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CHIRPED PULSE AMPLIFICATION OF OPTICAL PULSE BURSTS WITH ULTRAHIGH INTRABURST REPETITION RATE

A new technique enables the Chirped Pulse Amplification of a finite train of ultrashort pulses up to millijoule levels with ultrahigh, terahertz-scale intraburst repetition rate. This not only allows for several interesting applications, such as multi-probe time-resolved spectroscopy, but also generates frequency-tunable spectral peaks with exceptionally high spectral brightness. This is interesting especially for novel nonlinear spectroscopic applications such as Stimulated Raman Scattering (SRS) or Resonantly-Enhanced Multi-Photon Ionization (REMPI).

BACKGROUND

In the time-domain, the generation of a controllable and pulse-number-scalable train of ultrashort pulses is a tedious task. However, it is a necessary tool to increase observation speed in time-resolved spectroscopies, which currently mostly depend on the very slow translation of mechanical stages.
In the frequency domain, the need for tunable and intense spectral peak structures is present due to several nonlinear spectroscopic & machining applications.

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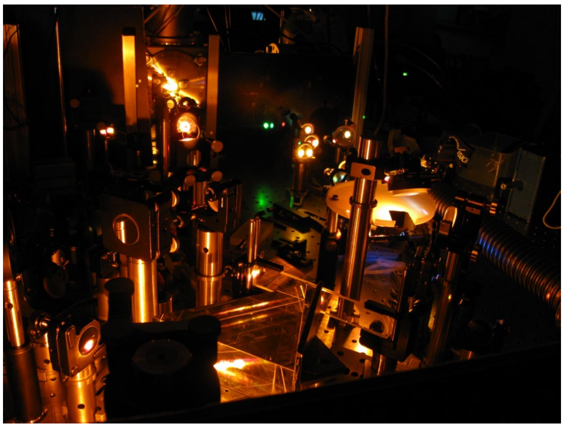
The present technique represents a further developed version of the famous Chirped Pulse Amplification (CPA) technique. With CPA an ultrashort pulse is stretched prior amplification and recompressed afterwards. This avoids the damage in optical amplifiers by reducing temporarily the temporal intensity. However, this concept breaks down for multiple pulses which are much tighter spaced than their stretched pulse duration and amplified together, where temporal intensity spikes by interference effects arise. By applying Phase-Scrambled CPA (PSCPA), a suitable phase modulation is imprinted on the seed pulses prior amplification (phase scrambling) regaining amplification conditions resembling those of a single pulse. After PSCPA, a specialized Optical Parametric Amplifier (OPA) utilizes the multi-mJ energy of amplified pulses to efficiently convert their optical carrier frequency to the required frequency range (XUV to Mid-IR) with microjoule energies after conversion. Further, the OPA demodulates the pulses in their phase such that in-phase pulses with a strong spectral peak structure are acquired.



ADVANTAGES

- MHz-broad spectral peaks with exceptionally high spectral brightness
- Shaping capabilities of the spectral peak structure
- A highly scalable number of burst pulses
- Tunability of the temporal spacing of burst pulses
- Control over individual burst pulse amplitudes

WISSENS/ TRANSFER/ OST/

REFERENCE:
M048/2020

DEVELOPMENT STATUS:
Labscale proof-of-concept; industrial full scale design concepts
TRL 3-4

APPLICATIONS:
Stimulated Raman Scattering / Multi-Photon Ionization / Time-resolved Spectroscopies / Material and Surface diagnostics

KEYWORDS:
Ultrashort laser pulses
Burst Amplification
Nonlinear Optics

IPR:
PCT patent application pending
WO2022/217301 A1

OPTIONS:
R&D cooperation,
Development partnership,
License agreement

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