Continuous Wave Intracavity Terahertz Source

M. Scheller[1,2], J. M. Yarborough[2,3], J. V. Moloney[2,3], M. Fallahi[2,3], M. Koch[1,2], and S. W. Koch[1,2]

1. Fachbereich Physik, Philipps-Universität Marburg, 35032 Marburg, Germany

2. Desert Beam Technologies LLC, 3542 N Geronimo Avenue, Tucson, AZ 85705, USA

3. College of Optical Sciences, University of Arizona, 1630 E University Boulevard, Tucson, AZ, 85721, USA

Sources for continuous wave (CW) terahertz (THz) radiation are desirable for a wide range of applications ranging from spectroscopy over quality inspection to THz astronomy. Tunable room temperature devices operating from 1 to 5 THz are of peculiar interest. The ability to convert infrared laser light into THz waves via a parametric frequency conversion is one of the promising approaches. Using Q-switched pump lasers several µW's of narrow band pulsed THz radiation can be generated [1]. Yet, generating pure CW THz radiation requires CW operating pump lasers. However, due to a weaker intensity a lower conversion efficiency results.

Here, we present a room temperature operating, compact and tunable CW THz source. With this device a generation of milliwatt power levels is feasible. The system is based on intracavity difference frequency generation (DFG) within a dual colour vertical external cavity surface emitting laser (VECSEL). A high conversion efficiency is achieved by using the extremely high circulating intracavity fields to mix the two laser modes within a nonlinear crystal. This generation scheme does not only provide access to the high intracavity infrared intensities but also allows for a compact and robust setup.

In previous work, it was shown that a VECSEL can emit dual wavelength simultaneously using an intracavity filter to select the desired laser modes [2]. Here, the difference frequency between the modes can be set to several THz due to the high bandwidth of the VECSELs quantum wells.

The heart of our new THz source is a VECSEL chip with an emission wavelength around 1030 nm. The VECSEL is mounted on a water cooled heat sink and is pumped by an external, fiber coupled semiconductor laser bar. The maximum pump power used in the experiments was 50 W. By inserting an etalon into the cavity, we force the laser to run simultaneously on two wavelengths with predefined frequency spacing. As nonlinear mixing element we chose a slanted periodically poled lithium niobate crystal as described in [3]. A Golay cell was used to detect the THz waves.

For a first demonstration of our proposed source we focussed on the generation of 1 THz and 1.9 THz. The measured THz power is shown as a function of the intravavity power in Fig. 1. As expected for a DFG process the power scales quadratically with the infrared intensity. In the case of 1.9 THz, the measured cw power exceeds 2 mW.

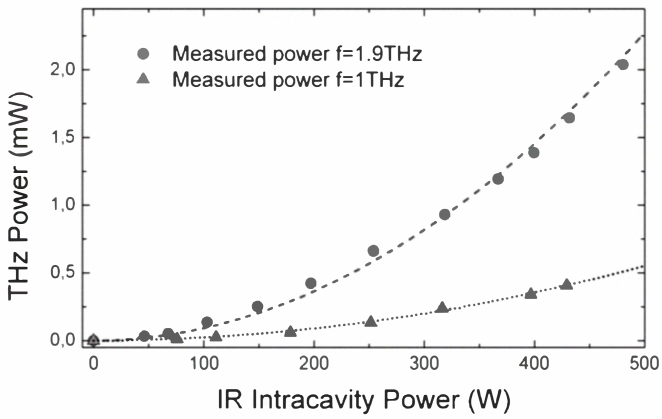

Fig. 1 Measured THz power as a function of the intracavity power for an emission at 1.0 THz and 1.9 THz.

In conclusion we present a room temperature THz source emitting milliwatts of THz power. Using a set of different crystals or a broadband nonlinear emitter the system can easily be adapted to emit any frequency between 0.3 and 5 THz by. We characterized the source in terms of power, wavelength and beam profile.

References

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