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Analysis of Integrated Flat Optics Effects on Cost-Effective InGaAs THz 'Bow-Tie' Detectors

Matas Bernatonis[1,2], Vytautas Jakštas[1], Renata Butkutė[1], Andrius Bičiūnas[1], Ignas Grigelionis[1] and Linas Minkevičius[1]

[1] Centre for Physical Sciences and Technology, Saulėtekio av. 3, 10257 Vilnius
[2] Vilnius University, Saulėtekio av. 9, LT-10222 Vilnius.
matas.bernatonis@ff.stud.vu.lt

Terahertz (THz) radiation encompasses electromagnetic waves between microwave and infrared frequencies. They're known for having properties suitable for assuring quality control, are used in non-invasive inspection of packages and airport security screening for potentially lethal weapons [1]. Currently used detectors for this frequency range such as microbolometers, JFET and MOSFET (field transistors) are expensive, require additional cooling and have a complex manufacturing process [2]. The increasing number of fabrication steps in such devices inevitably leads to a substantially higher final price and lower yield rate. In contrast, the proposed "bow-tie" terahertz detector is able to operate at room temperature, is significantly easier to manufacture if compared to equivalent wavelength range detectors [3].

To focus the signal from a larger surface area, diffractive optics were incorporated into the design of the detectors. Using modelling software, an optimal configuration of concentric rings was formed to focus incoming THz radiation using diffractive behaviour of light. For validation of the focusing capabilities, an imaging experiment was conducted, where "bow-tie" detectors were being turned in 2.5° increments from incident angle of radiation. Experiment results are represented in Figure 2.

In conclusion, the addition of flat optics into the design yielded an order of magnitude (34 times) increase in signal strength as opposed to imaging without them. This experiment has huge future implications, as the overall cost of imaging systems can be decreased, owing to a better signal to noise ratio and higher sensitivity.

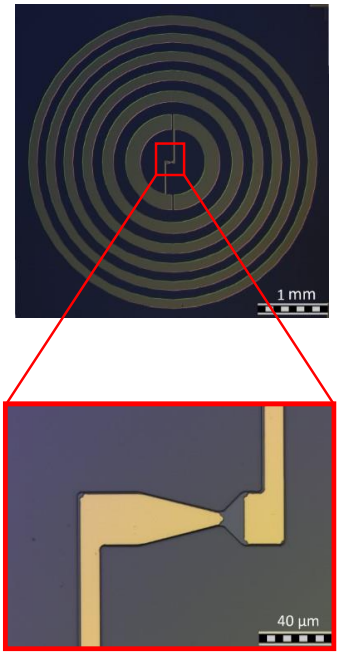

Fig. 1 "Bow-tie" detector with incorporated flat optics.

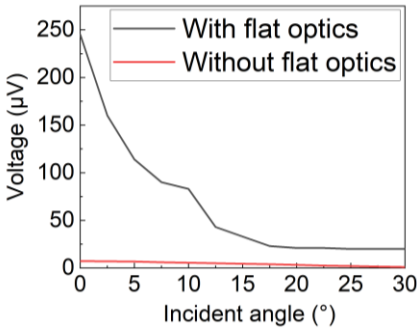

Fig. 2 Voltage dependence on incident angle with and without flat optics.

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