High-Power, Ultra-Broadband THz Generation in Organic Crystal MNA

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Motivation

THz source based on optical rectification in a new generation of nonlinear organic crystals:

- High power (>1 mW), high efficiency (percent level) and ultra broad bandwidth (>10 THz)
- Discovering, synthesizing and characterization of new crystals through structural data mining [1]
- Exceeding the performance of industry standards in terms of crystal size and quality

[1] https://doi.org/10.1002/adma.202107900

MNA (Amino-5-Nitrotoluene): a good candidate to be investigate with high power, high repetition rate, Yb-based pump laser:

- High molecular hyperpolarizability
- Relatively large molecular number density
- High nonlinear coefficient of 250 pm/V [2]

[2] https://doi.org/10.1143/JJAP.27.L1131

THz-TDS setup

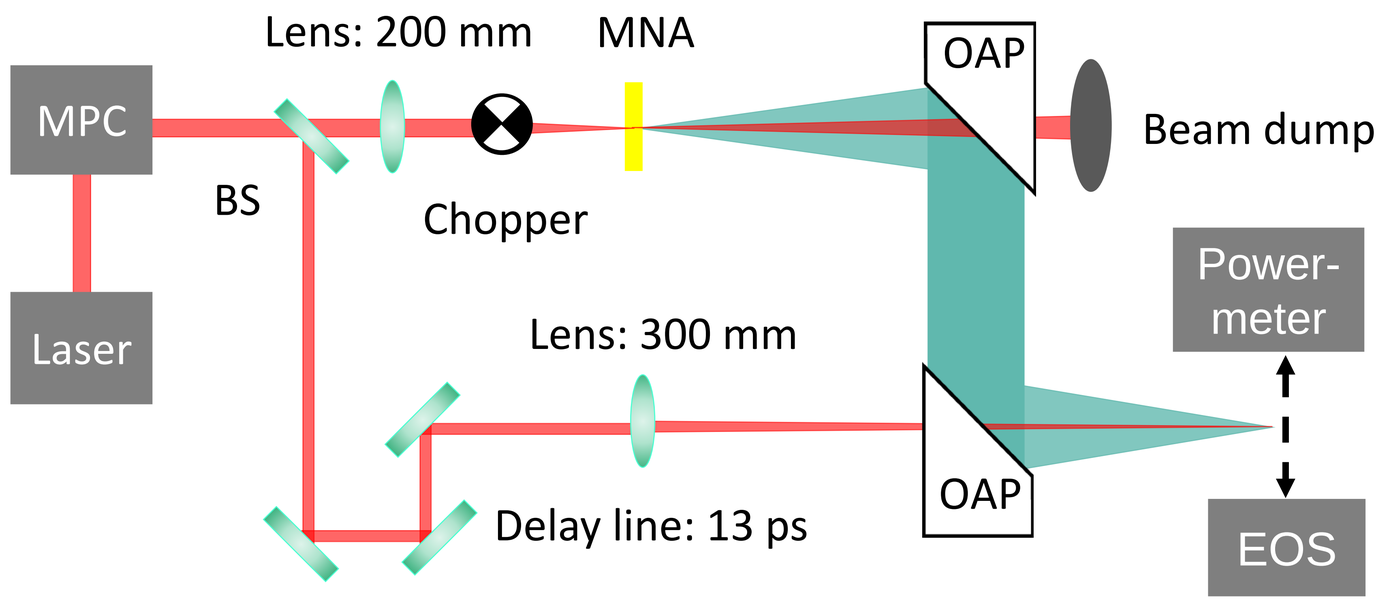
Driving laser: TruMicro 2000, TRUMPF

λ : 1030 nm P_{avg} : 18 W

f_{rep} : 400 kHz τ_p : 35 fs (after MPC)

THz generation
MNA crystal thickness: 1 mm
Beam diameter ($1/e^2$) on the crystal: 2.3 mm

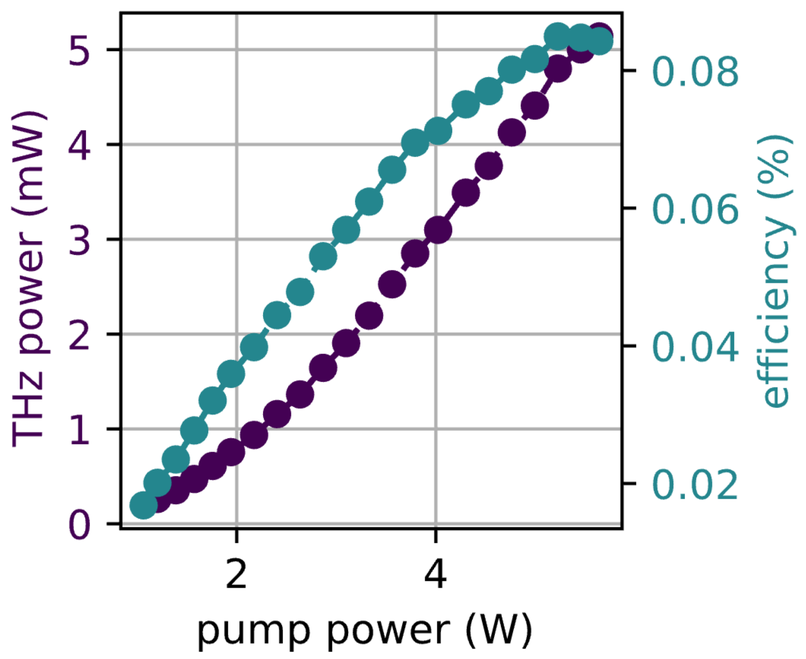
Detection crystal
MNA with thickness of 0.65 mm or
gallium phosphide (GaP) with thickness of 0.1 mm



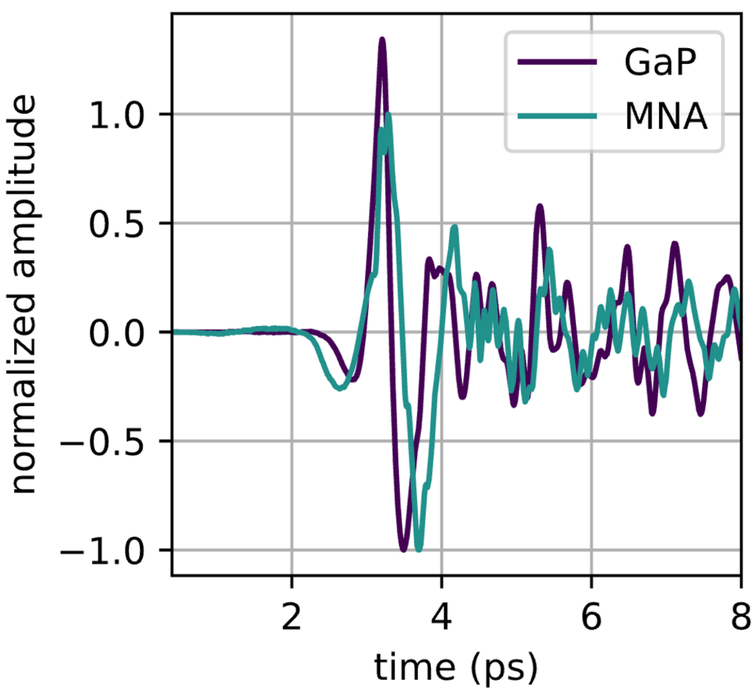
MPC: multi-pass cell
OAP: off-axis parabolic mirror
EOS: electro optic sampling
BS: beam splitter

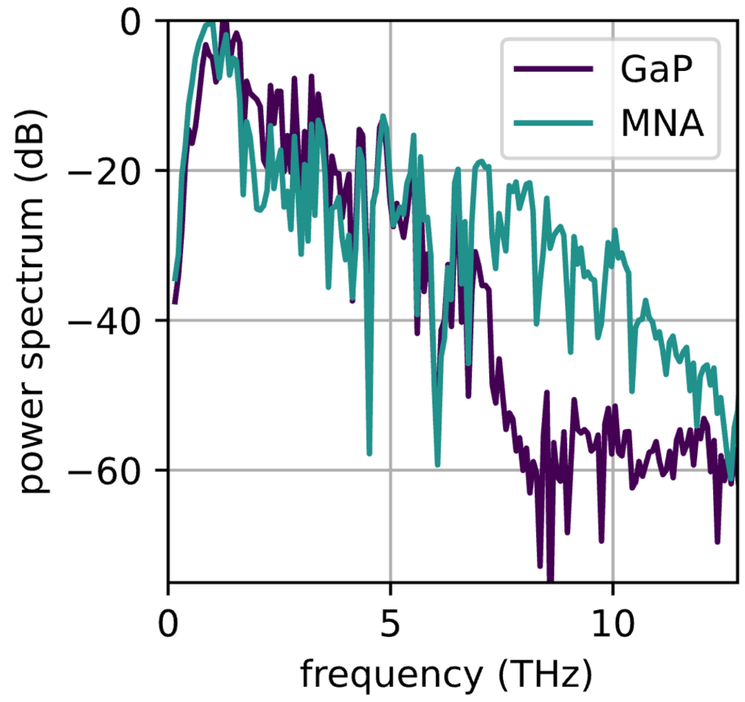
Results & Discussion

THz power measured by a calibrated power meter



Electro optic sampling (EOS)





Maximum THz power at pump power of 5.3 W: 5.2 mW
Maximum efficiency at pump power of 5.3 W : 0.08%

Detection GaP → Bandwidth of 7 THz
Detection MNA → Bandwidth of 12 THz

Conclusion & Outlook

- A high average power (5.2 mW), ultrabroadband (>12 THz), and high dynamic range THz-TDS based on MNA

terahertz.NRW Marie SFB/TRR 196

- A unique tool for a variety of spectroscopy experiments and nonlinear THz spectroscopy
- Power scaling by optimizing the pump spot, reducing the repetition rate of the laser and operating in purged conditions