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Toolbox for the Development of a MIR NOPA for Time-Domain Ptychography and Initial Results

This presentation discusses a noncollinear optical parametric amplifier as a source of ultrafast mid-infrared light for spectroscopic experiments and aims to provide a consistent method for the generation thereof. The proposed laser source at the Laser Research Institute is intended for the investigation of molecular vibrations of organic molecules on a femtosecond timescale. The underlining theory and fundamental principles of this device is outlined, as well as various experimental considerations considering key concepts such as difference frequency generation, phase matching and group velocity matching.
A design for an experimental setup to generate suitable ultrafast mid-infrared light is proposed and preliminary optical devices are implemented. This design features multiple optical amplification and generation stages to enhance both the intensity of the output pulses and the degree of spectral tuneability. Output pulse are expected to be centred between 3-8 µm. Initial experiments indicate that simple approaches to mid-infrared pulse generation fall short. Given the limited pulse energies, generation of a 160 nm bandwidth, near-infrared supercontinuum centred at 1067 nm is shown to be inadequate for the generation of mid-infrared pulses. Parasitic second harmonic-, sum frequency and difference frequency generation processes are also shown to impede mid-infrared generation. These restricting experimental phenomena are highlighted and methods to bypass these limits are given.
Finally, as a demonstration of the usefulness of such a source of infrared pulses, the novel time-domain ptychographic measurement, HIPPY, of a material's response to mid-infrared light is simulated. This spectroscopic method is shown to be efficient and computationally undemanding. Its introduction into an ultrafast spectroscopy lab expected to be relatively simple.
By covering the various aspects concerning the generation of mid-infrared pulses and some limiting phenomena, long with a proposed optical design and spectroscopic application, a comprehensive yet concise picture of mid-infrared pulse generation and application is shaped.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

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