Titano mikrobolometrų taikymas terahercinėje spektroskopijoje su laikine skyra

Application of Titanium-based microbolometers in Terahertz Time-Domain Spectrometers

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Terahertz waves have been widely studied and cover a broad spectrum of applications, such as medical inspection [1], security check [2], solar cell quality [3] or food control [4]. Due to the increasing demand, THz sensors must be highly sensitive, display a fast response and a high signal-to-noise ratio. Recently, titanium-based antenna coupled microbolometers have been demonstrated exhibiting the noise equivalent power of below 20 pW/Hz$^{1/2}$ and a response time in 5 µs range [5].

In this work, we present a comprehensive experimental study dedicated to reveal features of Ti-µbolometers useful for spatial mode control in THz-TDS systems. Before raster scanning, response spectra of Ti-µbolometers designed for resonant frequencies centered at 0.3 THz, 0.7 THz and for wideband detection were investigated using Fourier transform infrared spectrometer. Spatial beam profiles were explored with and without hyper hemispherical lens in THz-TDS system using 0.7 THz Ti-µbolometer in a recording distance of 55 mm away from the tip of the lens or the antenna. As it can be seen from the response spectra in Panel A of Fig. 1, each spectrum displays peculiarities related to the resonant nature of a dipole antenna coupled Ti-µbolometers designed for 0.3 THz and 0.7 THz frequencies. As for wideband sensor which is coupled with log-periodic antenna, a detection bandwidth falls in the range of 0.25 THz – 1.3 THz.

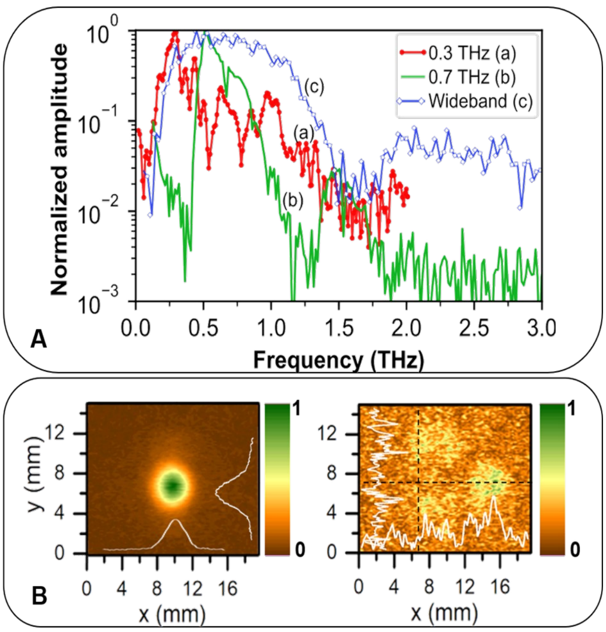

Fig. 1: **Panel A:** Response spectra of antenna-coupled Ti-µbolometersdesigned for resonant frequencies centered at 0.3 THz (a), 0.7 THz (b) and forwideband detection (c). **Panel B:** Intensity normalized beam profiles recordedby 0.7 THz Ti-µbolometers when the photoconductive antenna with lens(left)and without lens(right). White lines indicate intensity cross sections along the relevant axes.

Figure 1 (Panel B) shows normalized intensity spatial beam profiles recorded using 0.7 THz Ti-µbolometers separately when the photoconductive antenna is with (left) and without (right) collimating optics. With lens, the spatial mode profile exhibits nicely resolved quasi-gaussian shape. When the lens is removed, more detailed THz beam structure is unveiled: it can be seen spatial mode structure consisting of three constituents related to the emission antenna properties. Although the quality of the beam image is reduced (signal-to-noise ratio decreases down to 3), it is still enough to reveal features of the spatial mode profile of THz-TDS source.

The Ti-µbolometers with readout electronics exhibit high sensitivity of 200 kV/W and a relatively short response time within 5 µsmicroseconds including electronics circuit. Such devices can be an important part of the sensor family bringing together properties of solid-state based detectors for precise and convenient control of THz-TDS beam spatial profiles even without additional focusing or collimating optics.

Keywords: Ti microbolometers, THz-TDS, beam mode imaging

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