine Bearbeitungsstation auf der Basis eines Ultrakurzpulslasers aufgebaut (150 fs Pulsdauer bei 775 nm Zentralwellenlänge) und mehrere Glassubstrate erfolgreich strukturiert. Die Strukturgeometrie in Form von abgerundeten Ablationskratern mit ca. 3 $\mu m$ Durchmesser konnte gut reproduziert werden. Die Substrate unterschieden sich allein im Strukturabstand, was Einfluss auf die Strukturqualität hatte. Für die Anwendung in der Dünnschichtphotovoltaik wurden die strukturierten Substrate auf die Streueigenschaften im sichtbaren und nahen infraroten Spektralbereich untersucht. Anschließend wurden Dünnschichtsolarzellen auf den strukturierten Substraten hergestellt. Für die Dünnschichtsolarzelle auf dem Substrat mit der höchsten Strukturdichte wurde eine Erhöhung der Lichtabsorption und des externen Quantenwirkungsgrad für den Spektralbereich $> 620nm$ gemessen.