Ultrawideband THz detector based on a zero-bias Schottky diode

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The work in the field of THz technology includes the emitters as well as the detectors. While a large number of approaches for THz emitters with increased power levels are evolving the detectors have show less progress in the last years. But essential for all THz work is the signal to noise ratio which also benefits from improved detectors.
Nowadays, pyroelectric detectors and Golay cells are the most common room-temperature THz detectors available. They feature NEPs (noise-equivalent powers) down to 100 pW/Hz^{½}, but their response time is quite large limiting the modulation to few tens Hertz. These detectors are quite bulky which inhibits flexible use.

ACST has recently established a Schottky process for zero-bias detector diodes aiming at frequencies up to one THz and possibly higher. A specialised process allows forming of Schottky contacts with a very low barrier. This in turn provides low video resistances without the need for biasing. Due to the absence of bias, the noise of the detectors reduces to the Johnson limit of the video resistance and is free of 1/f noise. The presented devices exhibit a video resistance less than 10 kΩ at zero-bias and voltage noise of less than 15 nV/Hz^{½} (measurements in full paper). Also the devices responsivity shows values of more than 15 A/W or 2500 V/W. This results in a NEP of less than 6 pW/Hz^{½} combined with arbitrarily high modulation frequencies. The size of this detector with appendant amplifier is smaller than a matchbox (picture in full paper) allowing it to be placed and moved freely in any THz setup. However, it should be mentioned here, that this detector cannot compete yet with pyroelectric detectors or Golay cells at frequencies far beyond 1 THz.
The main frequency limiting factors for the Schottky detectors are the RC time constant and the size of the diode. The diodes size should be small compared to the effective wavelength to diminish effects of the geometry. The RC time constant is formed by the total capacitance of the diode and the RF impedance of the antenna. In this work a planar logarithmic-spiral antenna has been deployed with circular polarisation to be independent of the polarisation angle in case of linear polarised THz radiation. Hence, the responsivity of the detector reduces to half of its value due to the coupling of linear to circular polarisation. ´The impedance of the antenna is around 50 Ω and the total capacitance of the diode is around 3 fF resulting in a roll-off frequency of about 1 THz. First measurements up to 700 GHz have revealed no sign of a roll-off (measurements >1 THz in full paper). Further measurements will be carried out for the full paper.

This work presents a very compact, highly sensitive and fast THz detector based on RF rectification by a Schottky diode. It suits ideally the needs for fast spectroscopy due to the very fast response time and high sensitivity. The developed process allows for larger integration into arrays for imaging applications.

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