

Generation of Few-Cycle THz Pulses in DSTMS Driven by an 8.3-MHz Amplified Mamyshev Oscillator

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Abstract: We demonstrate few-cycle THz pulse generation at 8.3-MHz repetition rate via optical rectification in a 190- μm DSTMS crystal driven by a 31-fs, 1.1-W amplified Mamyshev oscillator, delivering 40 μW average THz power and > 4 THz bandwidth.

Ultrafast ytterbium-doped fiber lasers based on Mamyshev oscillators (MOs) offer broad spectra, high pulse energies and excellent compressibility to few-tens-of-femtosecond durations, making them attractive drivers for nonlinear optics and laser-driven terahertz (THz) generation via optical rectification (OR) in χ^2 crystals [1]. Here we investigate THz generation at multi-MHz repetition rate using a compact Yb-fiber system built around an amplified MO operating at 8.3 MHz and delivering 31-fs pulses at 1.1 W average power near 1 μm [2], which pump a 190- μm -thick DSTMS organic crystal.

Thanks to its large effective nonlinear coefficient and favorable phase-matching, DSTMS enables stable, broadband few-cycle THz emission [3]. By measuring the average THz power as a function of the incident infrared pump power, as shown in Fig. 1(a), we observe the purely quadratic dependence expected for an OR process, and we reach a maximum average THz power of 40 μW at 1.02 W pump power. Possible limitations due to heat accumulation and nonlinear absorption in the organic crystal at MHz repetition rate are evaluated by varying the duty cycle of a high-speed chopper between 10% and 50% at fixed pulse energy, and by comparing these measurements with continuous operation. The results are displayed in Fig. 1(b): the normalized THz power scales linearly with duty cycle and shows no evidence of saturation up to 100% duty, indicating that thermal effects, cascaded OR and multiphoton absorption remain marginal in our regime.

The electro-optic sampling shown in Fig. 2(a) confirms the few-cycle character of the emitted THz pulses and reveals a power spectral density extending from quasi-DC frequencies below 0.25 THz to beyond 4 THz, with clear water-vapor absorption lines and only moderate attenuation of the highest-frequency components due to the detection crystal, well visible in Fig. 2(b). When the DSTMS crystal is replaced by a 500- μm -thick GaP emitter under identical pumping conditions, the detected THz power drops by more than an order of magnitude while maintaining a comparable usable bandwidth, in agreement with the higher effective nonlinearity of DSTMS. A complementary Schottky-diode measurement of the power spectrum around the laser repetition rate shows a

narrow, high-contrast line at 8.3 MHz without additional excess noise introduced by the OR process.

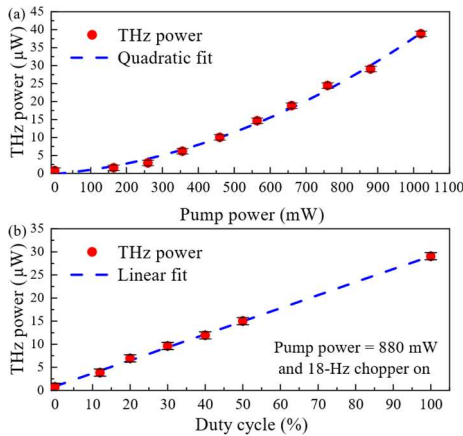


Fig.1 | THz average power measured with the pyroelectric power meter as a function of the infrared pump power (a) and of the chopper's duty cycle (b).

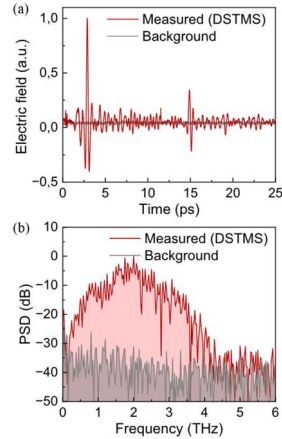


Fig.2 | Electro optical sampling of THz pulses (a) and spectrum (b).

Overall, these results demonstrate that amplified Mamyshev oscillators can efficiently drive thin organic crystals at multi-MHz repetition rates to produce broadband, few-cycle THz pulses, opening promising prospects for compact THz time-domain spectrometers and advanced spectroscopy schemes based on this laser technology. Future work will focus on exploring other organic emitters with different phase-matching characteristics, such as BNA, in order to tailor the THz spectrum and potentially further increase the conversion efficiency.

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References

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