NEWS RELEASE

Hamamatsu Photonics introduces a newly developed thermodynamic imaging module for PHEMOS®-X series emission microscopes, enabling non-destructive failure location detection in cutting-edge semiconductor devices with micron-level positional accuracy.

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Hamamatsu Photonics K. K.
Headquarters: 325-6, Sunayama-cho, Chuo-ku, Hamamatsu City, Japan
President and CEO: Tadashi Maruno

Hamamatsu Photonics' PHEMOS-X series is a high-resolution range of emission microscopes that pinpoints failure locations in semiconductor devices by detecting weak light and heat emissions caused by device defects.

By leveraging our advanced technologies involving lasers, optical sensors, measurement, and image processing and analysis, we have now developed a TD imaging (ThermoDynamic imaging) technology to serve as a new detector module for the PHEMOS-X series. Mounting the TD imaging module into the PHEMOS-X series gives it the high sensitivity and high resolution needed to pinpoint failure locations in the latest cutting-edge semiconductor devices, such as generative AI chips, which have miniaturized and 3D structures. This new TD imaging module will significantly boost failure analysis success rates when testing these semiconductor devices.

We will begin accepting orders for this new TD imaging module from semiconductor device manufacturers in Japan and overseas starting Monday, 12 May 2025.

Development Background

In the failure analysis of semiconductor devices, a semiconductor tester is first used to electrically detect whether there are any defects in the semiconductor devices fabricated on the wafer. A semiconductor failure analysis system such as the PHEMOS-X series, then narrows down the failure location. Finally, the suspect failure location is observed with an electron microscope to physically identify the failure's cause.

In recent years, advances in technologies such as AI, data centers and self-driving cars have spurred demand for cutting-edge semiconductor devices.

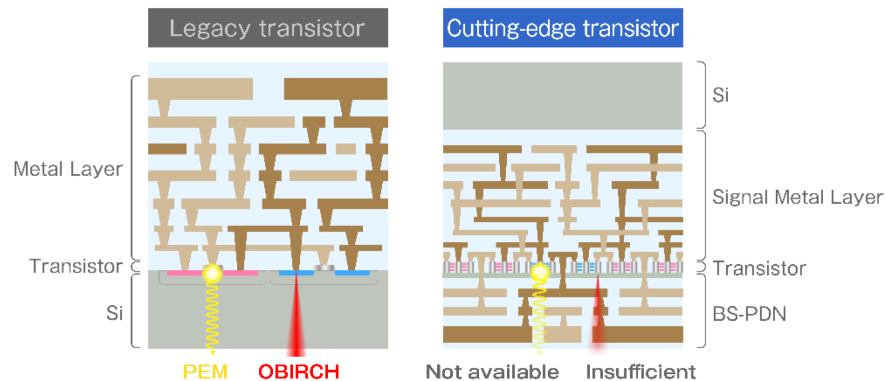
More and more of these cutting-edge semiconductor devices are 3D-structured and miniaturized, giving rise to sophisticated structures that differ from those of traditional semiconductor devices. This makes it difficult for PHEMOS-X series photoemission analysis and IR-OBIRCH analysis*1 to detect failure locations. At present, heat generation analysis called LIT*2 is known to be a very sensitive and effective technique, but its spatial resolution is too low to sufficiently narrow down failure locations. So, even with physical analysis based on the results of LIT, it is almost impossible to identify the cause of the failure.

Although non-destructive testing has been a mainstream technique for narrowing down failure locations in ordinary semiconductor devices, we are now facing situations where we

have to rely on destructive testing to narrow down the failure locations in the latest cutting-edge semiconductor devices.

*1: IR-OBIRCH analysis is a technique for identifying abnormal locations by detecting the changes in electrical resistance that occur when semiconductor devices are irradiated with an infrared laser beam.

*2: LIT or lock-in thermography is a technique using an infrared camera that identifies abnormal locations in semiconductor devices by capturing infrared images of localized heat emissions that occur when electrical pulses are applied to the semiconductor devices.



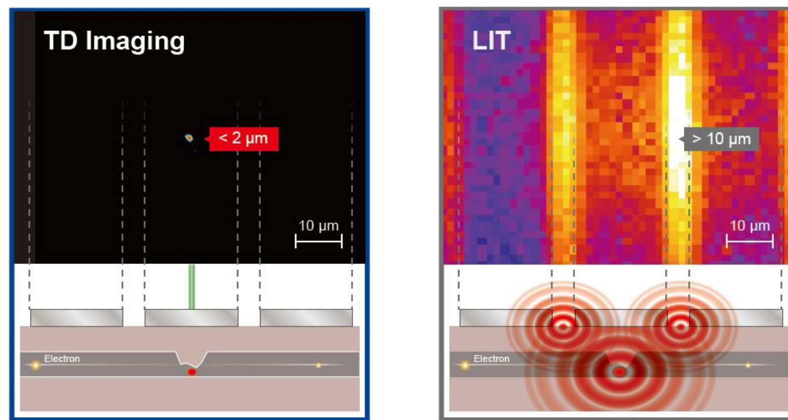
Product Overview

Hamamatsu Photonics has developed a TD imaging technology to serve as an innovative new heat-emission analysis and measurement module for the PHEMOS-X series. This unique technology analyzes heat emissions by irradiating a laser beam onto the surface of a target object and then capturing the localized heat emissions from the resulting changes in reflectance.

Technology to detect heat by utilizing light reflection is already available, but it has proven difficult to put to practical use due to low sensitivity. Now, however, we have succeeded in applying this technology by using a laser to drastically improve sensitivity, with an original approach recognized as official patented technology.

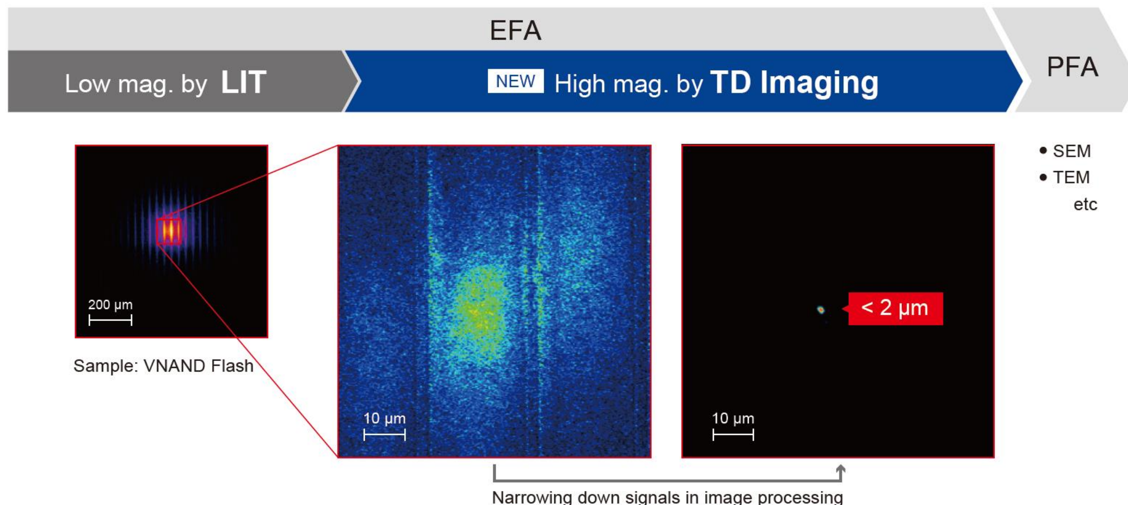
TD imaging technology has high sensitivity equivalent to that of LIT and also offers higher spatial resolution than LIT. While LIT provides strong heat generation signals emitted from gaps in metal layers on the device surface, TD imaging, on the other hand, obtains strong signals from positions directly above the heat-generating sources. This allows a non-destructive approach to identifying failure locations beneath metal layers.

The new TD imaging technology from Hamamatsu Photonics delivers efficient yet more precise failure analysis of semiconductor devices and vastly improves product quality.



<u>**Spatial resolution:** TD imaging is less than 2 µm, while LIT is more than 10 µm</u>

The PHEMOS-X series can house both LIT and TD imaging detectors in a single unit. After detecting a wide range of signals with LIT, TD imaging efficiently narrows the range down to 2 µm. This will vastly improve the success rate in physical failure analysis and quickly identify the cause of failures that have been impossible to find up to now. As with LIT, TD Imaging can find and narrow down failure locations in the tested devices non-destructively.



Failure analysis flow

Product Features

The newly developed TD imaging technology for analyzing heat emissions offers the following features and solutions:

1. High sensitivity equivalent to LIT and higher spatial resolution than LIT.
2. Non-destructive defect location, even under metal layers.
3. Drastically improved success rate in identifying failure causes in cutting-edge semiconductor devices such as generative AI chips, which are 3D-structured and shrunken in size.

Sales start date: Monday, May 12, 2025

TD imaging module

Semiconductor failure analysis systems

Dual PHEMOS®-X (left), iPHEMOS®-MPX (middle), PHEMOS®-X (right)