# NEWS RELEASE

Accelerating terahertz (THz) wave research with the world's first technology:
Mass production of THz wave detection modules (THz PMT module, THz I.I.)
with built-in high-voltage power supply
Orders will begin this spring

April 14, 2025
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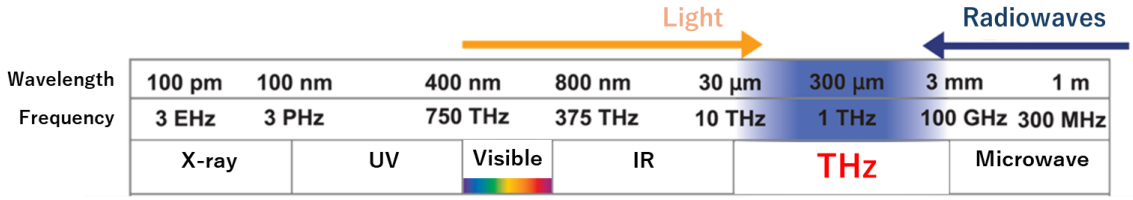
Hamamatsu Photonics has mass-produced the world's first terahertz (THz) wave detection module by utilizing our newly developed metasurface technology and our long-cultivated photomultiplier tube and image intensifier technologies. We offer two products: THz photomultiplier tube (THz PMT) modules, and THz image intensifiers (THz I.I.), which can detect THz wave pulse signals at high speed and with high sensitivity at room temperature.

Both products are the world's first modules to apply field electron emission technology (*1) to THz wave detection. They have unique properties that are not found anywhere else. These products are expected to further accelerate basic and applied research on THz waves for applications in drug discovery, analysis, semiconductors, non-destructive testing, and more.

Universities and research institutes can order both products from Monday 14th April.




THz waves

THz waves are electromagnetic waves in a frequency band called the intermediate region between light and radio waves. They can easily penetrate non-metals, exerting minimal effects on the human body. Other properties include reacting specifically with chemical substances and enabling observation of electrical properties through optical techniques. These properties are promising for applying new measurement methods in fields such as drug discovery, chemical analysis, semiconductors, and nondestructive inspections.

## Product Overview

Both the THz PMT module and the THz I.I. are THz wave detection modules that utilize metasurfaces for THz wave-to-electron conversion and have sensitivity in the THz wave range. By replacing the photocathode that converts light into electrons, something installed in conventional PMTs and I.I., with a metasurface based on the principle of field electron emission, we have succeeded in detecting THz waves, which have low photon energy and are difficult to detect.

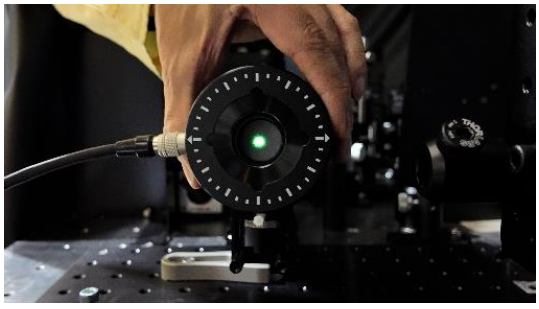
Conventional photocathodes use the principle of the external photoelectric effect (*2), so the wavelength range of light that can be detected is limited to ultraviolet to near-infrared light. This makes it difficult to detect THz waves, as they have longer wavelengths and lower photon energy. Therefore, in collaboration with the Technical University of Denmark, we conducted joint research (*3) on metasurfaces as a field electron emission technology that utilizes tiny antennas to resonate with THz waves.

This enabled us to establish deposition technology for the metasurface functional layer, combining our core alkali metal deposition technology with the new metasurface technology, specifically the THz wave-electron conversion section. As a result, we succeeded in developing and mass-producing the THz PMT module and THz I.I., which are THz wave detection modules. In addition, we have conducted joint research with the RIKEN (*4) to evaluate the developed detector, and by introducing the technology of a wavelength-tunable THz wave light source (injection-seeded THz-wave parametric generator: is-TPG), we have established a technology to evaluate the various characteristics of the detection module accurately.

The THz PMT module has a built-in driver circuit and high-voltage power supply. It can be used simply by connecting it to a computer via USB. Since the output current signal changes significantly with respect to the intensity of the incident THz wave, it is possible to detect minute changes in the THz wave with high sensitivity.

THz I.I. allows you to easily observe the shape and focal point of a THz wave beam. Its compact body allows it to be directly inserted into narrow optical systems, and its high-speed imaging of up to 1,000 frames per second allows it to capture high-speed phenomena that are difficult to capture with conventional thermal THz wave cameras.

Example of using THz PMT module



Observation of THz wave beams using THz I.I.

The successful development and mass production of a new type of THz wave detection module with unique characteristics is expected to accelerate basic and applied research into THz waves for applications in drug discovery, analysis, semiconductors, non-destructive testing, and more.

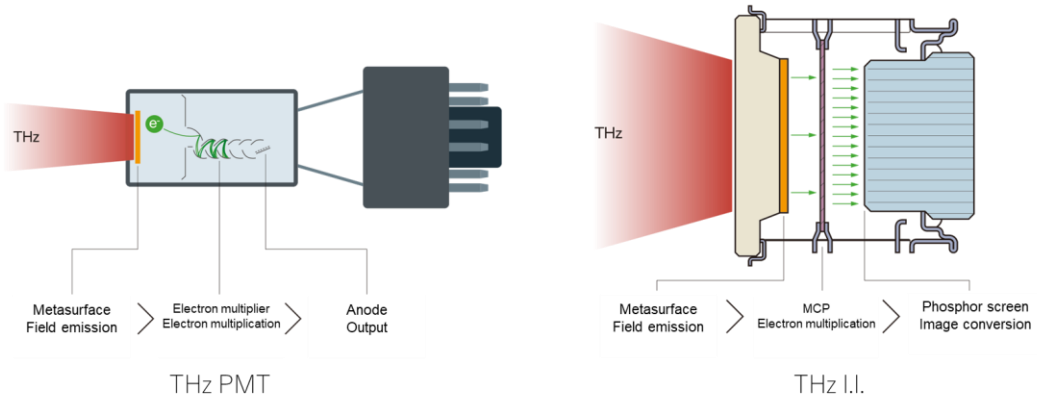
Going forward, we will continue development to further increase sensitivity and aim to expand applications.

*1. Field electron emission (or field emission) is a phenomenon in which electrons are emitted through the surface of a material by the tunnel effect that occurs when a strong electric field is applied to the material to lower its potential barrier.

*2. External photoelectric effect is a phenomenon in which electrons are emitted from the surface of a metal or semiconductor by light irradiation in a vacuum. The light must have a certain energy level to cause electrons to be emitted.

*3. This research was conducted in collaboration with Prof. Dr. Peter Uhd Jepsen, Asst. Prof. Dr. Simon Jappe Lange, Postdoctoral Researcher Dr. Tobias Olaf Buchmann, and Postdoctoral Researcher Dr. Matej Sebek of the Technical University of Denmark.

*4. This research was conducted in collaboration with Team Leader Hiroaki Minamida and Researcher Yuma Takida at RIKEN.




Principle of detecting THz waves

## Development Background

THz waves, which have the properties of both light and radio waves, have unique characteristics not found in other wavelength ranges, such as the straightness of light and the transparency of radio waves. Research and development have been conducted to take advantage of these characteristics and to apply them to industry. However, there are many challenges to the social implementation of THz wave technology. One of these is the limited options for detectors.

We believe that a detector with a new principle and unprecedented characteristics is necessary to solve this problem, and so we began development. In addition, in order to implement THz wave technology in society, ease of use, cost and maintainability as well as high performance, are all important factors. For this reason, we have been working on the technological development of THz wave detectors with new principles and characteristics, aiming for the early social implementation of THz wave technology.

**●Main specifications**

| Parameter | THz PMT module | Unit |
|---|---|---|
| Power input | USB bus power (+4.75 to +5.75) | Vdc |
| Current consumption | 0.1 | A |
| External dimensions (W × H × D) | 42 × 70 × 65 | mm |
| Weight | 266 | g |
| Recommended spectral response | 0.5 to 2.0 | THz |
| Threshold E-field (typ.) | 5 | kV/cm |

| Parameter | THz I.I. | Unit |
|---|---|---|
| Maximum frame rate | 1,000 | fps |
| External dimensions (W × H × D) | 66 × 92 × 43 | mm |
| Weight (*) | 310 | g |
| Recommended spectral response | 0.7 to 1.3 | THz |
| Minimum E-field to detect | 10 | kV/cm |

*Excluding accessory cables, AC adapter, and power box.

THz PMT module (left) and THz I.I. (right)