Coherent Detection of Broadband Terahertz Pulses via CMOS-compatible Solid-State Devices

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Extended Abstract

In the last decade, a growing interest in terahertz (THz, frequency between 0.1 and 10 THz) science gave rise to many exciting opportunities in different fields [1], which require the development of low-cost compact THz detectors. Currently, several optical methods are commonly employed to retrieve the THz electric field waveform (in time) such as photoconductive antennas (e.g., based on LT-GaAs) or optical rectification in second order nonlinear media (e.g., ZnTe and GaP). However, carrier mobility, optical absorption and phase matching typically limit the bandwidth of these techniques to 4 THz. An alternative method, named Air Biased Coherent Detection (ABCD), allows instead coherent detection over extremely large bandwidth (>10 THz). This approach is based on Electric Field Induced Second Harmonic (EFISH) generation in third order media (such as air) [2]. Unfortunately, this technique relies on bulk setups and requires kV bias voltage. In order to overcome these limitations, we propose a novel solid-state implementation (solid-state biased coherent detection, SSBCD) of the ABCD method, relying on EFISH. Our devices (see Fig. 1a) are fabricated by UV lithography, depositing 100-nm-thick gold electrodes on a 1-mm-thick UV-grade fused silica substrate, and covering with a 2-µm-thick silica layer. We tested several samples, with different combinations of gold electrodes sizes (10 and 100 µm) and gap sizes (3, 4, and 5 µm), connected to a high voltage source to provide the modulated bias required for coherent detection.

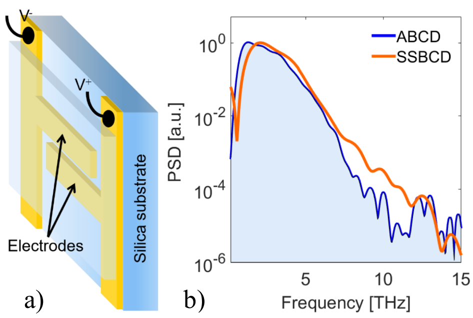

Figure 1. a) Device geometry; b) Power spectra recorded with SSBCD and ABCD technique.

The THz temporal traces were recorded as a function of bias voltage in the range of 50-600 V, and we report here only the 3-µm gap, 10-µm electrode size configuration, which gave the best performance. In this case, the optimum SNR was found for a bias voltage of 200 V, which is one order of magnitude lower when compared to the standard ABCD technique. The corresponding spectra are shown for comparison in Fig. 1b. In conclusion, our novel approach enables the use of portable battery pack, fiber-based oscillators and commercially available electronics for coherent broadband THz detection. Moreover, the CMOS-compatible technology allows full integration and may open up the way for a large variety of advanced applications.

References

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