Novel THz-ABCD spectrometer and its commercialization

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Abstract

A novel terahertz air-biased-coherent-detection (THz-ABCD) spectrometer with an ultra-broadband (0.5 THz ~ 35 THz) and a high electric field strength (>150 kV/cm) is invented. One order broader sensing bandwidth compared to conventional electro-optic sampling is achieved. This work has a great potential for creating the material database and bridging excellent collaborative opportunities between academic institutes and industry.

Relevance

Material sensing and imaging of explosives and chemicals in the far-infrared range is no longer limited by emitters and sensors. The THz-ABCD spectrometer, as shown in Fig. 1, supports a new generation of nondestructive material study. Unlike traditional far-infrared spectrometers, the spectrometer utilizes ambient air as the emitting as well as sensing materials, and integrates a novel THz-ABCD technology. Not only is linear spectroscopy studied, but also nonlinear carrier dynamics of semiconductors is performed. The multi-functional spectrometer provides a tool for suppliers within the fields of defense and homeland security who are seeking ways to better sense chemical and biological weapons as well as explosives, as shown in Fig. 4.

Technical Approach

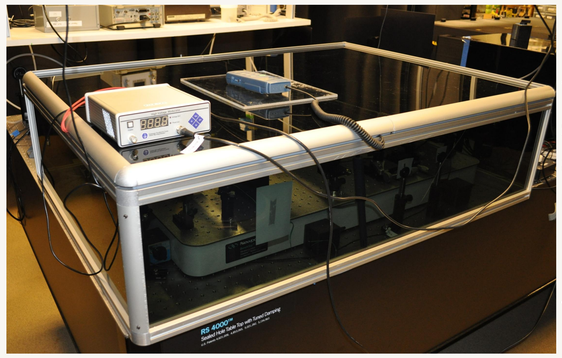

Fig. 1. The prototype of a THz-ABCD spectrometer with a high voltage modulator which provides a local bias (on the top of the spectrometer).

Fig. 2. Zomega air photonics (ZAP) THz time-domain spectrometer with a useful bandwidth from 0.5 THz to 20 THz.

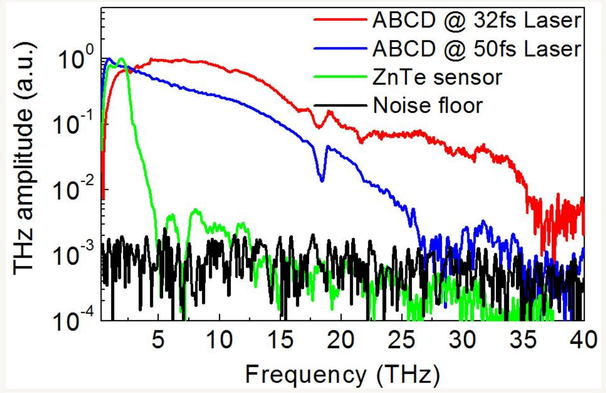

Fig. 3. Measured spectra via THz-ABCD sensor with 32 fs and 50 fs lasers compared with the one with conventional ZnTe sensor. We have demonstrated ultra-broadband THz spectrometer, covering a frequency range from 0.5 THz to 35 THz, which is one order of bandwidth improvement in comparison with conventional ZnTe sensor.

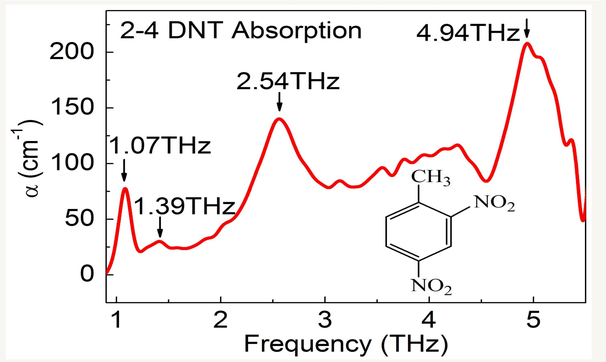

Fig. 4. The absorption spectrum of 2-4 DNT explosive measured with a THz-ABCD spectrometer.

Accomplishments Through Current Year

This project cooperates with the task of Zomega THz Corporation to develop table-top far-infrared spectrometers which have been commercialized in 2010, as shown in Fig. 2. This project also provides opportunities for students from Morehouse College to perform their REU projects at the PI's THz Center in summer 2009 and 2010.

Future Work

1. Further system integration and improvement are achievable. Signal-to-noise ratio (SNR) is expected to be several thousands and a higher electric field (>1 MV/cm) are anticipated.
2. The project provides the opportunities for basic science research such like nonlinear carrier dynamics study in semiconductors or chemicals.

Opportunities for Transition to Customer

A compact THz-ABCD spectrometer with
- Broad bandwidth 0.5~35 THz
- High peak THz field >150 kV/cm
- High SNR >1000
- Time-resolved spectroscopy

In 2010, through the academic-industrial cooperation, this technology has successfully transferred to Zomega Corp. to build up a THz ZAP spectrometer, which benefits many academic institutes in the world, such as Institute of Materials Research and Engineering in Singapore.

Patent Awarded

US Patent #7652253 - Method and system for plasma-induced terahertz spectroscopy. Xi-Cheng Zhang, Jianming Dai, and Xu Xie. Awarded on January 26, 2010.

Publications Acknowledging DHS Support

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