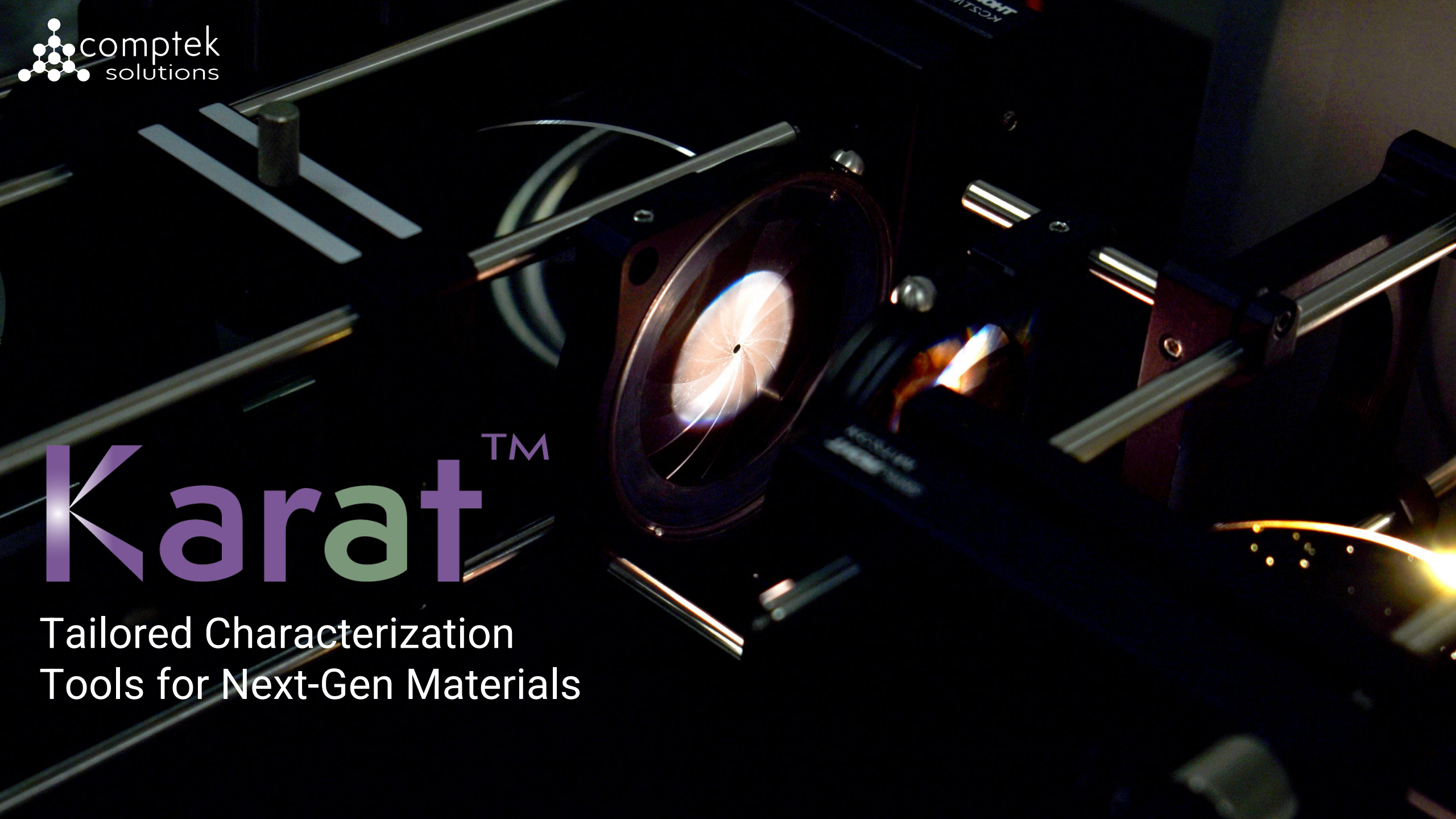

comptek
solutions
Karat™
Tailored Characterization
Tools for Next-Gen Materials

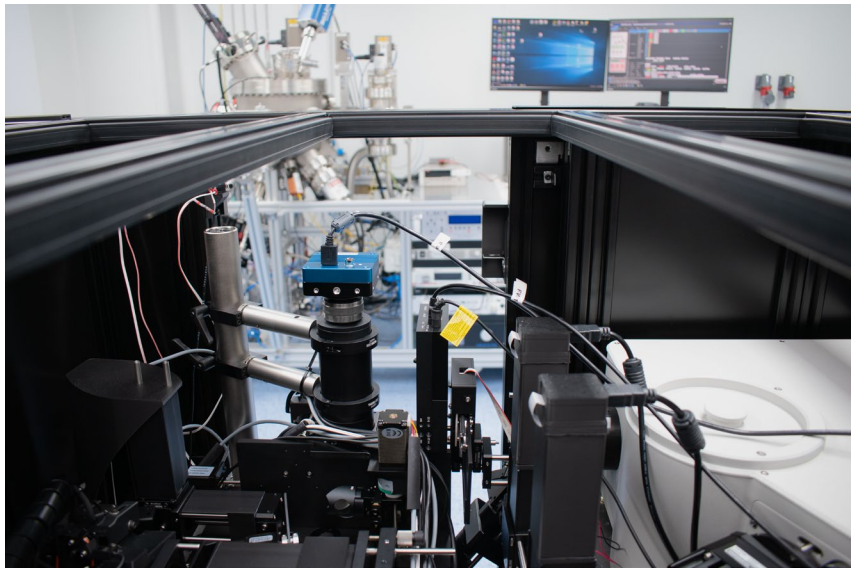
Expertise in Compound semiconductor surface engineering

Building on Our Passivation Legacy

Comptek Solutions has years of expertise in **III-V compound semiconductor surface engineering technologies.**

During this time, the R&D effort to provide the most efficient passivation, our Kontrox™ technology, for demanding applications such as µLEDs, Lasers and Photodiodes, has pushed our team to develop advanced characterization techniques and tools to obtain accurate and precise information about the quality of the materials and the performance of the chips from our customers.

As a result, we have built a characterization platform where we can combine multiple measurement techniques in a customizable and cost-effective way to provide high-end solutions meeting the particular needs for every customer.



Karat™ Characterization Platform

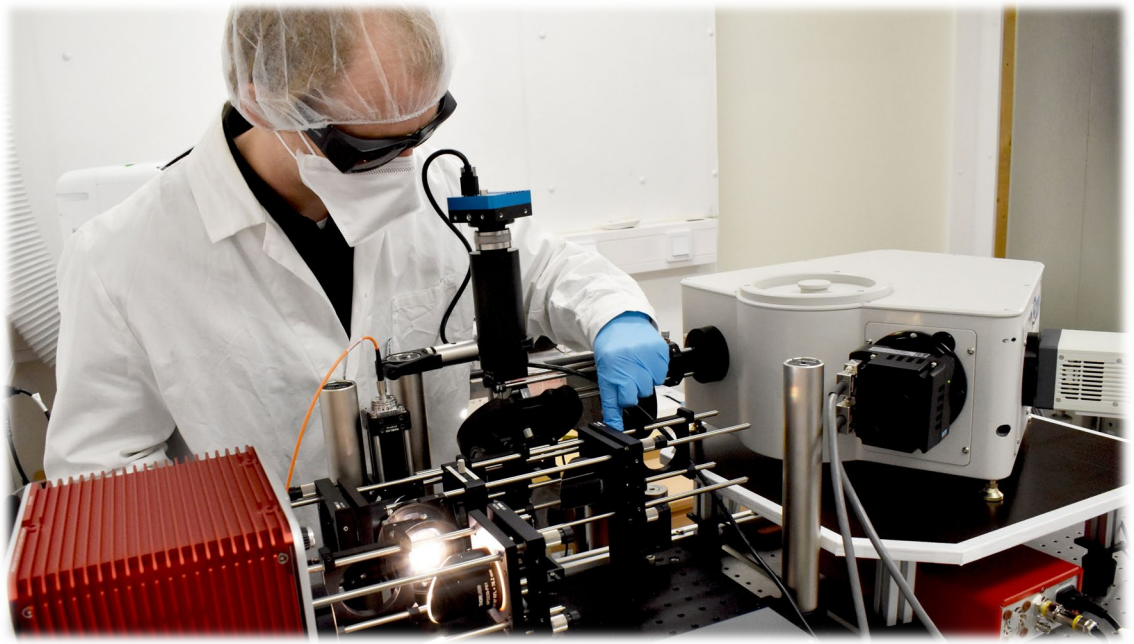
Platform baseline

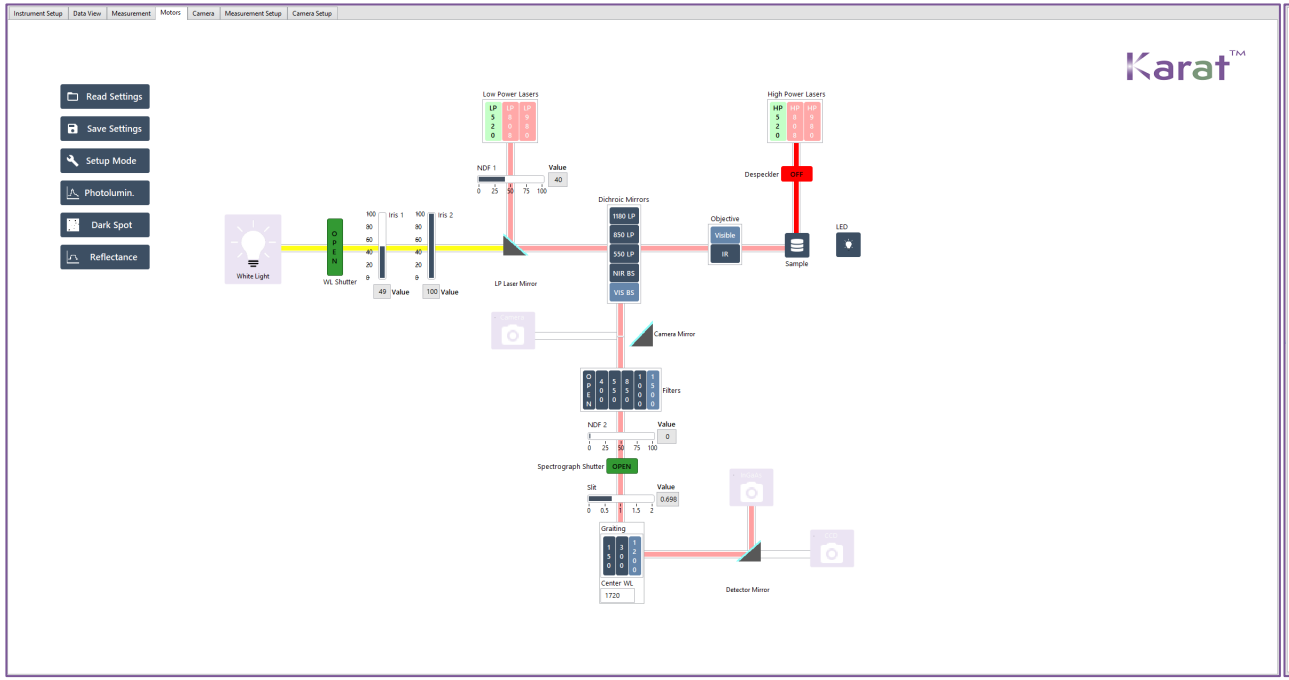
Combining optimized optical system designs, highly efficient and long-term stable optical components and robust mechanics, the Karat™ platform offers a variety of measurement techniques that can be combined in a single tool, whose specifications can be modified within certain ranges as required by customer needs.

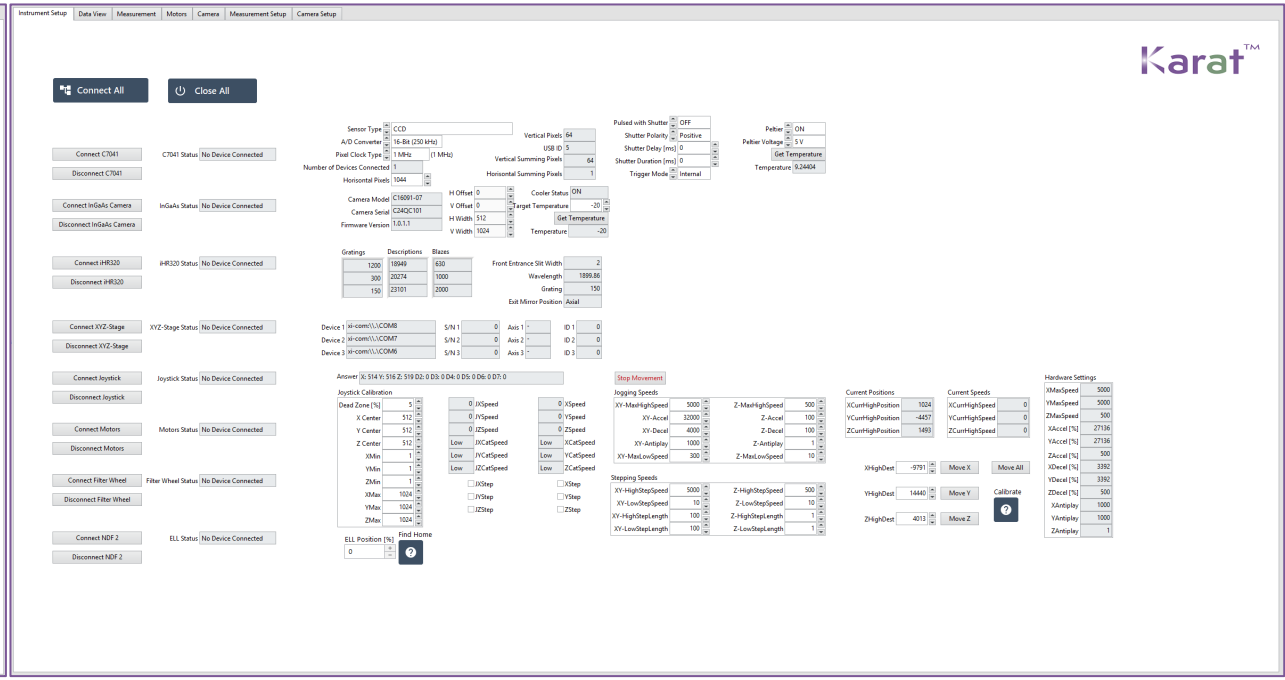
- *Example: **Karat 25** features Photoluminescence, Dark Spot, and Reflectance measurements in a single tool through a wide spectroscopy wavelength range (400-2500nm).*

Karat equipment is engineered to ease the research work and to provide a good user experience. The system is fully motorized, and all adjustments can easily be controlled by the user through an intuitive and interactive dashboard.

Pre-settings for each measurement technique are available and they are customizable by the user.



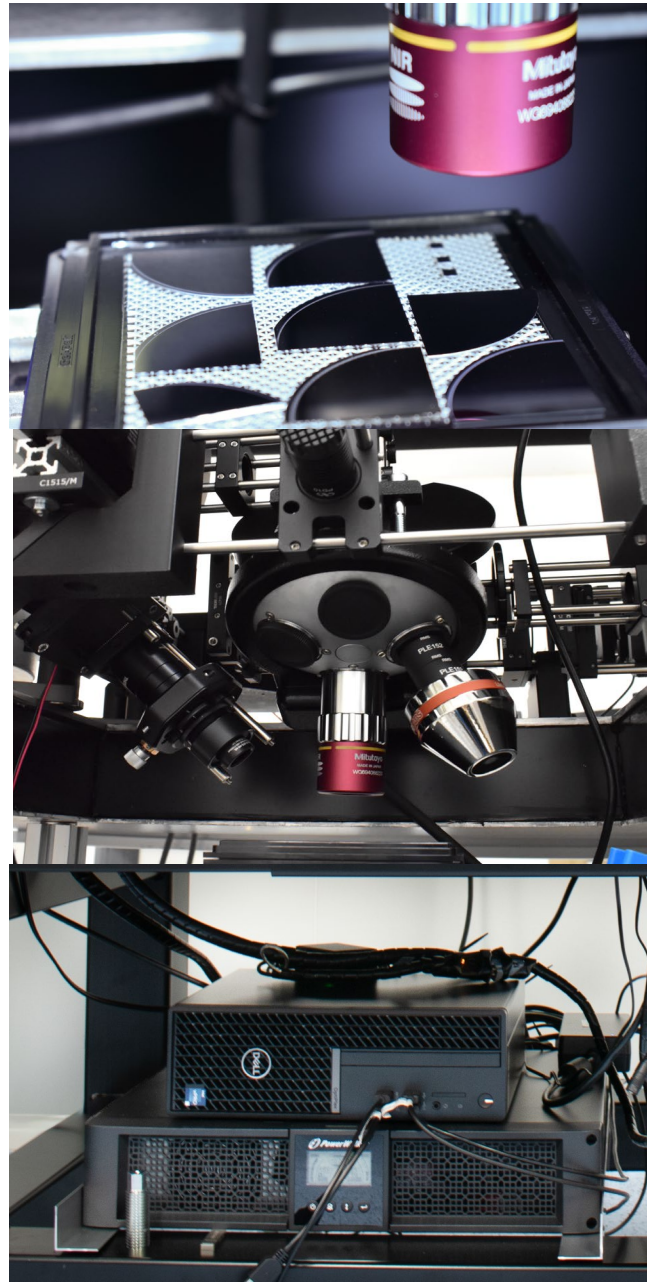




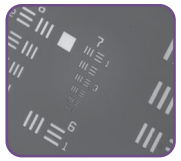
Karat™ Characterization Platform

Platform baseline

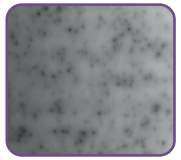
- Karat tools are equipped with an innovative vacuum chuck system that allows placing multiple samples with different sizes and shapes without need of additional jigs or special chucks, making easier and faster the loading of samples.
- ✓ A XYZ motorized stage allows rapid and automatic mapping of samples
- ✓ Sample size up to 8x8”. Larger sizes are also possible upon customer request
- ✓ The spatial resolution is adjusted based on the end-use case. Our baseline is
  - Mechanical: The default resolution used is 0,3μm in XY and 0.6μm in Z .
  - Imaging res: Depending of optics and wavelength. at VIS: 1μm, NIR: 4μm
  - Mapping res. : Objective dependent down to 3μm
- ✓ **Automatic** sample contour detection for measurement set up and data processing
- ✓ Wide detection range 350nm – 2500 nm
- ✓ Excitation wavelengths ranging from (350nm – 1500nm)
- ✓ Excitation power from mW to tenths of W, depending on the characterization techniques implemented and targeted materials.
  - System safety is thoroughly taken care of, so that operation is always safe and no harm can be caused in case of malfunction.
- ✓ System is equipped with a UPS power supply to prevent damage to/from lasers due to faults in the electrical supply.



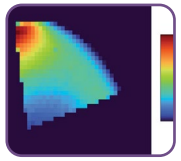
Karat™ Main Characterization Techniques



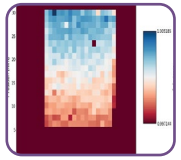
Microscopy imaging



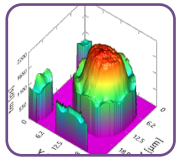
Dark spot imaging



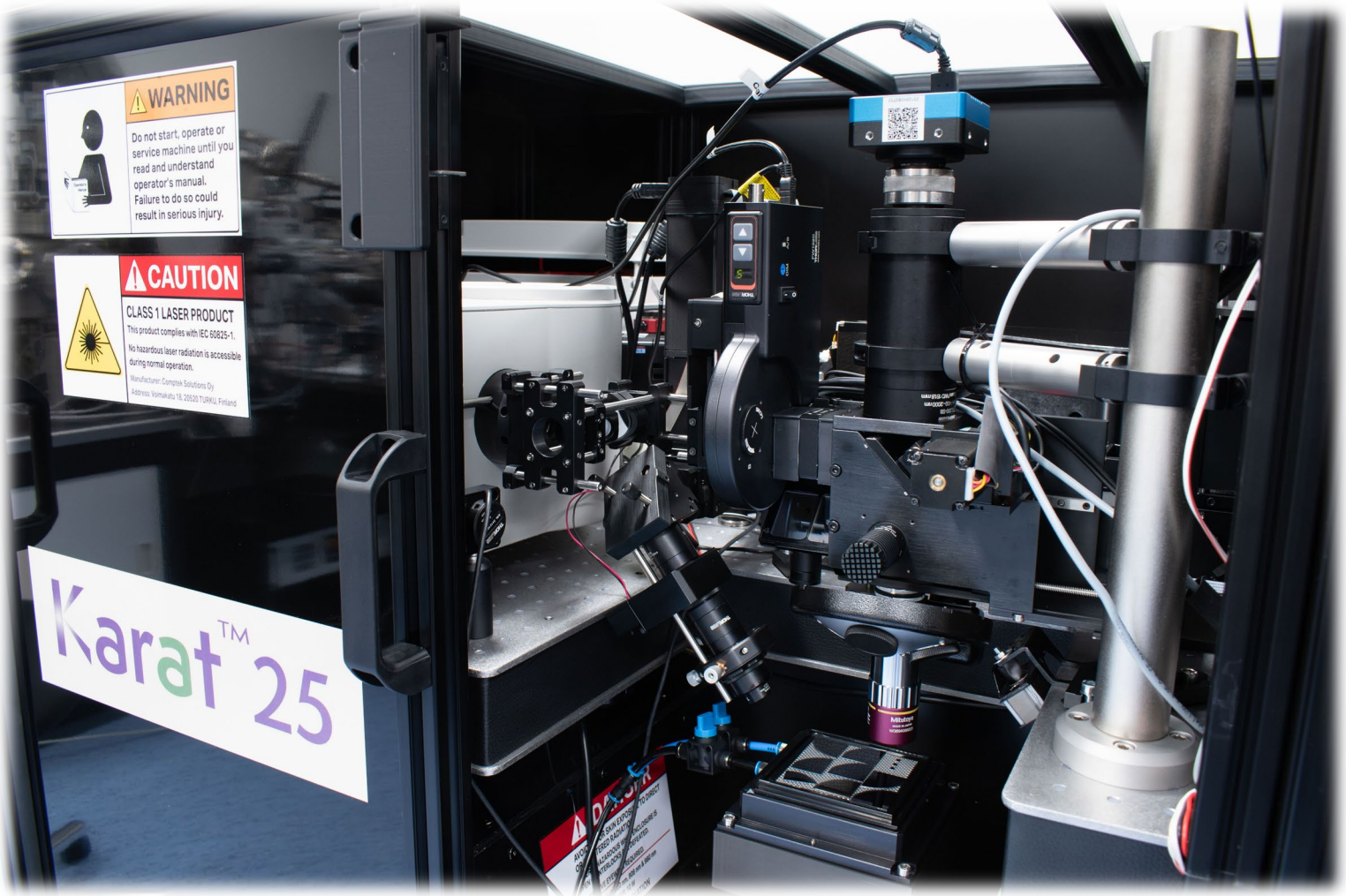
Photoluminescence



Reflectance spectroscopy

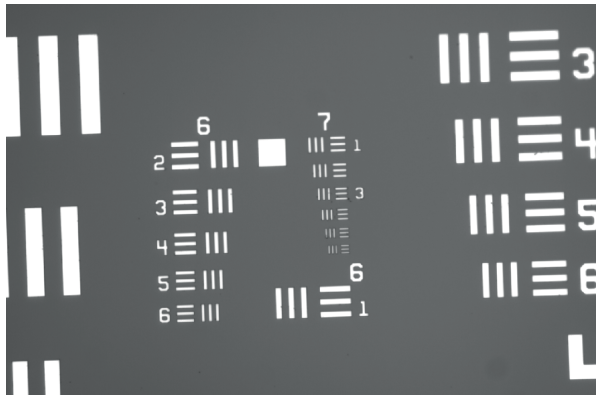


Carrier lifetime



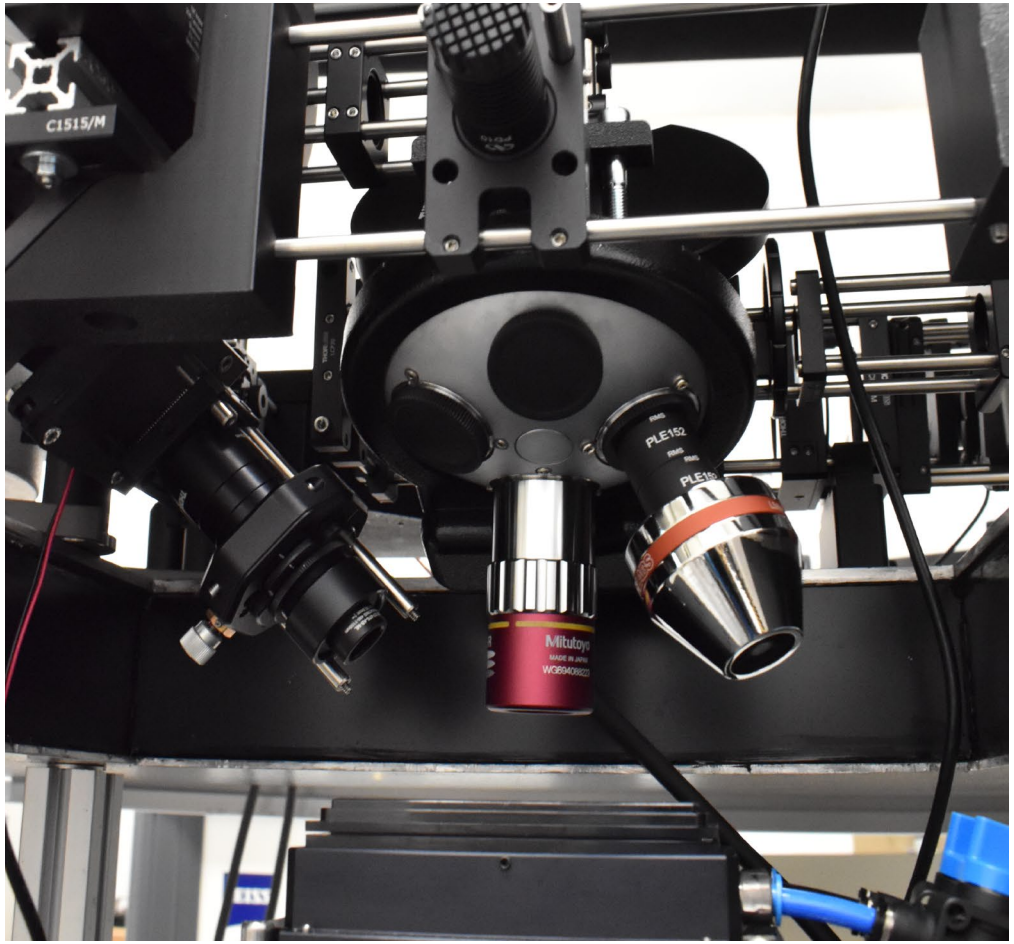
Epi-illumination Microscopic imaging

- High-resolution imaging under epi-illumination (reflected light microscopy) reveals surface morphology and defects.
- The adjustable illumination area enables control of the measured region—essential for reflectance studies and localized analysis.
- The resolution depends on the optical objectives selected. X100, x50, x20, x10, x5 are available as standard options.



Wide-field epi-illumination image showing uniform illumination across the field of view.

Epi-illumination image at the same magnification, showing adjustable illuminated area (approx. 0.1-2mm) for optimizing spatial resolution and signal throughput in reflectance measurements.

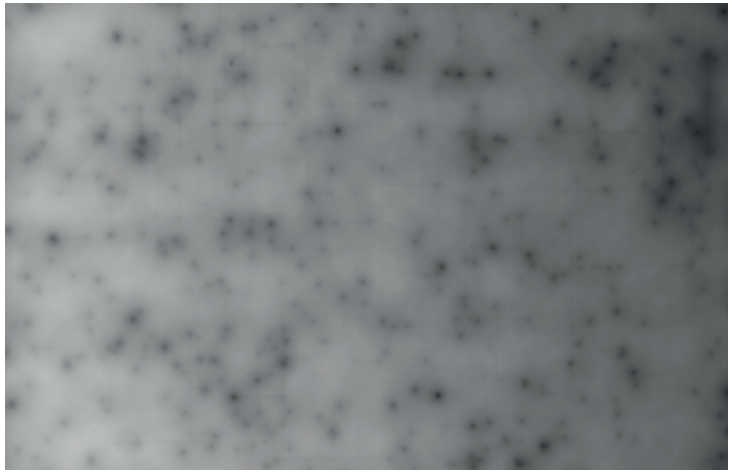


Up to 4 objectives can be placed in a motorized turret.

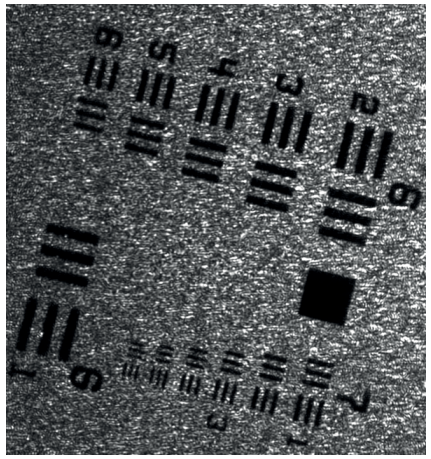
Dark Spot imaging

The dark spot module enables imaging of luminescence intensity variations at micrometer scales, revealing crystal growth defects and other features invisible under standard illumination.

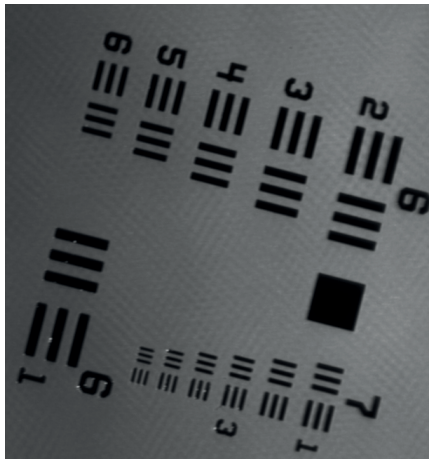
- The system features an efficient **speckle removal solution** and optimized **beam-shaping optics** for uniform illumination and sharp imaging
- Support of multiple high-power excitation lasers (up to 10 W each) with wavelengths within the range of 400nm – 1000nn
- Full wafer mapping by image stitching techniques
- Automatic defect detection and categorization by size.



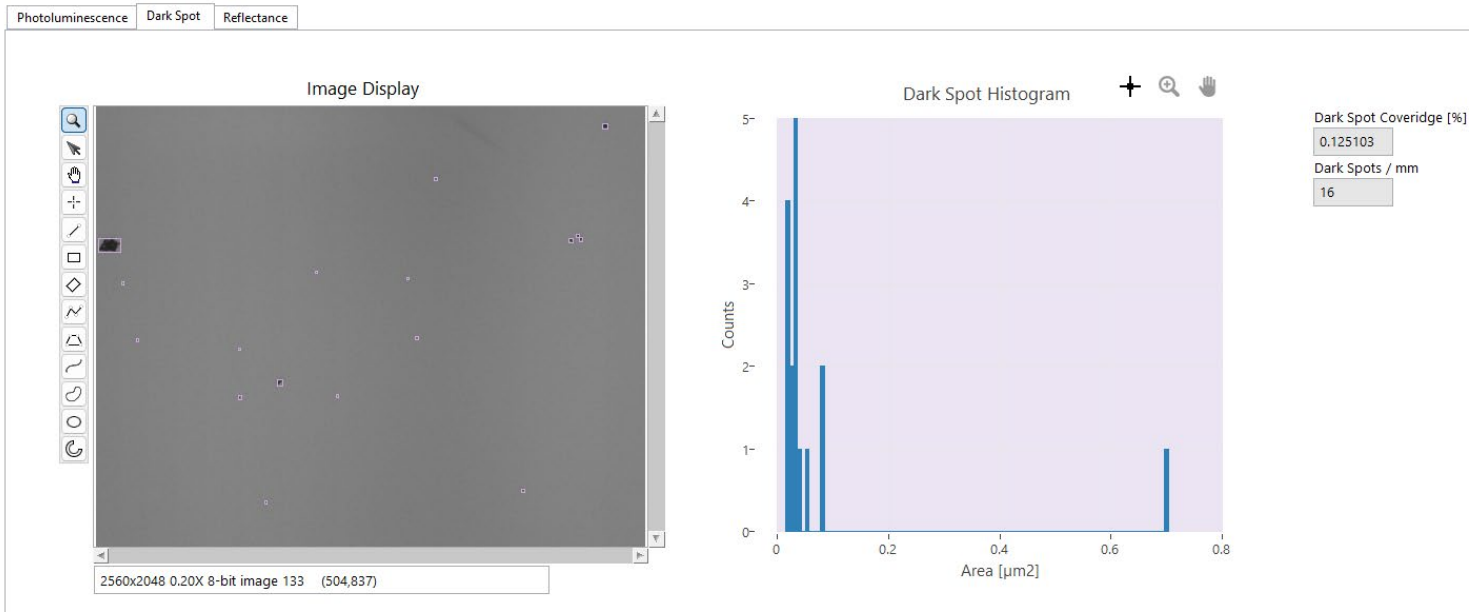
Dark spot imaging of a sample surface under laser illumination, revealing dark spot regions from a customer sample



Laser-illuminated target – despeckler off



Laser-illuminated target – despeckler on, showing improved uniformity.

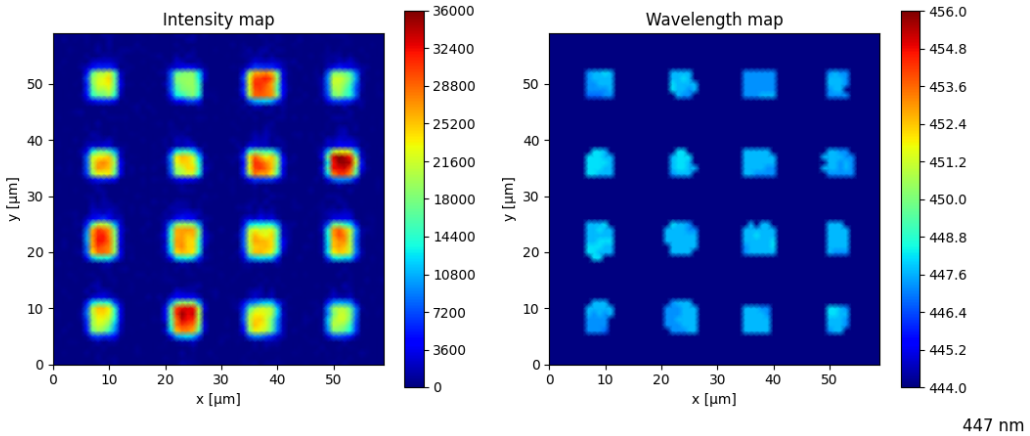


Photoluminescence (PL) Mapping

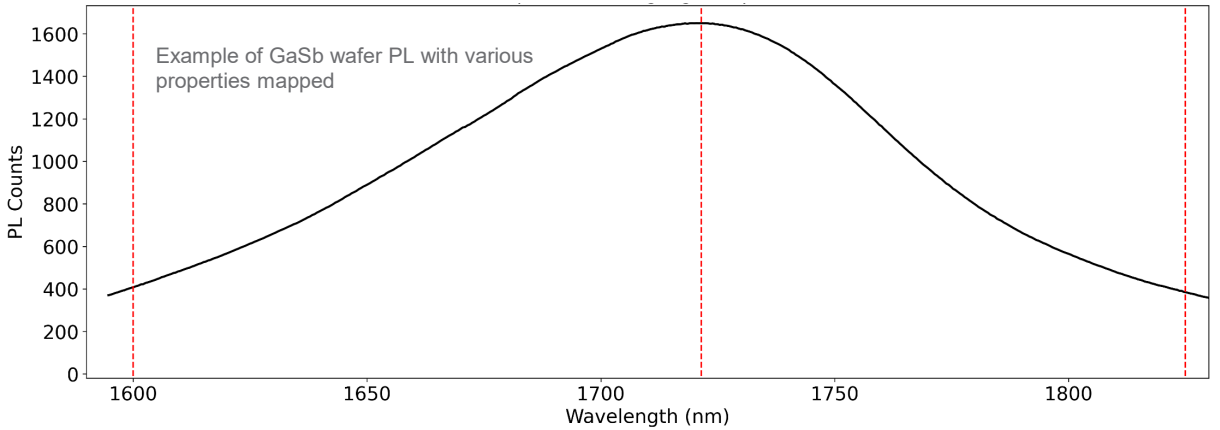
Unlocking Defect Dynamics & Material Quality

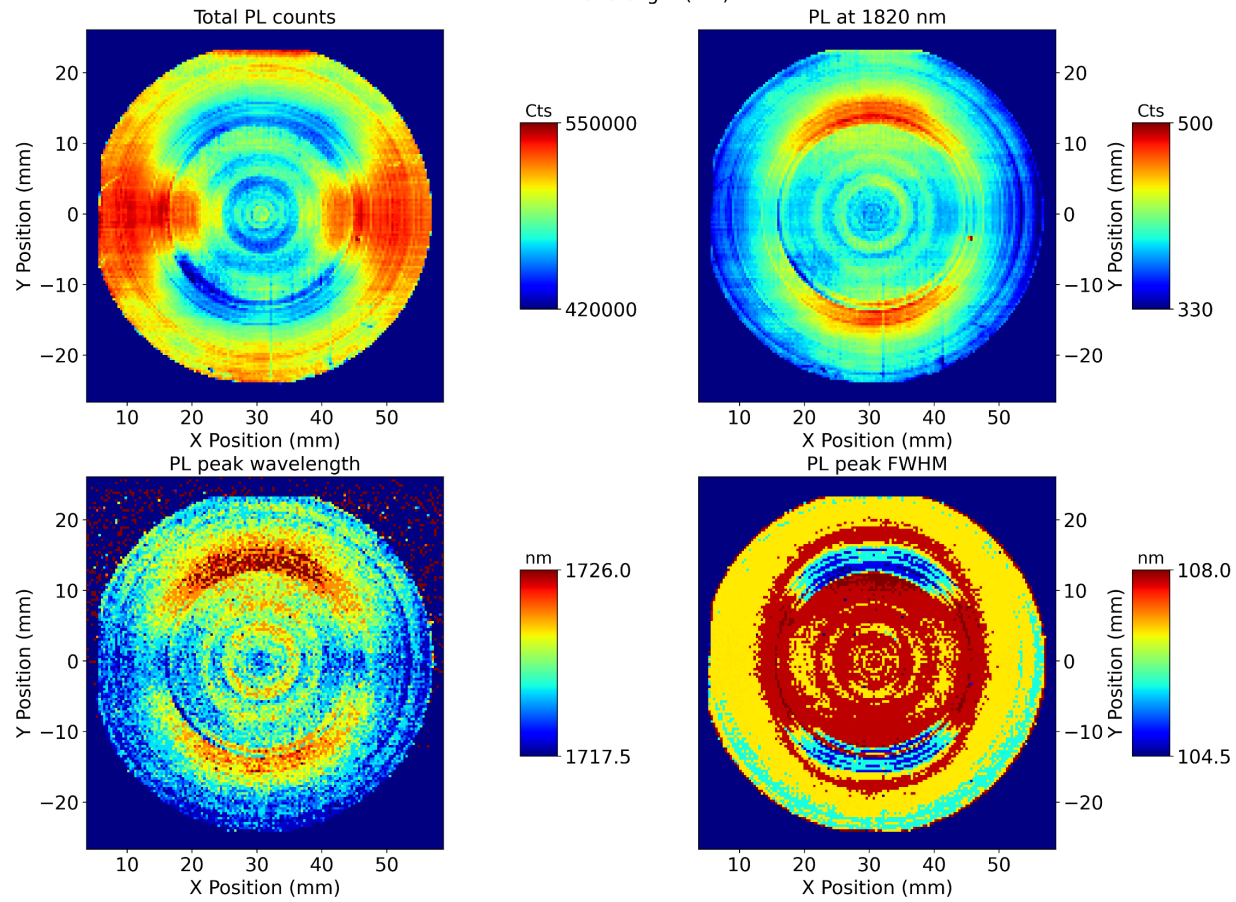
- **High-resolution PL mapping** reveals non-uniformities, defects, and wavelength shifts across wafers and devices.
- Possibility to combine steady-state PL and time-resolved carrier lifetime measurements, providing detailed spatial spectral insight into semiconductor materials and devices. Ideal tool to characterize µLEDS and optoelectronic devices

- **Measurement modes: Point & mapping**
  - Measurement path and point matrix can be defined by user
  - Mapping mode will scan automatically the PL/TRPL response on an evenly spaced grid through the whole sample surface
  - Dynamic analysis by point selection from the maps



Example of a PL map from an array of 5µm µLEDs. Left image shows PL intensity map. Right image shows the wavelength map





Photoluminescence (PL) Mapping

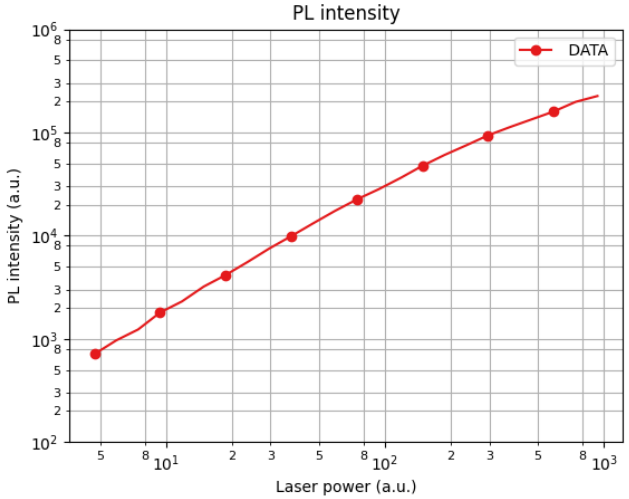
Unlocking Defect Dynamics & Material Quality

- Excitation lasers are selected according to the target materials and the required measurement techniques
  - Mutiple excitation lasers. CW for steady-state or Pulsed lasers if TRPL is required
  - Typical wavelengths include 405nm, 470nm, 532 nm, 563nm, 808nm, 980nm etc.

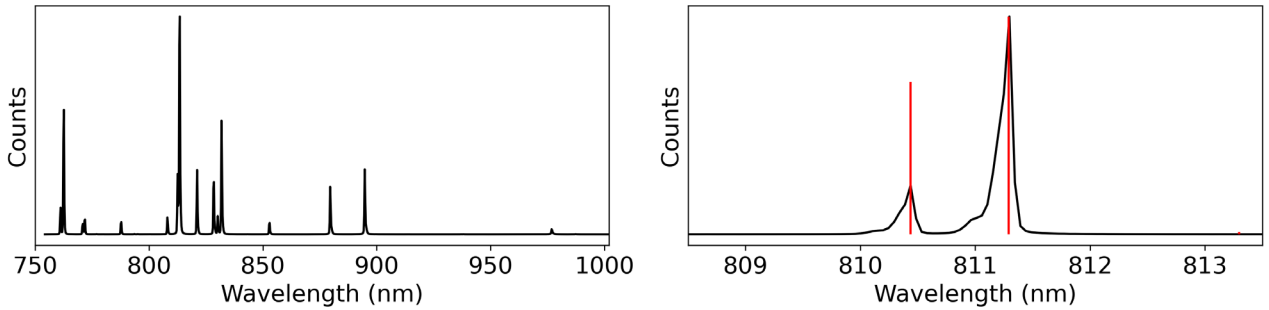
- Excitation **power-dependent PL measurements** are possible thanks to automatic laser power adjustment. This technique can be used to differentiate between extraction efficiency improvements versus IQE improvements

- High resolution and wide spectral range available with multiple gratings spectrograph

- Array detectors for rapid spectral acquisition. 400 – 2500nm (VIS 200-1100nm / NIR 900- 2500nm)



Example of PL intensity evolution vs excitation power



Atomic line spectra demonstrating broad single-acquisition range (left) and high resolution (right)

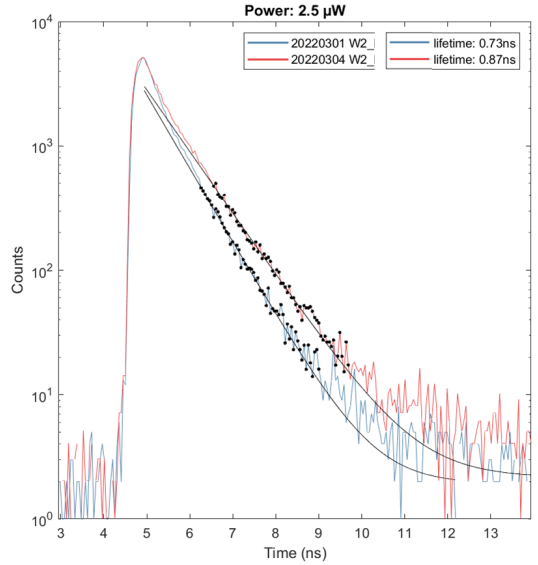
Carrier lifetime mapping

Evaluation of optoelectronic device and materials efficiency

By using **TCSPC** (**time-correlated single-photon counting techniques)**, the carrier lifetime mapping option provides Time-resolved PL to evaluate carrier dynamics and recombination mechanisms.

It helps researchers and development teams to get more information about:

- recombination rates (radiative vs non-radiative)
- Carrier lifetime in the materials.

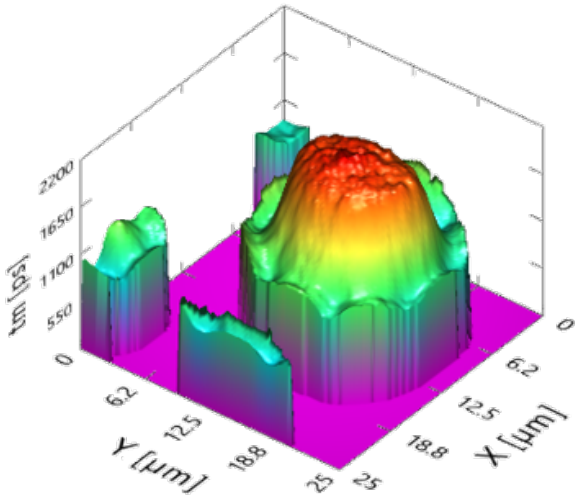


Example of carrier lifetime measurements of 2 different 10µm µLEDs showing the decay raw data and the decay fit

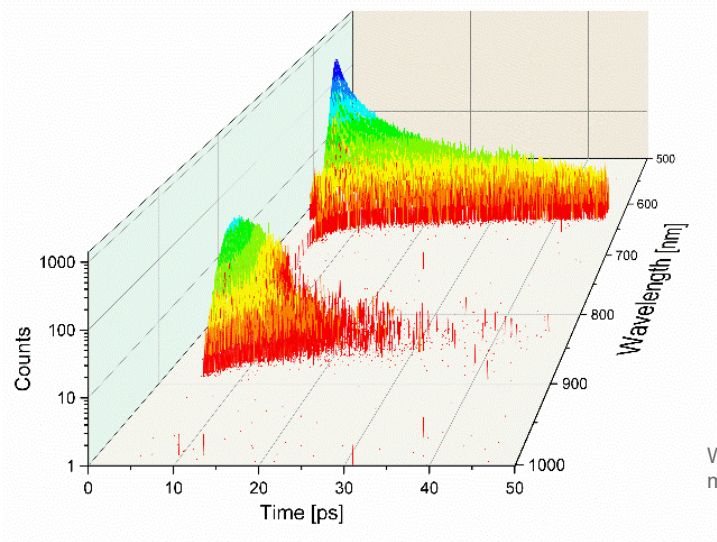
Using high pulse repetition rates and narrow picosecond pulses we ensure short measurement times and high performance to detect short fluorescence lifetimes.

The standard IRF (instrument response function) of Karat™ system is below 50ps.

The Karat™ system is equipped with a spectrograph that helps to filter the time-resolved PL emission to certain wavelengths , generating a **wavelength-resolved carrier lifetime analysis** in a chip. This measurement can be used for example to provide information of carrier lifetime evolution in different layers of a chip



Carrier lifetime map in a 10µm µLED



Wave-length-resolved carrier lifetime measurements of a 10µm µLED

Carrier lifetime mapping

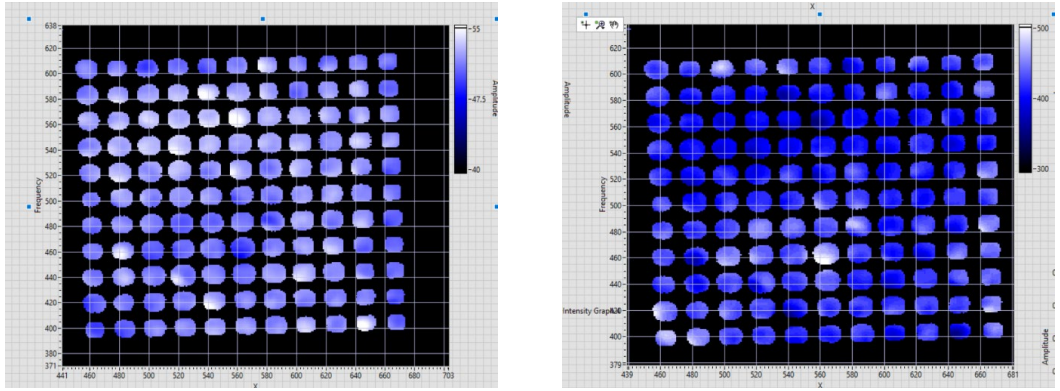
Evaluation of optoelectronic device and materials efficiency

When full wafer rapid characterization is needed, we offer an upgrade option based **on FD-FLIM (Frequency domain Fluorescence Lifetime imaging)** technique, to make quick maps of carrier lifetime through the wafer.

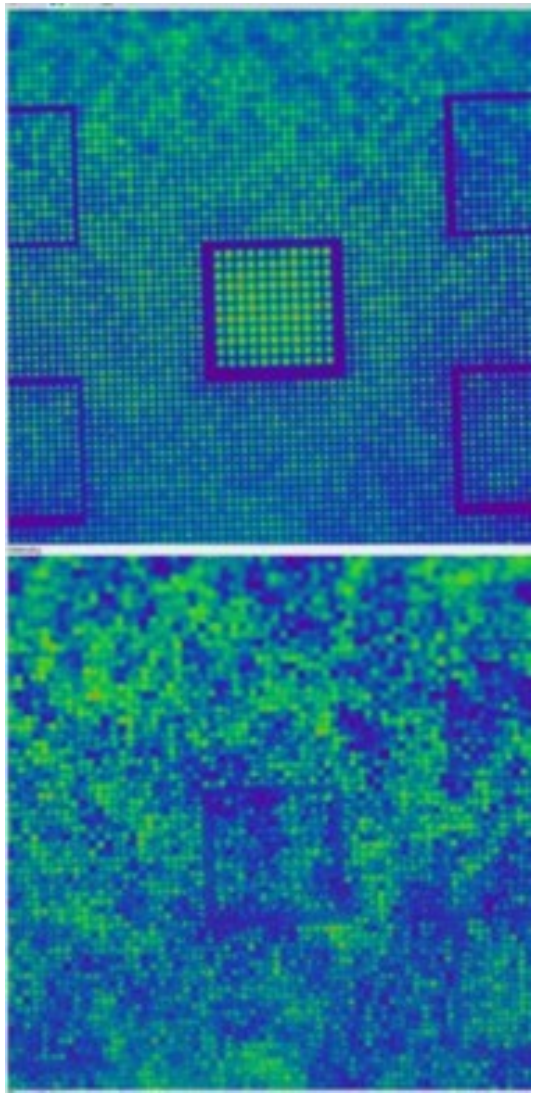
- Resolution of 1008x1008 pixels with a frame rate of 45 double images at full resolution.
- Lifetime measurements from 1ns to 100µs
- wavelength range 400nm- 850nm.

- This technique provides quick data about process and performance uniformity in optoelectronic devices, providing statistic analysis through the sample.

- Our KARAT™ analysis SW, provides information related to the radiative and non-radiative recombination mechanisms in the optoelectronic devices.



Example of carrier lifetime measurement and analysis separating the contributions to radiative and non–radiative recombination mechanisms.

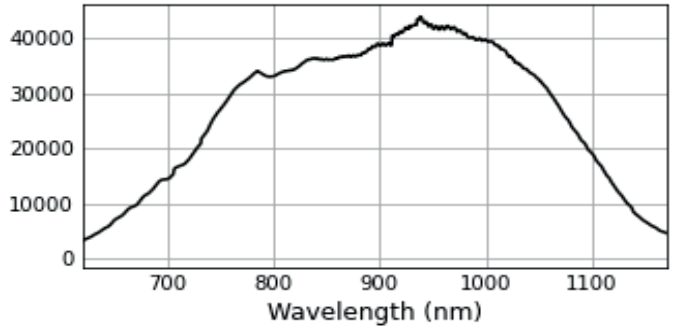


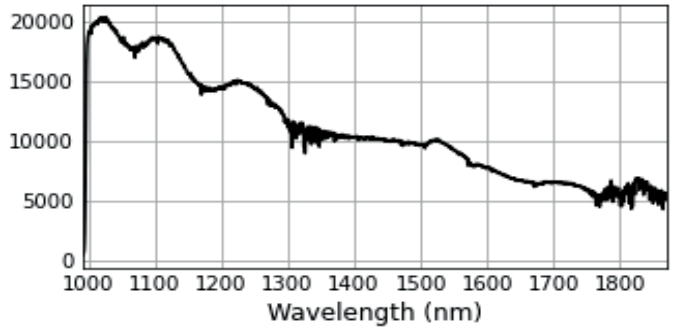
Example of carrier lifetime measurement (1 measurement point) done on a µLED wafer.

Reflectance measurements

Reflectance spectroscopy helps monitor surface damage and defects. It can be used to precisely measure thickness of thin films and coatings, or to quantify the reflectance (efficiency) of mirrors, such as multilayer dielectric mirrors.

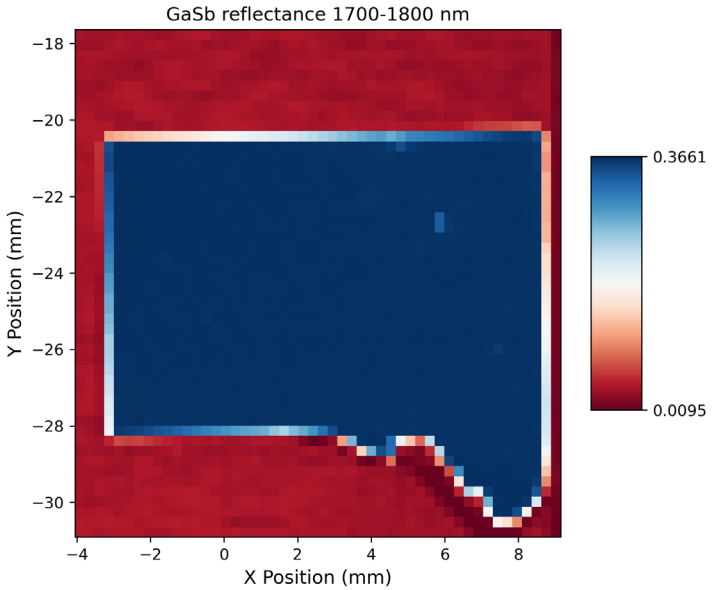
- Broadband white light illumination (400-2500nm)
- Adjustable Illumination spot size e.g. 100-1000µm
- With Karat, we evaluate reflectance measurements using array detectors to obtain full spectra in a single acquisition step

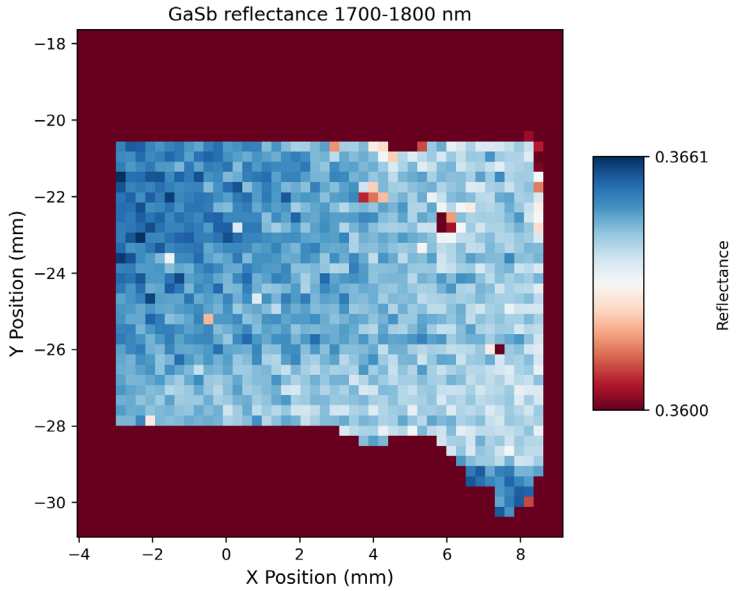


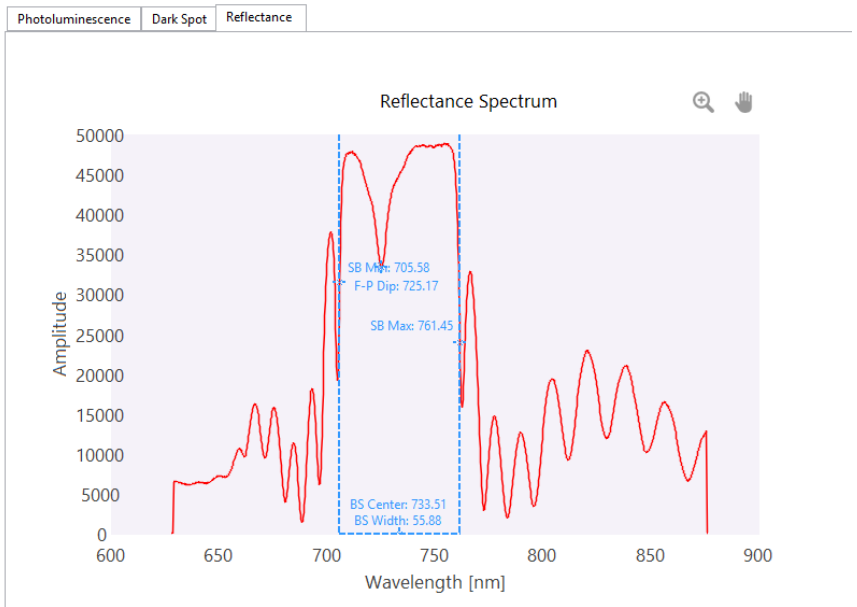


White-light spectrum (mirror reference) showing broadband range.

Very high resolution of the reflectance measurements. <1% variation detection limit.







Karat™ 25 Technical specifications

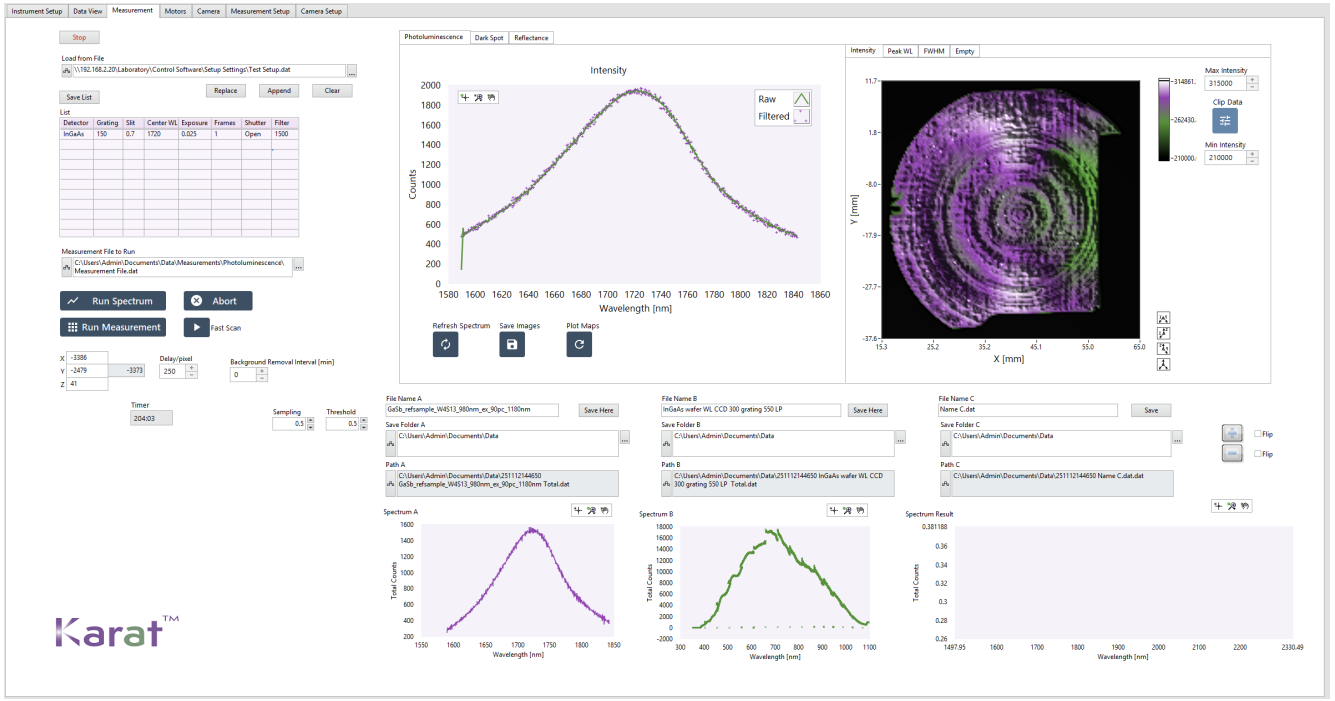
Example setup tailored to customer requirements

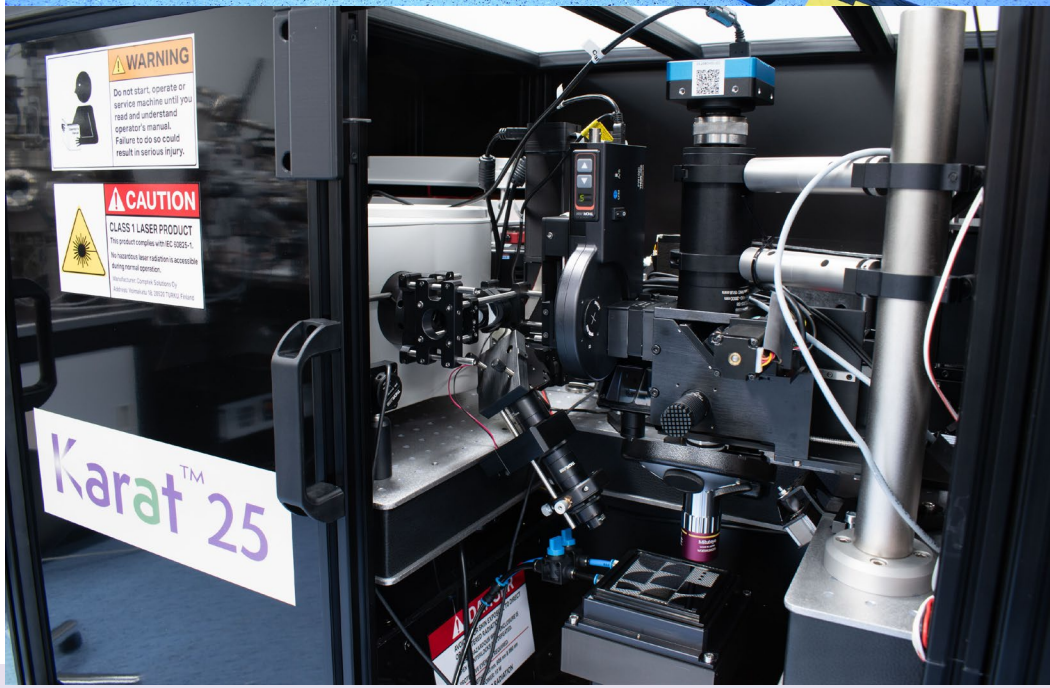
Karat 25 is a characterization tool that combines:

- Steady-state Photoluminescence
- Dark spot measurement
- Reflectance

This configuration offers a perfect tool to characterize semiconductor substrates used for optoelectronic applications.

The system is designed and made in Finland, with the assembly fully done in cleanroom.

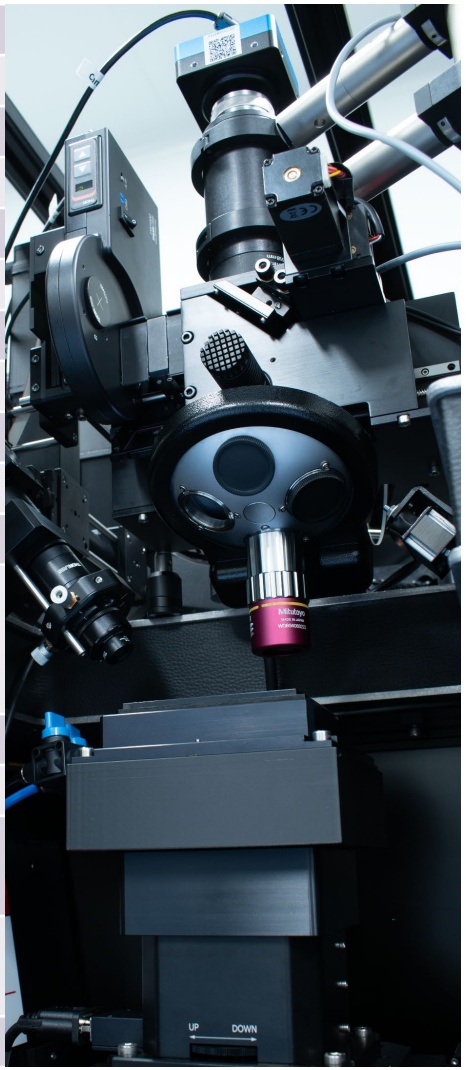




Karat™ 25 Technical specifications

Example setup tailored to customer requirements

Spectroscopy Range	400-2500 nm
Grating Turret	Triple-grating; resolution & range optimized
- Fine grating	Spectral resolution ≤ 0.17 nm
- Coarse	Spectral range per shot up to 500 nm
Imaging Field Area	0.5-1 mm² at sample (objective-dependent)
Imaging Sensitivity	400-1200 nm (extendable to 400-1700 nm)
Imaging Spatial Resolution	< 4 µm
White-Light Illumination	Broadband (400-2500 nm)
Laser Excitation Support	500-1000 nm
- PL lasers	Up to 3 low-medium power lasers (< 200 mW)
- Dark spot lasers	Up to 3 high-power lasers (<10 W)
Illumination Spot Size	PL: 400 µm Dark spot: 1000 µm Reflectance: adjustable 1000-100 µm
Laser Homogeneity	Speckle contrast <5% (dark spot mapping)
Vacuum Table Size	Supports sample sizes 1-102 mm
Motorized XYZ Stage	XY travel: 102 mm x 102 mm (4”) Z travel: 25 mm
Positioning Resolution	XY: 2.5 µm (full step), 0.31 µm (1/8 step) Z: 5 µm (full step), 0.625 µm (1/8 step)
Repeatability	Bidirectional repeatability: 2 µm

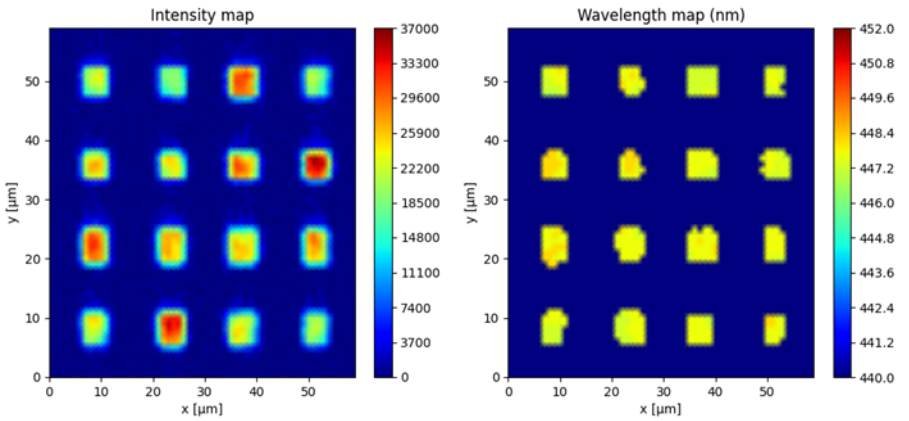


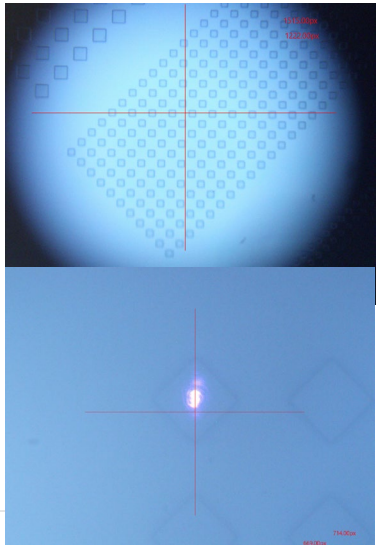
System Dimensions (W X L X H)	1000 mm x 1550 mm x 1450 mm
Mounting	Vibration-isolated optical table
Power supply	230 V, 10 A UPS for power stability and protection
XYZ Stage Details	100 mm X 100 mm X 25mm (travel range)
Power Consumption	< 2.3 kVA
System Cooling	Air cooling

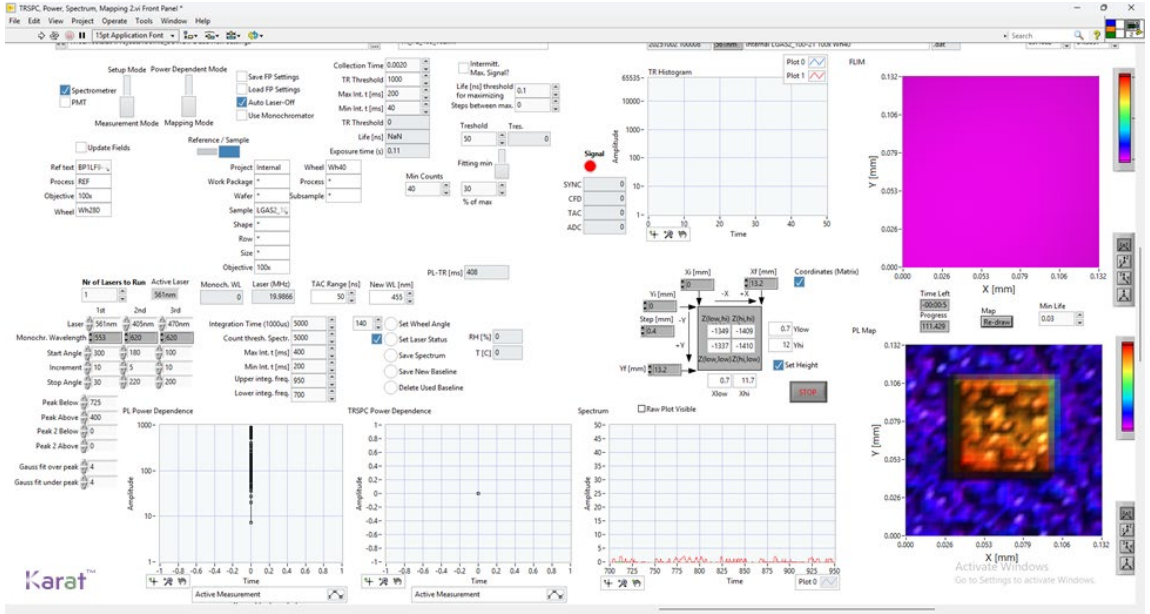
Example of PL Mapper specifications for µLED characterization

Steady-state and Time Resolved PL in one unit

Detection	Simultaneous data collection via 2 detectors (spectrometer and PMT)
- Spectrometer range:	200-1100 nm (Steady-state PL)
- PMT range:	300-900nm (For TRPL via spectrograph) < 150 ps FWHM
- Spectrograph range:	400- 2400nm
- IRF for TRPL**	<50 ps
Excitation	
- Pulsed lasers	405m, 470nm, 563nm *
- Pulse frequencies	20,10, 5, 0.2 MHz
- Pulse width	40 ps
- Adjustable Laser power	via motorized NDF wheel
Measurement modes	
- Mapping	Automated scanning of spatially distributed PL/TRPL response over surface or line paths
- Point Measurements	Detailed spectral or temporal data at single location. Excitation Power variation or response wavelength sweaps during measurements
Optics	Objectives 100x, 50x, 20x,10x. Motorized turret.
Sample mounting	High precision Motorized XYZ stage
Sample size	Up to 200mm wafers
	* Other options available ** Instrument response function







Thank You

comptek solutions

Let’s Customize Your Insight

Tell us your application—wafer-scale µLED QC, VCSEL R&D, or bio-material imaging—and we’ll configure a solution for the clarity and efficiency you need.

contact@comptek-solutions.com

www.comptek-solutions.com

Your Point of Contact

Elias Tsiatas
Sales & Business Development Director

elias@comptek-solutions.com
+358 40 503 5300