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Terahertz Detector Calibration at PTB

Schwerpunkt: A7 Mikrowellen- und Terahertzsensorik

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The measurement of radiant power is the crucial part of many Terahertz applications. This requires suitable THz detectors with known sensitivity, i.e. calibrated response with respect to radiant power. Calibration is done by comparison with a highly accurate radiometer. Confidence in the accuracy and reliability of absolute measurements is achieved by the concept of traceability to the International System of Units. Traceability means that the result of a measurement can be related to national or international measurement standards through an unbroken chain of comparisons all having specified uncertainties [1]. Such a traceable calibration of a THz detector has been missing until 2008.

Then the Physikalisch-Technische Bundesanstalt (PTB) performed the first traceable measurement of radiant power of a quantum cascade laser at 2.52 THz and the first absolute calibration of a THz detector against a cryogenic radiometer [2]. This detector became the standard detector for PTB´s THz detector calibration facility [3] and PTB started the worldwide first calibration service for customers in 2009 [4]. Following customer´s demands PTB has intensified their development efforts to expand its actual detector calibration service at 2.52 THz to a wider frequency range spanning from 1 THz to 5 THz. To achieve this goal a THz laser radiation source tunable in this extended spectral range and a reference detector with known spectral dependence are needed.

The radiation source of the calibration facility is a far-infrared molecular gas laser. It is running at 2.52 THz but can also be operated at a variety of discrete lines in many different gases at frequencies between 1 THz and 5 THz. This THz laser delivers stable radiation power in the 1 mW to 10 mW range. For calibration purpose the beam profile of the laser has to be known. As it depends on the wavelength of the laser it is controlled by a THz sensitive camera.

The reference detector has to be carefully characterized to understand its THz radiation absorption and losses. It is a commercially available but modified thermopile detector using a volume absorber for the radiation. The reference detector was calibrated first against the standard detector at 2.52 THz. In order to use it for radiant power measurements at other frequencies between 1 THz and 5 THz a physical model of the radiation losses of this reference detector is required and has to be verified by experiment, e.g. the wavelength depending reflection of the surface of the absorber has to be measured. The radiant power at a given frequency is the sum of the detected absorbed power and the known optical losses. On the one hand, these losses at 2.52 THz can be directly measured by comparison with the standard detector. On the other hand, the losses must be derived from physical principles and verified by spectroscopic measurements of the volume absorber at other frequencies.

Results on the investigation of the reference detector and, based on that, expanded calibration services for users in the scientific and commercial community will be presented.

References

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