TuoTuo Technology

THz Emitter/Detector Evaluation System

(Based on THz Time Domain Spectroscopy)

TTT- OPTP-02

Introduction

Terahertz (THz) radiation is defined as an electromagnetic wave ranging from 0.1 THz to 10 THz. After decades of growth, THz technology attracts great attention due to its special properties. For THz imaging, THz wave can penetrate various materials such as paper, silicon wafer, fabric and plank. Series of materials, including drugs and explosive materials, have intrinsic absorption peaks at THz range. This fingerprint-like feature gives THz technology a unique advantage in materials detection.

On the other hand, the development of the THz emitters/detectors is the most emerging part of modern THz technologies. Besides the standard emitters, e.g., EO crystal and LT-GaAs based photoconductive antennas, researchers are continuing to explore new candidates to promote the development of THz technology. Meanwhile, THz emission spectroscopy can be utilized for studying the ultrafast dynamic of materials/devices.

TTT-OPTP-02 is a disruptive game changer of the field, users can switch the measurement modes easily among:

- **TDS mode,** transmission/Reflection
- **OPTP mode,** "Optical pump – THz probe mode"
- **TE mode,** THz emitter evaluation mode
- **TD mode,** THz detector evaluation mode

With an optimized optical structure, THz system has an enhanced stability and better achromatization and therefore a better focus of THz beam. Most importantly, we can achieve ultra-high signal-to-noise ratio **(up to 75 dB)*,** excellent stability **(<0.5% peak fluctuation)**** and high reliability, which bringing the THz characterization to a new era.

Wide range of upgrade option are available, for instance, if the femtosecond laser is equipped with an optical parametric amplifier, the pump in OPTP or excitation wavelength can cover from ultraviolet, visible to near infrared range. Low temperature cryostat can be integrated and auto alignment module is also available as an option

Applications

Typical applications of the system including, but not limited to:

- Standard TDS measurement, characterize the optical properties of materials
- Nondestructive and non-invasive detection
- Standard OPTP measurement
- THz emission study
- THz detection study

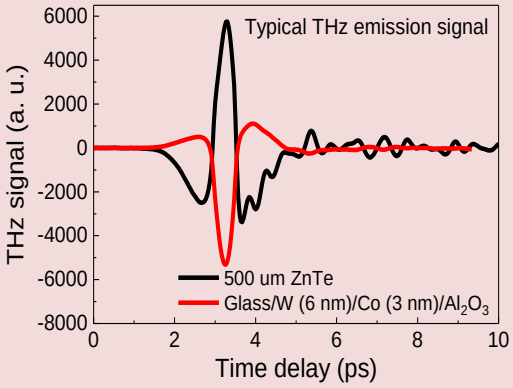
* 1 kHz laser, 800 nm, 500 mW excitation power;
** 1 kHz laser, 800 nm, 500 mW excitation power, Trace TDS peak signal

We understand the high performance may break your common sense
Feel free to contact us to know more.

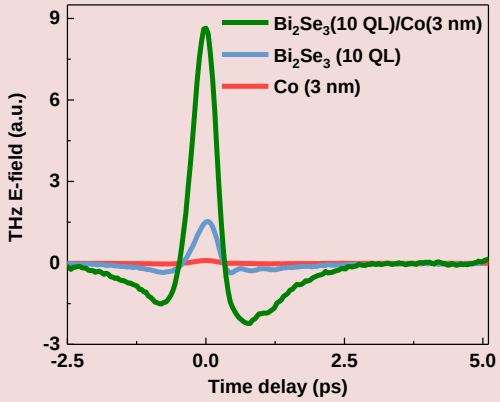
1. **Ultrahigh stability (<0.5% peak fluctuation)**
2. **High signal-to-noise ratio (up to 75 dB)**
3. **Multiple functions**

Example data from TTT-OPTP-02

ZnTe and FM/NM sample as THz emitters [Adv. Mater. 29, 1603031 (2017)]



THz emission measured from Topological insulators [Adv. Mater. 30, 1802356 (2018)]



System upgrade components (Basic)

1. Sample imaging
2. Optical pump/THz polarization control
3. Low/High temperature
4. Magnetic field

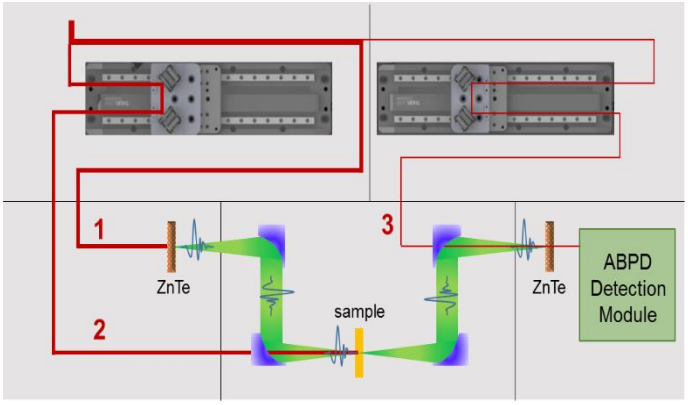
System upgrade components (Premium)

1. Reflection mode
2. Synchronous optical pump
3. OPA pump
4. Auto alignment of optical paths

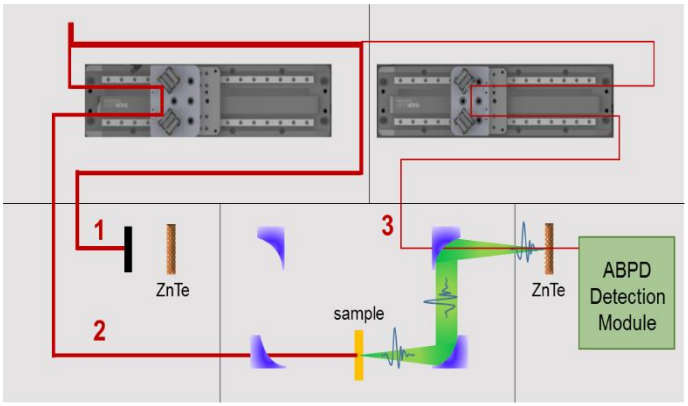
Schematic for operation mode (Mode: TTT-OPTP-02)

In TTT-OPTP-02, there are several operation modes available, OPTP and TE modes will be introduced as examples. Users can switch between two modes via software to fulfill testing requirements. As shown in the left figure below, in OPTP mode, optical pump 1 is utilized to generate THz probe beam and optical pump 2 is used for pumping the sample. In TE mode, with proper software setting, optical pump beam 1 is blocked and there is no THz wave generated before sample. Meanwhile, the optical pump beam 2 excites the sample for THz emission. In both modes here, we are using the same optical probe beam 3 for THz detection. More details of the operation modes, please contact us.

OPTP mode

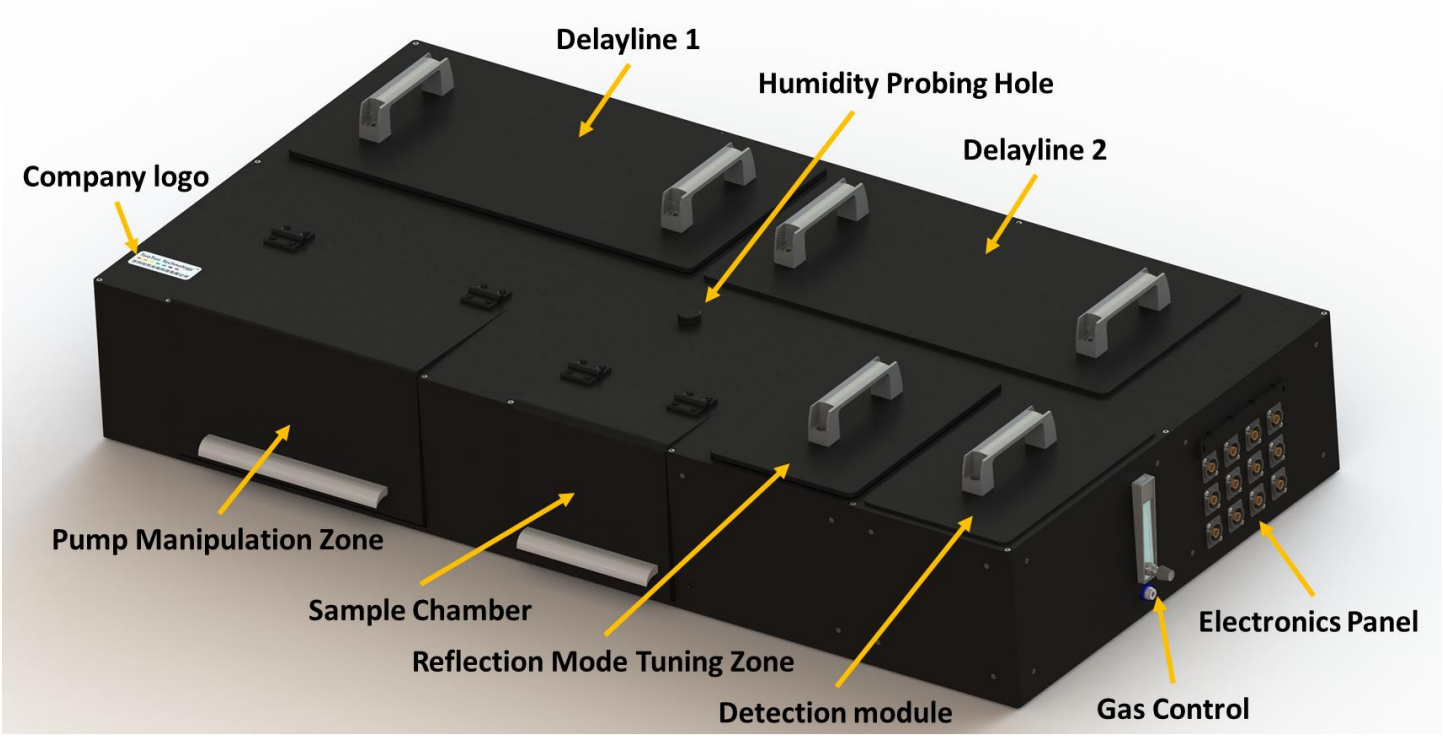


TE mode



System schematic

System schematic is shown below and it can be customized based on user's requirement.



Key Specifications

	TTT-OPTP-02
THz detector[1]	ZnTe crystal or Customized Option
THz emitter	ZnTe crystal & Spintronics Emitters or Customized Option
Spectrum range [2]	Standard Option 0.1 – 3.5 THz
SNR	> 70 dB (Typical 75 dB)
TDS peak Fluctuation	< 1% (Typical <0.5%)
Measuring principle [3]	Transmission and reflection mode
Optical Pump	800 nm or 400 nm (OPA is optional)
Software [4]	LabVIEW Run Time Engine
Dimensions	600 mm * 1200 mm * 250mm

Notes:

[1] According to the users' requirement, we can change the electro-optic crystal. The default electro-optic crystal is (110)-oriented ZnTe.

[2] The spectrum range might be different under different lab environment, the range mentioned is the guaranteed range.

[3] Reflection Mode is provided as an option.

[4] The LabVIEW software is not included.

Installment requirement

Recommend laser source	**1 kHz, 800 nm, > 1 mJ, < 120 fs**
Dry environment*	< 1 % relative humidity
Optical stage	> 700 mm * 1400 mm

*7-24 Dry air generator is provided as an option.

List of related publications (The experimental data in the below listed publications can be reproduced upon requests):

1. Y. Wu, M. Elyasi, X. Qiu, *et al.* "High-Performance THz Emitters Based on Ferromagnetic/Nonmagnetic Heterostructures" Adv. Mater. **29**, 1603031 (2017)
2. M. Chen, R. Mishra, Y. Wu, *et. al.* "Terahertz Emission from Compensated Magnetic Heterostructures" Adv. Opt. Mat. **6**, 1800430 (2018).
3. X. Wang, L. Cheng, D. Zhu, *et. al.* "Ultrafast Spin-to-Charge Conversion at the Surface of Topological Insulator Thin Films" Adv. Mat. **30**, 1802356 (2018)
4. L. Cheng, X. Wang, W. Yang, *et. al.* "Far out-of-equilibrium spin populations trigger giant spin injection into atomically thin MoS_2," Nat. Phys. **15**, 347 (2019)
5. M. Chen, Y. Wu, Y. Liu, *et. al.* "Current-Enhanced Broadband THz Emission from Spintronic Devices" Adv. Opt. Mat. **7**, 1801608 (2019)
6. T. Seifert, S. Jaiswal, M. Sajadi, *et. al.* "Ultrabroadband single-cycle terahertz pulses with peak fields of 300 kV·cm^{-1} from a metallic spintronic emitter" Appl. Phys. Lett., **110**, 252402 (2017)

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