Voltage Controlled Intracavity Emitter of Terahertz Radiation

J. Darmo, G. Strasser, T. Müller, K. Unterrainer, Tuan Le, A. Stingl

Generation of THz radiation within a femtosecond mode-locked laser cavity was recently demonstrated [1], [2]. A saturable Bragg reflector (SBR) with a single quantum well (SQW) was employed, but the performance of the SQW based emitter is restricted in terms of radiation intensity, frequency, as well as efficiency. A low-temperature molecular beam epitaxy grown (LT) GaAs layer is an alternative to the SQW for both as a saturable absorber and as a THz emitter. Here we present a new type of THz emitters capable to operate in a femtosecond mode-locked Ti:sapphire laser cavity. A new degree of freedom is added to the THz emitter as the emitted THz power can be modulated pseudo-independently from the laser operation.

The voltage controlled intracavity THz emitter comprises a Bragg mirror stack made of AlGaAs/AlAs layers and the LT GaAs layer grown at 220 °C and annealed at 600 °C. The electrical contacts to the LT GaAs layer were formed photolithographically by Ti/Au metals and had a form of parallel metallic stripes 20 µm width and separated by 50 µm. The processed emitter structure was mounted onto a high resistive silicon substrate with a hemispherical lens attached to it to form an emitter unit. The emitter unit was placed into a cavity of a standard mode-locked 12 fs femtosecond laser head as the end mirror. The laser is in this configuration self-starting regardless of the emitter biasing.

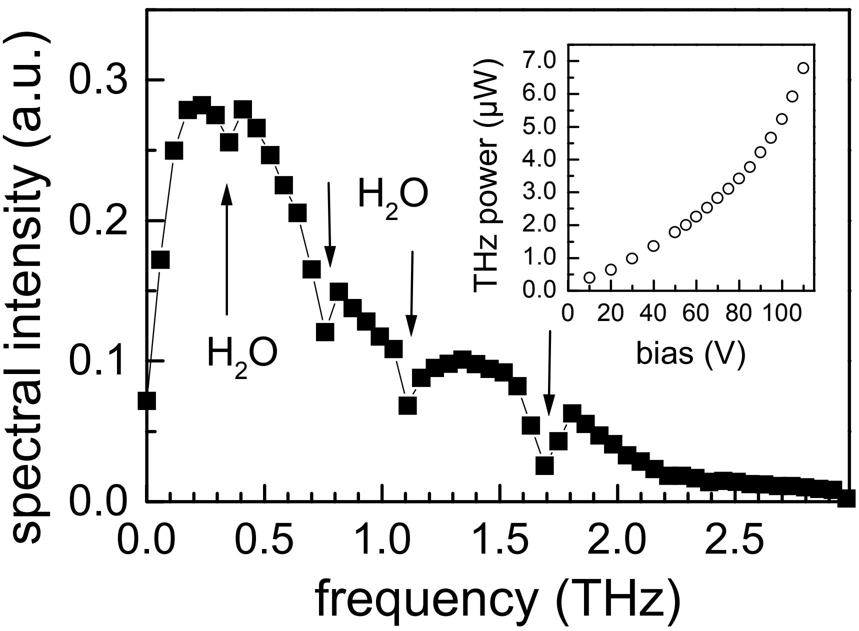

Fig. 1: Fast Fourier spectrum of the THz radiation from the LT/SBR emitter. The inset shows the output THz power as a function of the emitter bias.

The generated THz radiation was detected by a free space electro-optic detection technique using a 1 mm thick ZnTe crystal. Figure 1 presents a typical intensity spectrum of the terahertz transient measured for the emitter element biased at 80 V and at an average intracavity optical power of 900 mW. The experimental set-up was not purged with dry nitrogen, therefore, absorption lines of water vapor are visible in the spectrum. The THz emission spectrum has maximum at about 0.3 THz with frequencies extending beyond 2 THz.

The average THz power measured by a 4.2 K cooled silicon bolometer increases quadratically with bias without any tendency to saturate. The maximum THz power generated from the intracavity emitter was about 6.7 μW at a intracavity optical power of 900 mW.

References

[1] N. Sarakura et al., Jpn. J. Appl. Phys. 36, L560-L562 (1997).

[2] N. Sarukura et. al., Jpn. J. Appl. Phys. 37, L125-L126 (1998).