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Terahertz detectors based on Si CMOS MOSFETs for characterization of broadband and narrow radiation sources

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The so-called "terahertz gap" is gradually being filled with new compact devices and effective solutions for the detection and emission of radiation. In particular, the development of field-effect-transistors (FET) is starting to play a significant role in this process [1, 2] and had demonstrated in applications together with pulse free electron lasers and gas laser [3, 4] and fast time-domain system [5]. In this report, we present the analysis of different methods which can be applied for the improvement of detector performance in wide range of frequencies. We focus on a standard Si CMOS (complementary metal-oxide-semiconductor) process technologies that can be used to produce cost-efficient THz detectors and sensors which are ready for scaling to sensor lines or arrays.

We implement different types of integrated antennas: a patch-type antenna for the front-side radiation coupling and a slot dipole antenna for the coupling with a substrate or booster lens. Furthermore, we extend our research toward the on-chip integrated amplifier. These solutions are not mutually exclusive and can be combined to achieve the best performance.

Although the best practical performance is achieved with substrate lens coupled devices, patch antenna coupling brings the advantage of a strong reduction in packaging complexity. The disadvantage of patch-antenna coupled detectors is the relatively small effective area of the antenna which limits its total efficiency in comparison to a backside-illumination solution with the slot antenna. This shortcoming can be improved by an additional dielectric lens that is attached to the top of the patch. We simulate and test the performance of detectors with dielectric lenses of different shapes: a dielectric rod, hyper-hemisphere, and aspheric curvature. Several different materials have been employed to fabricate these types of lenses, like silicon, sapphire, or various polymer materials. For example, the polyethylene hemisphere lens with 4 mm diameter improves the directivity of the patch antenna by minimum in 1.5 times with an additional advantage of an improvement in antenna efficiency.

The amplifying of the output signal – can be realized by using an integrated amplifier implemented on the same chip. Noise-optimized design and minimized distance between the detector output and amplifier input results in cost-efficient devices without the deterioration in the signal-to-noise ratio.

Reference:

[1] Valušis, Gintaras, et al. MDPI Sensors 21.12, 4092 (2021);

[2] E. Javadi, et al. MDPI Sensors 21.9 2909 (2021);

[3] Regensburger, S., et al. Opt. expr. 23.16, 20732-20742 (2015);

[4] But, D. B., et al. J. of App. Phys. 115.16 164514 (2014);

[5] Ikamas, K., et al. Semicond. Sci. Technol., 33.12, 124013 (2018).

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