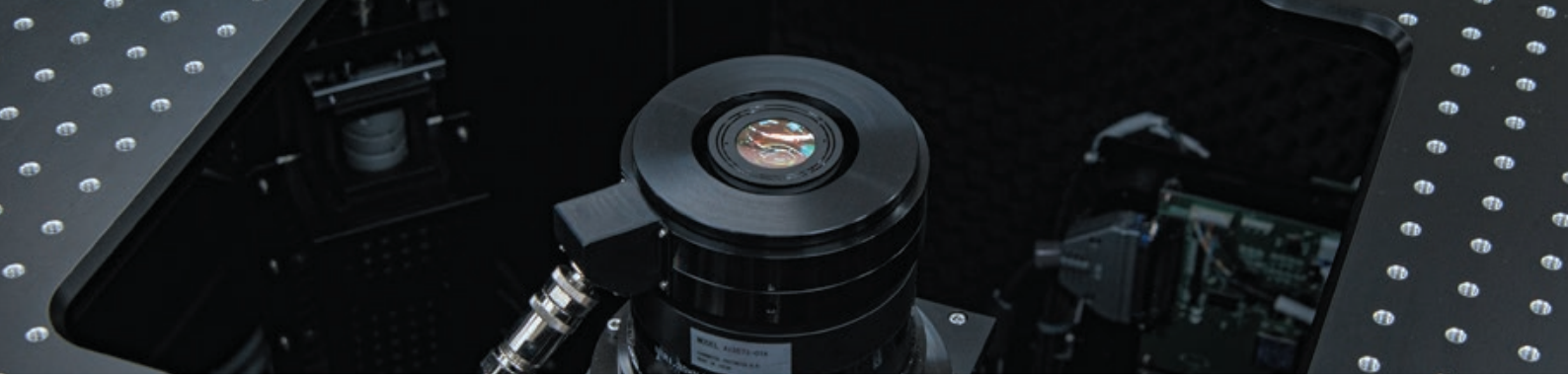
NEW

iPHEMOS™-DDX

Inverted emission microscope C18040-11

HAMAMATSU

PHOTON IS OUR BUSINESS



iPHEMOS-DDX

iPHEMOS-DDX is an inverted emission microscope designed for failure analysis of advanced semiconductor packages, including AI chiplets, HBM, 2.5D/3D packages, and large-scale semiconductor packages. Its direct-docking configuration from three directions enables rapid setup of a tester-centric Electrical Failure Analysis (EFA) environment.

In addition, its low-temperature, high-stability design minimizes drift during analysis, while the integrated multi-application platform combines a variety of analytical techniques, including emission and thermal analysis. This enables both static and dynamic failure analysis, improving workflow efficiency and reducing overall analysis time.

Features

- **Flexible docking structure**

  The system adopts a structure that enables direct docking to a tester from three directions, allowing rapid construction of a tester-centric EFA environment while improving layout flexibility and reducing setup time.

Docking side 1 | Docking side 2 | Docking side 3

- **Advanced semiconductor package analysis**

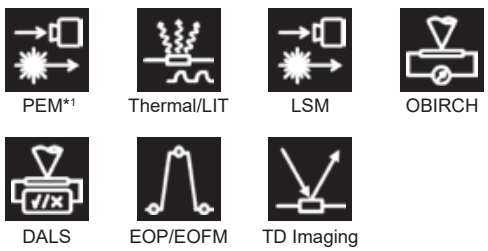
  Failure locations can be identified while maintaining direct docking to a tester for advanced semiconductor packages utilizing AI chiplets, HBM stacks, interposers, and stacked-die architectures.

High-stability design

A high-stability design minimizes temperature drift and vibration under both ambient and cooled operating conditions, enabling stable, long-term analysis of large and thermally sensitive semiconductor packages.

- **Multi-application analysis platform**

  A platform integrating seven analytical techniques, including PEM, Thermal/LIT, LSM, OBIRCH, DALS, EOP/EOFM, and TD Imaging, enables the entire FA workflow to be performed on a single system.



*1 Solid Cold Emmi-X camera available
[NOTE]: Please contact us regarding other platforms.

- **High-precision stage for advanced devices**

Optical stage travel range

X	70 mm
Y	70 mm
Z	22 mm

* The travel range may be reduced depending on interference with the prober or sample stage, or when a NanoLens is installed.

Camera

Solid Cold Emmi-X Camera for emission analysis (NIR)

The Solid Cold Emmi-X camera for emission analysis features Solid Cold cooling (linear cooling technology). Its LN2-free cooling system enables continuous 24-hour operation while delivering high reliability with an MTTF (Mean Time To Failure) of 90 000 hours and excellent maintainability.
The detector employs an MCT (HgCdTe) sensor, covering the wavelength range from 1000 nm to 2000 nm. It combines a wide field of view with a high S/N sensor and high-speed wavelength switching to enable ultra-low-level emission detection. This allows efficient, high-uptime analysis of advanced logic and high-density memory devices.

Application

- Advanced logic device backside analysis
- High-density memory device backside analysis

InGaAs camera for photo emission (NIR)

The low operating voltage that accompanies the miniaturization of semiconductor devices leads to a decrease in the intensity of light emitted from the failure location as well as to longer wavelengths. A detector with high sensitivity to near-infrared light of 900 nm or longer is essential for detecting such faint light emission.
The InGaAs camera series offers high sensitivity (high quantum efficiency) in the 900 nm to 1550 nm*1 wavelength range and is effective for low-voltage drive IC measurement and weak light analysis from the device's bottom side. Combined with a laser scan system, it also enables high-resolution and high-sensitivity analysis.
*1 Solid Cold InGaAs camera wavelength range: 900 nm to 1540 nm.

Application

- Backside emission analysis of Si semiconductor devices
- Junction defect detection in low-voltage devices

Solid Cold InGaAs camera

This is a camera with high sensitivity in the near-infrared wavelength range. It operates without contact using a linear motor (magnetic force), which allows for the movement of the cylinder and piston with minimal mechanical wear, resulting in a reliable structure. It is possible to run the unit continuously for 24 hours, which was difficult with the LN2 cooling type.

InGaAs camera Peltier cooling

This camera is sensitive in the near-infrared wavelength range.

ThermoDynamic® camera for thermal emission (MIR)

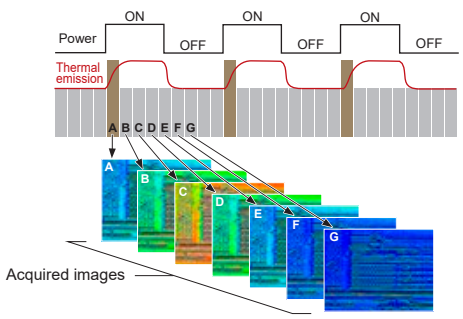
With miniaturization and low-voltage drive of semiconductor devices, infrared light originating from heat generated at failure locations is becoming increasingly weak and difficult to detect. The ThermoDynamic camera has high sensitivity in the mid-infrared wavelength range and can capture such weak thermal signals with high sensitivity.

Application

- Metal wiring short-circuit detection
- Contact resistance anomaly analysis
- Insulation leakage detection

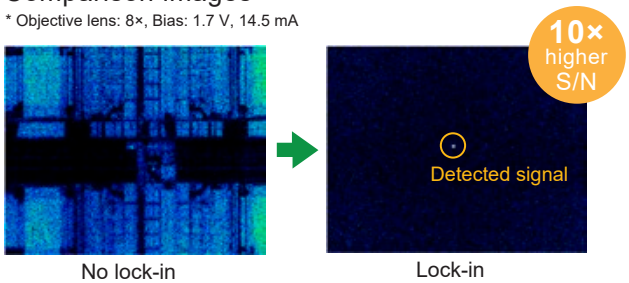
Thermal lock-in measurement

The lock-in measurement method deducts noise by synchronizing the timing of power supply to a device and image capture. With this method, a thermal lock-in unit can provide high quality images even for low voltage devices.



Comparison images

* Objective lens: 8×, Bias: 1.7 V, 14.5 mA



High S/N is achieved by acquiring signals at a specific frequency and eliminating signals at other frequencies as noise.

Laser

Laser scan system

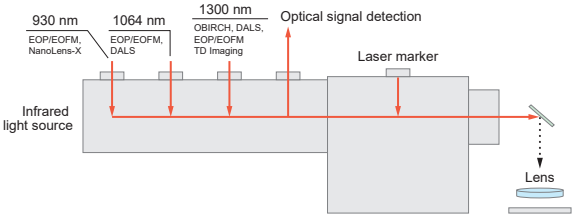
The laser scan system is designed for semiconductor analysis, enabling users to switch and operate light sources of multiple wavelengths. Two models are available: one that supports only the near-infrared region, and another that extends coverage to the visible light spectrum. With high-speed scanning from six directions in as fast as 1 second, the system allows users to change the scan direction without rotating the device, significantly improving operational efficiency.
In IR-OBIRCH analysis, selecting the optimal scan direction according to the wiring orientation of interest enables clearer imaging. The system also supports DALS (Dynamic Analysis by Laser Stimulation) and EO (Electro-Optical) probing analysis. Additionally, the scan speed and scan shape can be adjusted to match the OBIRCH response characteristics.

● Laser configuration

The standard model is specialized for the near-infrared region and supports three wavelengths: 930 nm, 1064 nm, and 1300 nm, as well as a laser marker.
It is optimized for OBIRCH, DALS, EOP, and EOFM analysis, and supports high-resolution scanning up to 2048 × 2048 pixels.

■ Standard function

- **Dual scan**
  Obtain a pattern image and an IR-OBIRCH image simultaneously
- **Flexible scan**
  Normal scan (2048 × 2048, 1024 × 1024, 512 × 512, 256 × 256), Area zoom, Slit H, Slit V, Area Flexible, Mask, Point scan, Scan direction changeable (0°, 45°, 90°, 180°, 225°, 270°)



Laser marker

Failure location information can be easily transferred to another analytical instrument by marking the area of an identified failure location, or by marking around it.
The laser marker uses a pulse laser, and its spot size is Φ5 μm under a 100× lens.

TD Imaging analysis

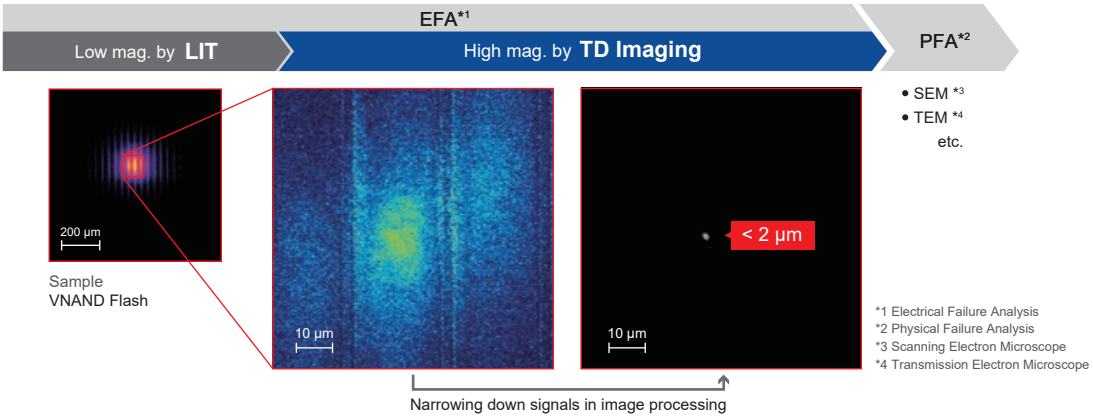
The TD Imaging is a new technology suitable for identifying defects in semiconductors with complex structures, such as logic semiconductors. It is available to pinpoint defects in semiconductors that contain metal parts internally.
Incorporating TD Imaging significantly improves the success rate of identifying failure causes in advanced semiconductor devices, which are increasingly structured in three dimensions and miniaturized. (patented)

■ Features

- **Patented laser scan technology**
  Improves signal-to-noise ratio (S/N) by 38 times. Our company holds the patent for laser-based TD Imaging, delivering superior precision and reliability in thermal imaging and continues to lead innovation in this field.
- **Higher sensitivity**
  Flexible scan speed, size, and integrations, with data acquisition in 90 seconds, providing higher S/N than LIT.

Proposed combined workflow

After detecting a wide range of signals using LIT (Lock-in Thermography) technology, the PFA hit rate is improved by narrowing down the signals to 2 µm using TD Imaging (ThermoDynamic Imaging) while leveraging image processing. This makes defect identification more accurate and enhances the efficiency of analysis.



IR-OBIRCH analysis

The IR-OBIRCH (InfraRed Optical Beam Induced Resistance CHange) analysis detects current alteration caused by leakage current paths and contact area resistance failure in devices by irradiating an infrared laser.

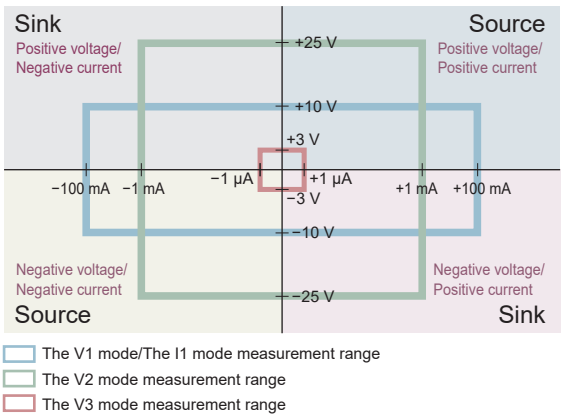
Features

- High-resolution, high-contrast reflection pattern images
- Bottom side observation capable (using a 1300 nm wavelength laser)
- Utilizing infrared lasers, IR-OBIRCH technology ensures that OBIC signals do not occur in semiconductor regions made of silicon. This feature significantly simplifies the identification of fault locations.
- Possible to measure at four quadrants of voltage/current

The OBIRCH amp can work for devices, which need to apply four quadrants of voltage/current.
V1 mode, I1 mode, V2 mode, and V3 mode are selectable via software.

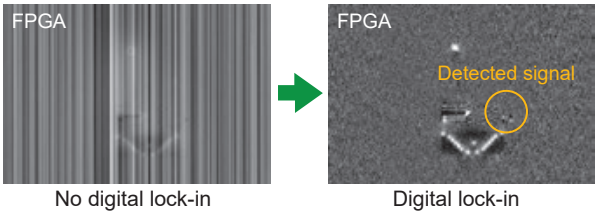
	V1 mode	I1 mode	V2 mode	V3 mode
Voltage range	−10 V to +10 V		−25 V to +25 V	−3 V to +3 V
Current range	−100 mA to +100 mA		−1 mA to +1 mA *1	−1 µA to +1 µA
Detectability	1 nA *2	1 µV *3	3 pA *2	1 pA *2

*1 Specifications may vary depending on the options used.
*2 Minimum detectable pulse signal input into the amplifier.
*3 Calculated value.



Digital lock-in

The digital lock-in is a function of OBIRCH analysis that boosts detection sensitivity by converting the data from one pixel into multiple data using software lock-in processing.



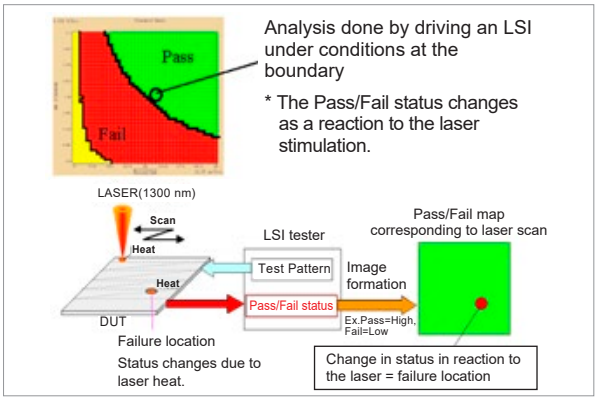
No digital lock-in　　Digital lock-in

Analysis using the current detection head

A current detection head can be used to measure devices that require higher voltage (Max. 3 kV) or higher current (Max. 6.3 A) than the range of standard OBIRCH amp.

DALS

Due to high integration and increased performance of LSI, functional failure analysis under LSI tester connection becomes very important. DALS (Dynamic Analysis by Laser Stimulation) is a new method to analyze device operation conditions by means of laser radiation. The device is stimulated with a 1300 nm and/or 1064 nm laser while being operated with test patterns from an LSI tester. Then device operation status (pass/fail) changes due to heat generated by the laser. The pass/fail signal change is expressed as an image that indicates the point causing timing delay, marginal defect, etc.



Concept of the analysis of a failed device
by utilizing the "drive voltage – operating frequency" characteristics

EO probing analysis

In EO (Electro-Optical) probing analysis, incoherent light (930 nm, 1064 nm, and/or 1300 nm) is irradiated to the bottom side of a semiconductor device and the reflected light is measured to check whether the semiconductor device is operating normally on the basis of the transistor operating frequency and its change over time.
EO probing analysis includes an EOP (Electro-Optical Probing) function that measures the operating voltage at high speeds and an EOFM (Electro-Optical Frequency Mapping) function that captures images of sections operating at a specific frequency. When used with a NanoLens, measurements can be made with higher resolution and sensitivity.

EOP Function

This function rapidly acquires the operating timing of a specified transistor using high-speed sampling. Combined with emission and OBIRCH analysis results, the EOP function improves failure localization accuracy and helps reduce the time required for subsequent physical analysis.

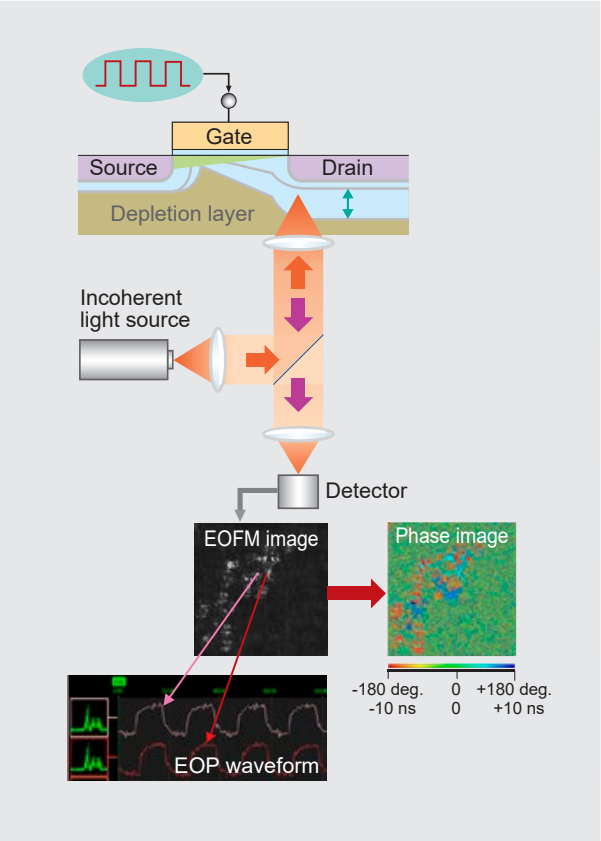
Bandwidth	1 kHz to 7 GHz

EOFM Function

This function measures transistors switching at a specific frequency and images them. The reflected light from a drain has the power spectrum distribution. The EOFM picks up the intensity of signal under certain frequency from the distribution and visualizes it as an image. By operating transistors in a specific region under certain frequency, it is possible to observe if the circuits are correctly switching or not. 4 images can be acquired simultaneously. (patented)

Bandwidth	1 kHz to 1.5 GHz

Principle



Lens

Lens selection

Up to 10 types of objective lenses can be mounted on the motorized turret.
The macro lens for emission analysis can be installed on the system.

Objective lens

Product name	Product number	NA	WD (mm)	Analysis
Objective lens 1× for OBIRCH	A7649-01	0.03	20	OBIRCH
Objective lens 2× IR coat	A8009	0.055	34	Emission/OBIRCH
Objective lens NIR 5×	A11315-01	0.14	37.5	Emission/OBIRCH
Objective lens NIR 20×	A11315-03	0.4	20	Emission/OBIRCH
Objective lens PEIR Plan Apo 20× 2000	A11315-21	0.6	10	Emission/OBIRCH
Objective lens PEIR Plan Apo 50× 2000	A11315-22	0.7	10	Emission/OBIRCH
High NA objective lens 50× for IR-OBIRCH	A8018	0.76	12	OBIRCH
Objective lens NIR 100×	A11315-05	0.5	12	Emission/OBIRCH
Objective lens NIR-UHR 50×	A11315-10	0.65	10	Emission/OBIRCH
Objective lens MWIR 0.8×	A10159-02	0.13	22	Thermal emission
Objective lens MWIR 4×	A10159-03	0.52	25	Thermal emission
Objective lens MWIR 8×	A10159-06	0.75	15	Thermal emission

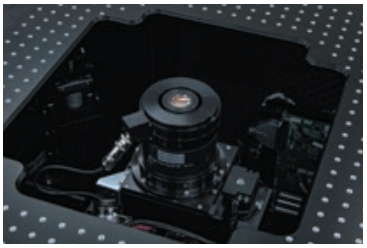
Macro lens

Product name	Product number	NA	WD (mm)	Analysis
Macro lens 1.35× for iPHEMOS	A13573-01A	0.38	15	Emission

Macro lens

The 1.35× macro lens features a high numerical aperture (NA) of 0.38, enabling highly sensitive detection of weak light emission. In addition, the software allows smooth switching between macro observation and micro observation using an objective lens.

Note: The macro lens may interfere with the sample depending on the sample structure and specifications.



NanoLens

For bottom-side observation, near-infrared light is used to penetrate the silicon layer. However, optical resolution decreases at longer wavelengths. The NanoLens (a solid immersion lens) is a hemispherical lens placed in contact with the LSI substrate. By utilizing the refractive index of silicon, it increases the numerical aperture, significantly improving spatial resolution and light collection efficiency.
By placing the NanoLens-WR (NA 3.1) or NanoLens-X (NA 3.3) over the area of interest on the bottom side of a device, sub-micron spatial resolution can be achieved, significantly improving failure localization accuracy.
The Thermal NanoLens (NA 2.6) can also be used for thermal analysis.

External connection

CAD link software

The CAD link software enables bidirectional communication between CAD and SemiShop®. A key feature is the ability to acquire EOP signals directly from points specified in CAD Viewer and transfer them to SemiShop. In addition, automatic notification of measurement locations and export of pattern images help improve analysis efficiency.

Specification

Dimensions / Weight

Main unit	1350 mm (W) × 950 mm (H) × 1350 mm (D) *1 Approx. 1620 kg	
System rack	1230 mm (W) × 2252 mm (H) × 790 mm (D) *2 Approx. 420 kg	
Operation desk *3	● **C16216-01 Operation desk** 1000 mm (W) × 700 mm (H) × 800 mm (D) Approx. 39.2 kg	● **C16216-02 Operation desk** 1480 mm (W) × 700 mm (H) × 800 mm (D) Approx. 48.6 kg

*1 Excluding joint sections
*2 Including signal tower
*3 Optional

Utility

Line voltage	Single phase AC 200 V to AC 240 V
Power consumption	Approx. 3300 VA
Compressed air *1	0.5 MPa to 0.7 MPa

*1 Regulator included

LASER SAFETY

The iPHEMOS-DDX is a Class 1 laser product. Hamamatsu Photonics classifies laser diodes, and provides appropriate safety measures and labels according to the classification as required for manufacturers according to IEC 60825-1. When using this product, follow all safety measures according to the IEC.

Description Label (Sample)


Caution Label

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