Tunable THz source with less than 100 GHz bandwidth

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A tunable THz source for remote sensing has been realized using difference frequency generation of the signal and idler wavelengths of a BBO based optical parametric oscillator [1]. THz pulses with frequencies 1 – 20 THz and a bandwidth of less than 100 GHz are produced in two operational modes via difference frequency generation (DFG) process by mixing two infrared waves in novel organic crystals with extremely high optical nonlinearities (DSTMS and OH1) [2]. One operational mode is at a fixed THz wavelength of 1.25 THz for high output powers using OH1 as organic material for stand-off applications, and the second mode is for tuning between 1 – 20 THz using the organic crystal DSTMS for spectroscopy applications. The optimum wavelength range in view of the material properties of DSTMS and OH1 is centered at 1400 nm.
To provide the pump for the DFG process, an optical parametric oscillator (OPO) using KTP crystals as the nonlinear crystal was selected [3]. The KTP crystals are cut at an angle of 64° for type–II phasematching in the xz plane. The pump laser is a Q-switched frequency doubled Nd:YAG laser at 532 nm with pulses of 8 ns and a repetition rate of 100 Hz. Signal waves of around 860 nm are generated and idlers (λ_1 and λ_2) in the 1400 nm region.
In this work we present results of the optimization of the OPO in terms of output power and spectral linewidth and show results of the THz generation via DFG in DSTMS and OH1. Fig. 1 shows the generated output power at 1.25 THz as a function of the OPO idlers' power for an OH1 crystal with a length of 3.15 mm and a useful aperture of 5 mm. The THz power was calibrated using another source with a well known power at 0.55 THz. At the maximum OPO idler power of 1.27 W, a THz power of 15.5 µW with a linewidth of 100 GHz has been obtained. In the tuning mode of the THz source a DSTMS crystal with a length of 0.8 mm was used with a useful aperture of 3 mm. The generated THz radiation frequency was tuned by changing one of the idler wavelengths and the generated THz power was measured. Fig. 2 shows an example of such a scanning measurement in the frequency range between 1.2 and 4.0 THz. The radiation above 3.5 THz was strongly attenuated by a black polyethylene filter in front of the THz detector (Golay cell). We expect higher generated THz power, for higher wavelengths, taking into account that the photon energy increases proportionally with frequency. In this configuration a maximum THz radiation power of about 6 µW has been reached at 3.2 THz for the combined idlers' power of 1.13 W.

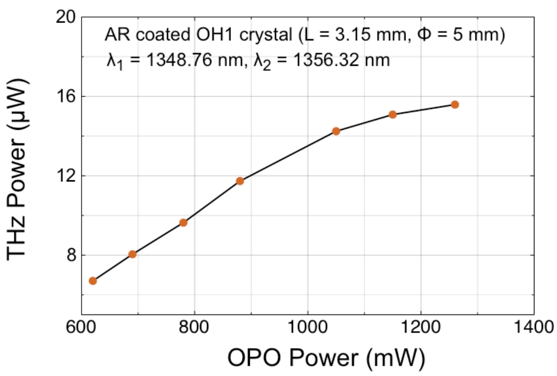

Fig. 1 Generated power at 1.25 THz as a function of the OPO (idler) power. The THz generating crystal OH1 had a length of 3.15 mm and a useful aperture of 5 mm.

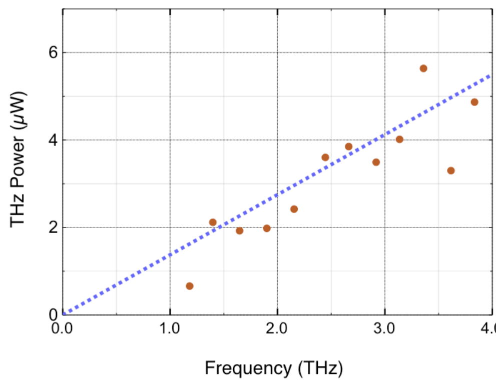

Fig. 2 Generated tunable THz radiation in a DSTMS crystal.

References

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