THz pulses at mJ level from organic crystal pumped by a $Cr:Mg_2SiO_4$ laser

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Single-cycle Terahertz transients at high fields are a powerful tool to explore fundamental properties of condensed matter and ultimately to initiate coherently collective processes by nonionizing light [1]. While intense pulses at mid-infrared frequencies between 20-100 THz (15 µm -3 µm) have been demonstrated [2], the production of high-energy single-cycle pulses with fields of several MV/cm in the Terahertz gap (3000 µm - 30 µm) remained a challenge. We present a table-top source based on organic crystal [3-5] emitting single-cycle transients at frequencies of 0.1-5 THz with electric and magnetic fields at the focus larger than 40 MV/cm and 14 Tesla. The source is realized by optical rectification in recently developed 4 cm^2 partitioned DSTMS [6] pumped by 30 mJ $Cr:Mg_2SiO_4$ (Cr:F) laser, for details see [7]. With respect to optical parametric amplifier used in the past to drive the organic crystal, the Cr:F laser offers one order larger energy and which turns into THz pulse energy as large as 900 µJ and energy conversion efficiency of 3 %.

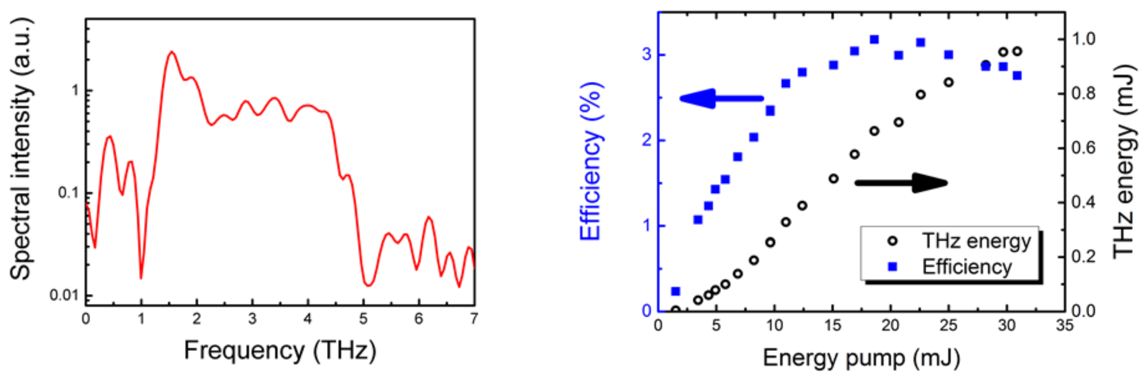

Fig. 1. (Left) terahertz spectrum measured by THz Michelson interferometer, (right) THz pulse energy (black circles) and conversion efficiency (blue points) as function of the pump energy.

Shown in Figure 1 left graph is the spectrum produced in DSTMS at maximum pump power and recorded by Michelson interferometer. The THz pulse carries a spectrum which covers the full range between 0.1 and 5 terahertz and is peaked at around 2.8 THz. The dip at 1 THz is due to a phonon-active resonance in DSTMS

Shown in figure 1 (right plot) are the measured THz pulse energy and conversion efficiency in dependence of the pump pulse energy. THz pulse energy above 900 µJ is achieved for 33 mJ pump. The laser-to-THz conversion efficiency of about 3% is measured at intermediate pump energy (20 mJ) before it drops to approximately 2.7% for higher pump intensities. The THz beam could be focused down to 260 µm FWHM resulting in record-high electric and magnetic field of 42 MV/cm and 14 Tesla respectively. This is the largest ever-reported terahertz field in the 0.1-5 THz frequency range and open new opportunities in THz science [8].

3. References

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