Generation of ultrashort laser pulses via OPCPA in the infrared spectral region

Due to the lack of solid state gain materials in the mid- to long-wave infrared spectral region beyond 3 µm wavelength, optical parametric chirped pulse amplification (OPCPA) has become the key technique for the generation of intense femtosecond pulses. This talk introduces a novel front-end for the mid-wave and long-wave infrared spectral region based on a Cr:ZnS oscillator emitting pulses centered at 2.4 µm with 30 fs pulse duration. This front-end simplifies the typically complicated laser architecture by providing the pump and the signal simultaneously.

A Ho:YLF regenerative amplifier serves as the pump at 2.05 µm and provides at 1 kHz repetition rate pulses with 3 ps duration and a record energy of 13 mJ [1]. Self-frequency shifted solitons in a nonlinear ZBLAN fiber serve as the signal seed for the mid-wave infrared OPCPA. It is based on $ZnGeP_2$ crystals and generates tunable idler pulses between 5.4 and 6.8 µm with sub-100 fs duration [2]. In the long-wave infrared region, a 3-stage OPCPA based on GaSe generates idler pulses at 11.4 µm with a pulse duration of 185 fs and an unprecedented energy of 65 µJ. This enables for the first time to estimate the lifetime of the librational (L2) band of water via direct excitation [3].

[1] P. Fuertjes, L. von Grafenstein, D. Ueberschaer, C. Mei, U. Griebner, and T. Elsaesser,"Compact OPCPA system seeded by a Cr:ZnS laser for generating tunable femtosecond pulses in the MWIR", Opt. Lett. 46, 1704 (2021).
[2] P. Fuertjes, L. von Grafenstein, C. Mei, M. Bock, U. Griebner, and T. Elsaesser,"Cr:ZnS based soliton self-frequency shifted signal generation for a tunable sub-100 fs MWIR OPCPA", Opt. Express 30, 5142 (2022).
[3] P. Fuertjes, M. Bock, L. von Grafenstein, D. Ueberschaer, U. Griebner, and T. Elsaesser, "Few-cycle 65-µJ pulses at 11.4 µm for ultrafast nonlinear longwave-infrared spectroscopy", Optica 9, 11 (2022).