Possibility of carbon-dioxide pumped terahertz sources

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Terahertz generation in nonlinear media is known to be a widely used way to generate single cycle terahertz pulses with great efficiency. Using high pumping intensity in semiconducting materials at the close infrared region is not feasable due to the high multiphoton absorption. [1] As of now, carpon-dioxide lasers with sub-picosecond pulse durations are available [2], which can eliminate low-order multiphoton absorption since their central wavelength is approximetly 10 µm.

Numeric 1D+1 calculations were used with pulse durations between 0.5-2.5 ps and intensities from 20- to 100 GW/cm^2 for investigation. The model took account for the optical rectification, cascading up- and downconversion of pump pulse, the self phase modulation of pump pulse [3] and the second harmonic generated by the pump pulse. The inclusion of second-harmonic generation (SHG) is very important since it can reduce the THz conversion efficiency by up to 50%. The nonlinear media was chosen to be Gallium-Arsenide (GaAs). The result with 1.5 ps pulse duration and 60 GW/cm^2 pumping intensity is shown on Fig.1.

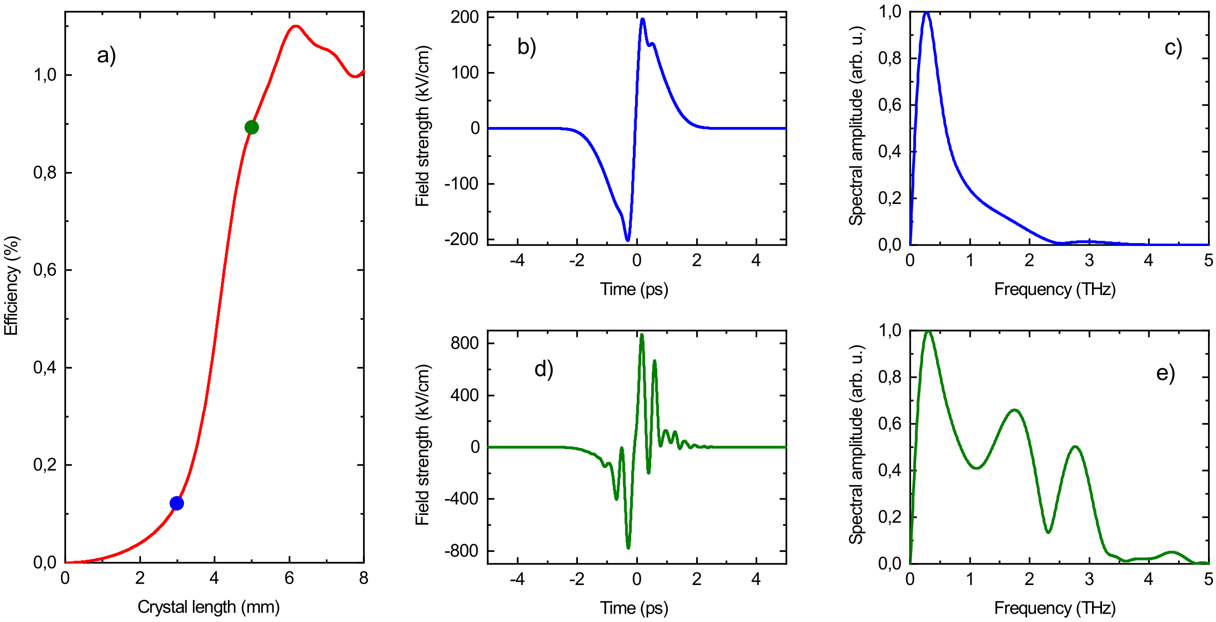

Fig. 1 Results of numeric calculations: a) conversion efficiency,
b)-c) electric field and spectrum at 3 mm, d)-e) electric field and spectrum at 5 mm

The results show that carbon-dioxide pumped GaAs crystal is capable of generating THz pulses with adequate efficiency and field strength. At 3 mm crystal length the shape of the THz pulse is usable for most applications that require single-cycle THz pulses. The efficiency at 3 mm is 0.1% and the peak field strength is 200 kV/cm and by focusing 10 MV/cm peak field strength is achievable [4]. At 5 mm crystal length the conversion efficiency further increases to 0.9% however the THz pulse becomes highly modulated.

References

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