MiNY® PL

Micro LED PL inspection system C15740-01

A new way to improve the yield of micro LEDs

HAMAMATSU

PHOTON IS OUR BUSINESS

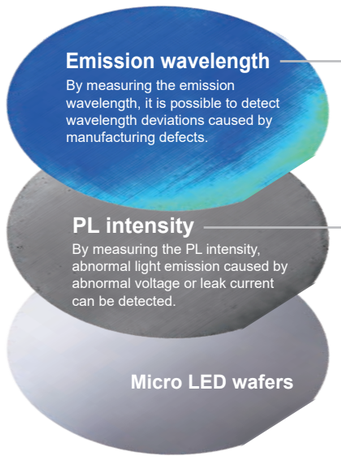
High-speed, non-contact, non-destructive, automatic inspection of the entire wafer for micro LEDs

MiNY® PL is an inspection system for micro LED wafers using the photoluminescence (PL) measurement method.

Three capabilities

that photoluminescence (PL) measurement makes possible

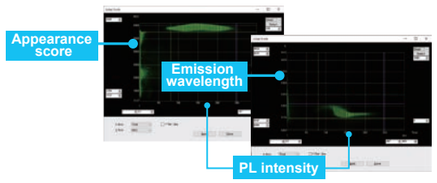
- Detects abnormalities in luminescence and wavelength that cannot be detected by Automated Optical Inspection (AOI)
- Enables 100 % inspection, which is not possible with electroluminescence (EL) inspection
- Enables inspection in the front-end of the manufacturing process, contributing to higher yields.



Measure at once

Automatic screening of LED defects on wafers using the measurement results of “Emission wavelength”, “PL intensity” and “Appearance”

Detects shape abnormalities, cracks, dust, scratches, etc.



Classifies the measurement results into three axes:
emission wavelength, PL intensity, and appearance.

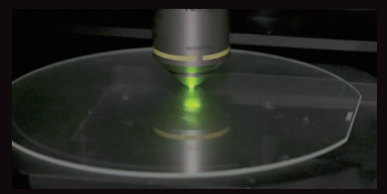
Determines “Good” and “NG”* products automatically based on preset threshold values

*NG stands for Not Good.

What is PL measurement

that enables high-speed, non-contact, non-destructive 100 % inspection?

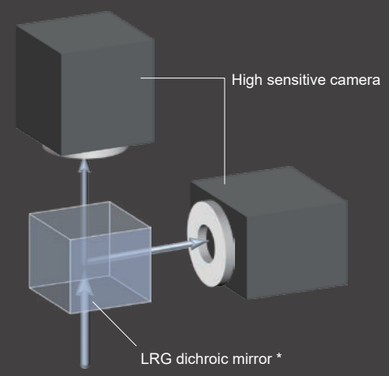
PL measurement is a non-contact, non-destructive method for evaluating LED characteristics by imaging the light emitted from a LED by photoexcitation.
MiNY® PL is a unique two-dimensional imaging technology that calculates the emission wavelength in a wafer plane at once without measuring the spectrum using a spectroscope. Compared to spot measurement using a spectroscope, in-plane emission wavelength can be obtained at high speed.



λ-Capture

New wavelength detection method

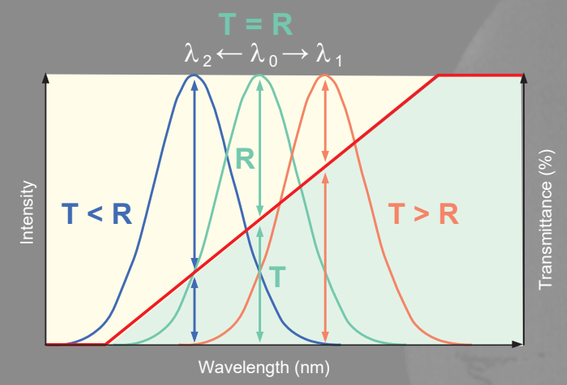
Wavelength detection method “λ-Capture” technology



λ-capture is a new wavelength detection technique that enables wavelength measurement without a spectrometer.
When performing wavelength measurement of the entire wafer, point measurement with a conventional spectrometer or line measurement with an imaging spectrometer takes an enormous amount of time.
λ-capture can measure wavelengths in an area by using highly sensitive cameras, enabling spectral measurement of entire wafer at high speed.
By using this technology that is simultaneous evaluation of PL intensity mapping and PL wavelength mapping of micro-LEDs, wavelength management of displays is possible in a short time.

* Linear Reflectance Gradient on the wavelength axis (LRG) dichroic mirror

■ Measurement principle



$$\lambda=\lambda_0+A\frac{(T-R)}{2(T+R)}$$

Amount of reflected light: R
Amount of transmitted light: T
Center wavelength of dichroic mirror: λ_0
Wavelength range of dichroic mirror: A

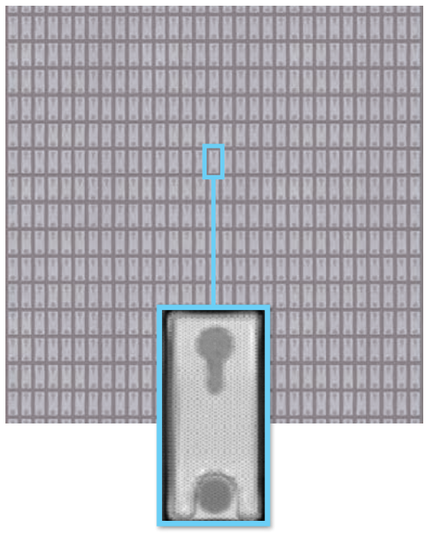
In λ-Capture technology, two high-sensitive cameras and an LRG dichroic mirror are used. When the wavelength of center gravity is equal to the center wavelength of the dichroic mirror, the light intensities of the transmitted and reflected signals are the same. If the wavelength shifts toward the longer wavelength side, the transmitted signal becomes larger, and if it shifts toward the shorter wavelength side, the reflected signal becomes larger.
By simultaneously measuring the light intensity passing through the dichroic mirror with two high-sensitivity cameras, the deviation from the center wavelength can be determined. Thus, it makes possible to measure both light intensity and wavelength with a single measurement.

New Technology that improves detection accuracy of micro LED defects

The PL measurement method used in MiNY® PL is a technology that greatly improves the accuracy of defects detection for micro LEDs.

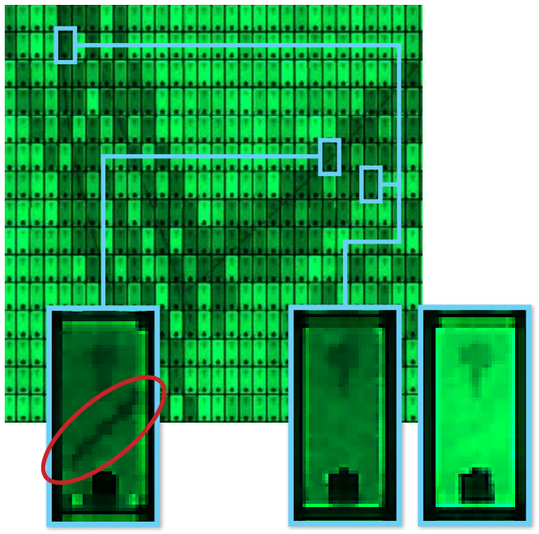
1 Highly sensitive detection of defects that cannot be detected by AOI.

Appearance inspection



No defect found

Internal defects inspection with PL measurement method



Detect defects in chips with clear images

In general, scratches, dust, and wiring failures can be detected by appearance inspections such as automated optical inspection, but cracks in crystals and defects in LED chips cannot be adequately detected by AOI.

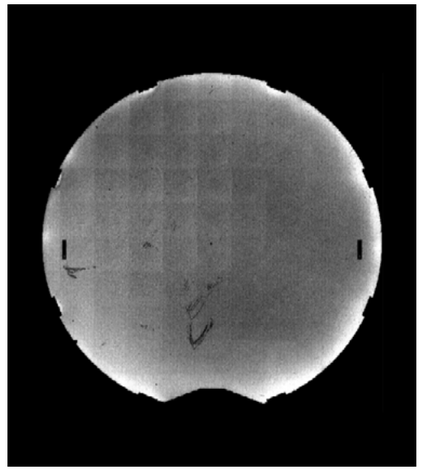
Hamamatsu Photonics has focused on the "emission wavelength" and "emission intensity" that can be measured by PL-based imaging and developed a technology to detect defects and impurities inside the crystal of semiconductor wafers for micro LEDs.

As MiNY® PL allows defects detection with highly sensitive images, clear observation of microscopic defects will be possible.

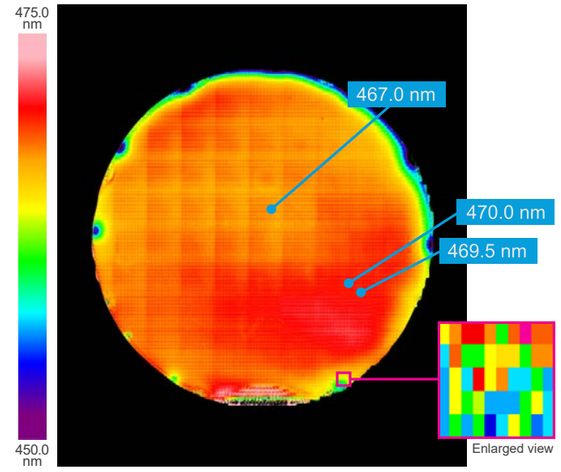
Combining this internal inspection using PL measurement with appearance inspection makes more precise inspections possible.

2 Converts emission wavelength to a mapping image and detects wavelength variations with high accuracy of ± 0.5 nm

Appearance image

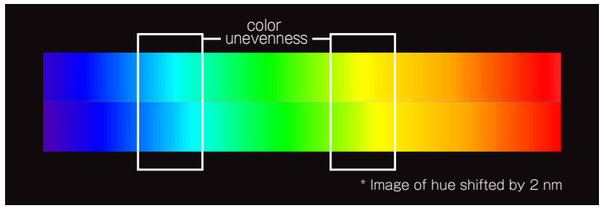


Wavelength mapping image



Emission wavelength variation observed through color irregularity.

Subtle variations in the emission wavelength of the micro LEDs are said to directly affect the color and brightness of the display. A wavelength variation of 2 nm in the emission wavelength of a micro LEDs can be recognized by the human eye as color unevenness. Variations in emission wavelength is a key parameter for producing micro LEDs with uniform hue and brightness.



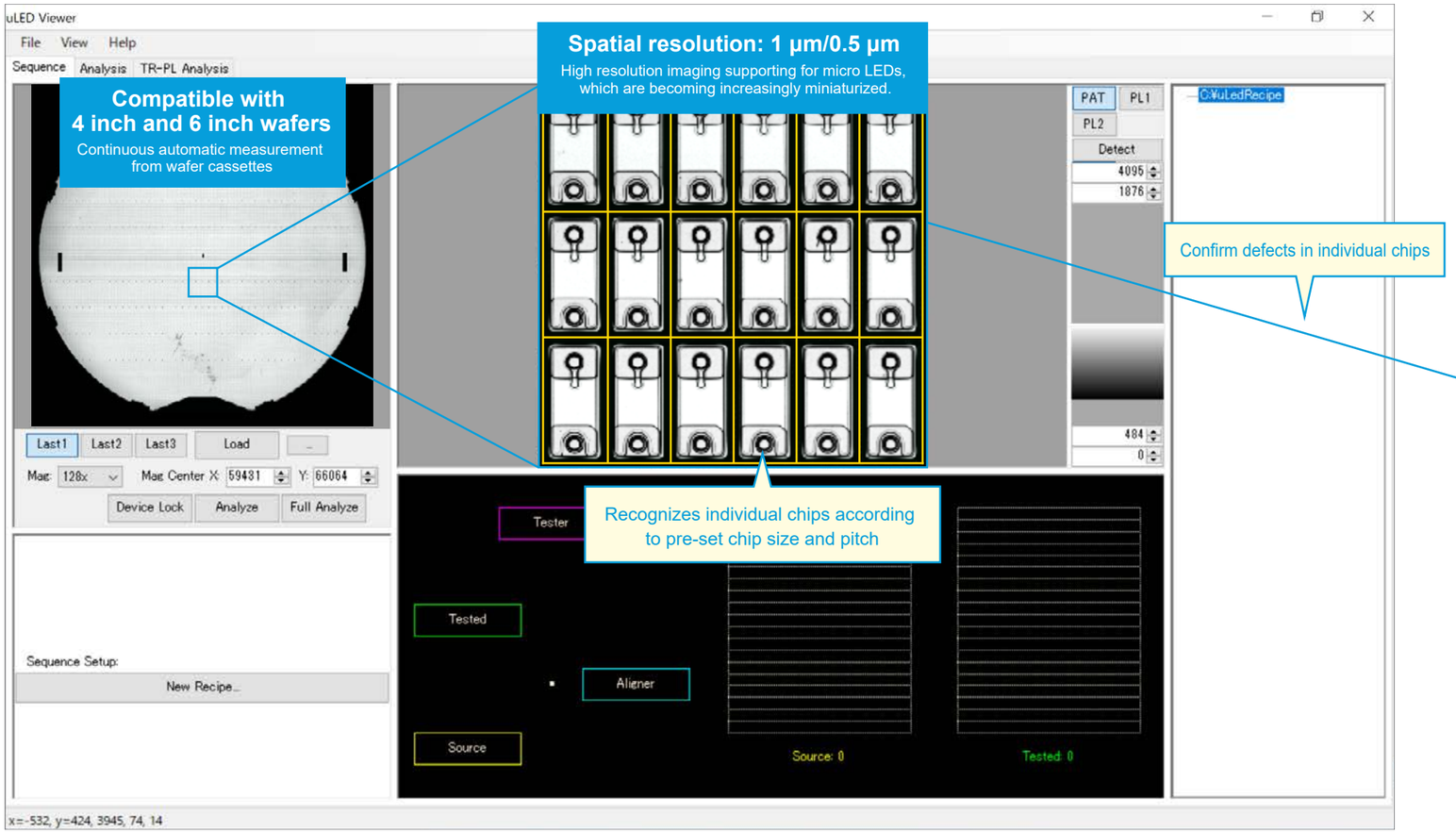
MiNY® PL can detect wavelength variation with an accuracy as high as ±0.5 nm and visualize variations in emission wavelengths within a wafer as color unevenness by converting differences in emission wavelengths from chip to chip into a mapping image. This enables more precise and efficient determination of wafer quality.

The emission spectrum can also be measured by using the optional spectroscopic analysis module.

New Technology that improves detection accuracy of micro LED defects

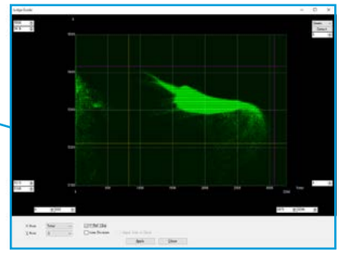
The PL measurement method used in MiNY® PL is a technology that greatly improves the accuracy of defects detection for micro LEDs.

3 Software for detailed analysis from Emission wavelength, PL intensity, and Appearance check.



The software for MiNY® PL acquires and displays appearance and PL images. It also has the performances to enhance the accuracy of analysis such as analysis supporting various.

Quality judgment screen



You can check defects in each region of a few µm size micro LED chip.

Quality judgment is made for each chip based on PL emission wavelength and PL intensity and defects will be listed and displayed.

Features that increase analysis accuracy

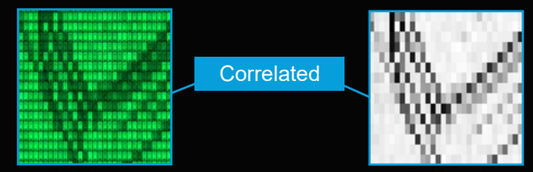
- Supports a variety of chip designs
- RGB-compatible measurement settings
- Guide function for quality judgment

Validation of the PL measurement method

Correlation with EL measurement method

Conventional EL measurement method is the electrical method established as a common inspection method for LEDs. In contrast, PL measurement method detects defects from luminescence emission that occurs when LEDs are excited by photon light. This new method is very effective and advantageous for micro LEDs which have huge number of LEDs chips per wafer. Hamamatsu Photonics has benchmarked in detail those two EL and PL methods, for the specific micro LEDs inspection. In conclusion, we confirm that we could access the same results with both methods.

Measurement of PL intensity



MiNY® PL Micro LED PL inspection system C15740-01

Specifications

Model name	C15740-01
Supported wafer size	100 mm (4 inches) or 150 mm (6 inches) (other sizes negotiable)
Measurement time	Approx. 12 minutes (Objective lens 10×, PL measurement, 4 inch wafers)
PL measurement wavelength	R, G, B
Spatial resolution	1 μm/pixel (standard mode), 0.5 μm/pixel (high resolution mode)
Measurement items	Shape abnormality, PL intensity, PL wavelength
External dimensions / weight	2000 mm (W) × 1878 mm (H) × 1130 mm (D) / Approx. 1800 kg
Clean room	Compatible

Options for analysis

Options for more detailed analysis of abnormalities are also available.

- M16439-01 Spectroscopic analysis module
- M16439-02 Fluorescence lifetime analysis module

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