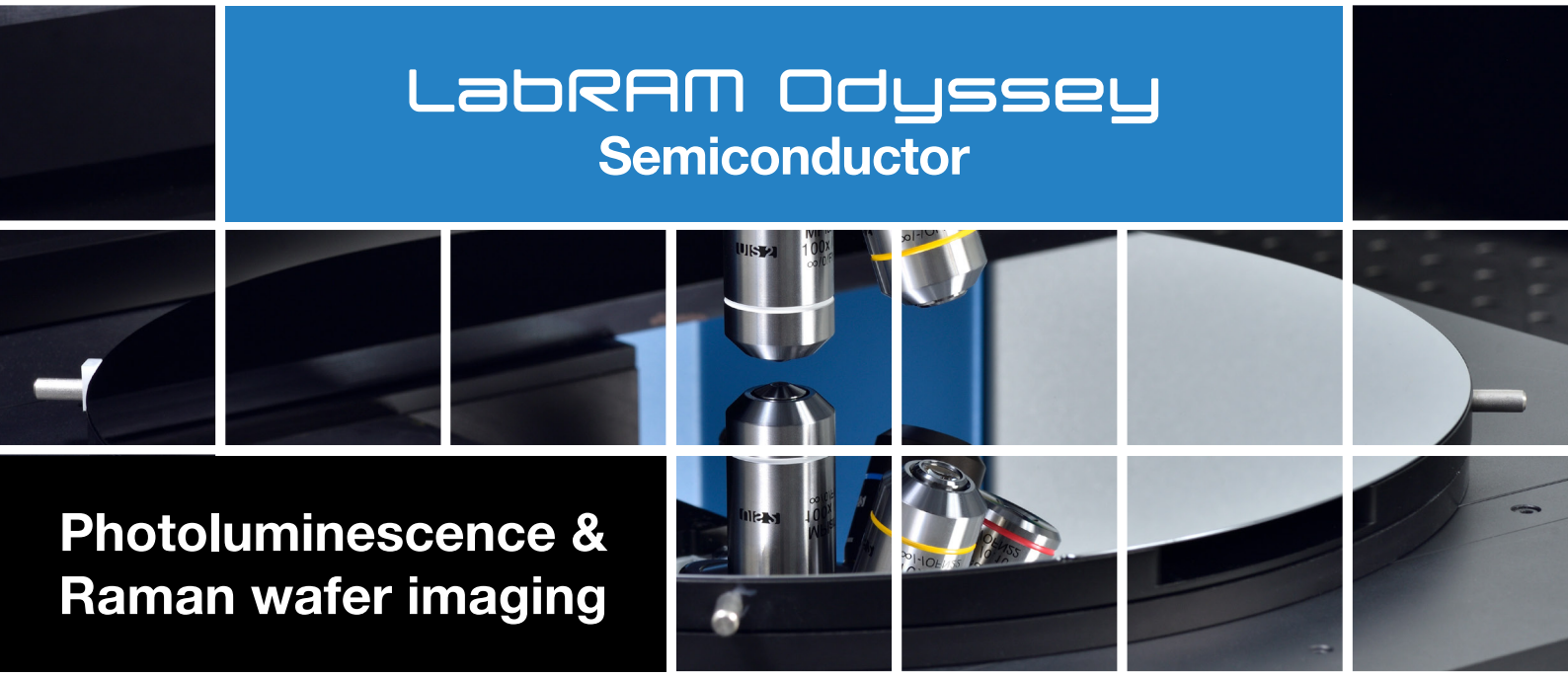
HORIBA

LabRAM Odyssey
Semiconductor



Photoluminescence & Raman wafer imaging

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JOBIN YVON Technology

Full wafer Photoluminescence and Raman mapping

HORIBA offers a solution for process qualification, wafer uniformity assessment, and defect inspection of blanket wafers and dies-on-wafers using *ex-situ* photoluminescence and Raman imaging with a microscope that can image wafers ranging from 4 to 12 inches.

LabRAM Odyssey - Semiconductor will allow you

- To assess wafer uniformity in a fast and repeatable way thanks to the automated sample stage and wafer tilt correction
- To simultaneously characterize your wafers with both Raman and photoluminescence maps
- To investigate smaller regions containing defects with the high-resolution imaging mode

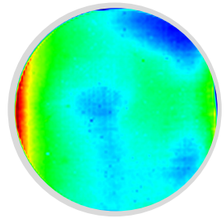
What is Raman Spectroscopy?

Raman spectroscopy is a non-destructive technique that uses inelastic scattering of light to study the vibrational modes in a sample. In the context of semiconductor R&D, it is used to analyze crystal structure, electronic properties, detect impurities and defects.

What is Photoluminescence?

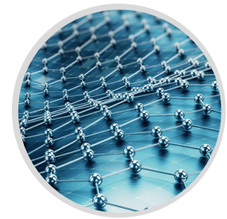
Photoluminescence (abbreviated as PL) is a technique that measures the light emitted by a sample upon absorption of photons when excited by a specific higher energy light. It is used in semiconductor R&D to analyze the electronic and optical properties of materials, identify defects and impurities, and study the efficiency of devices.

LabRAM Odyssey - Semiconductor
provides multiple types of information used to optimize R&D processes and improve device yield:



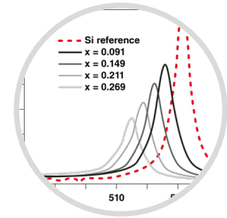
Wafer Uniformity Assessment

Layer Thickness

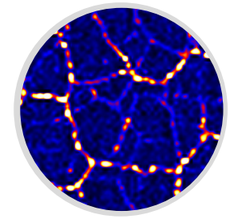


Crystallinity Distribution

Stress



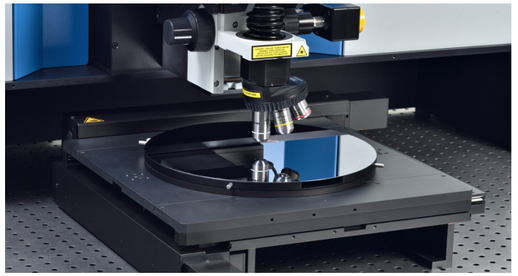
Composition



Defect Inspection

Hardware and software designed for Semiconductor analysis

Detailed technical features of the LabRAM Odyssey - Semiconductor

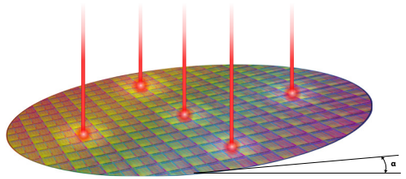


Wafer mapping with automated turret and sample stage

The automated 300 mm × 300 mm XY **sample stage** accepts **wafers up to 300 mm (12") diameter** for Raman and Photoluminescence mapping of both full wafers and small regions of interest (ROI). The travel speed of the stage together with its stability ensure fast and reliable measurements over ROIs spread over the wafer surface.

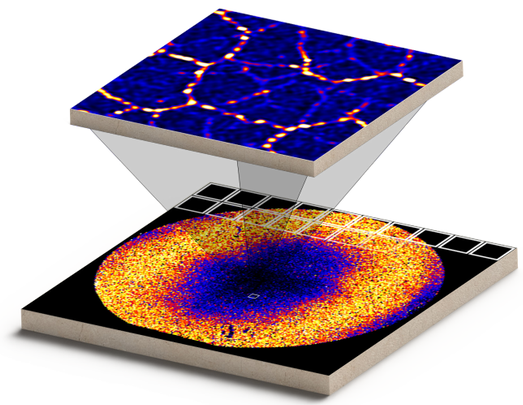
Uniformity measurement with wafer tilt correction

The **"Tilt at midway" autofocus function** corrects for any wafer bow and tilt, producing accurate whole wafer uniformity data, even from thin layers. This function is rapid since it determines the optimum focus height at only five points prior to mapping: in the center and four points at midway between the center and the edges.



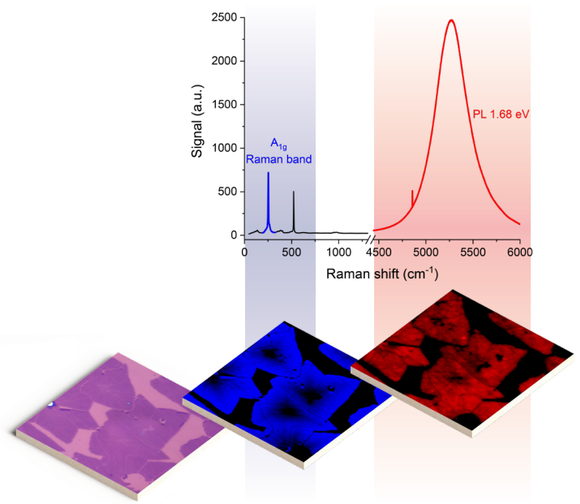
From full wafer to high resolution defect mapping with DuoScan™

DuoScan™ confocal imaging technology is a confocal imaging mode with both capabilities of variable size laser **macro-spot scanning** (using ultra-fast rastering mirrors) and high precision **sub-micron step scanning**. Macro-spot scanning is suitable for full wafer mapping while sub-micron step scanning is adapted to defect analysis.



PL and Raman metrology in one tool.

The availability of many excitation lasers together with the wide spectral range of the system, **from deep UV to near IR**, allows simultaneous measurement of photoluminescence and Raman signals in the same spectrum. PL and Raman **in one tool** significantly speeds up wafer characterization.



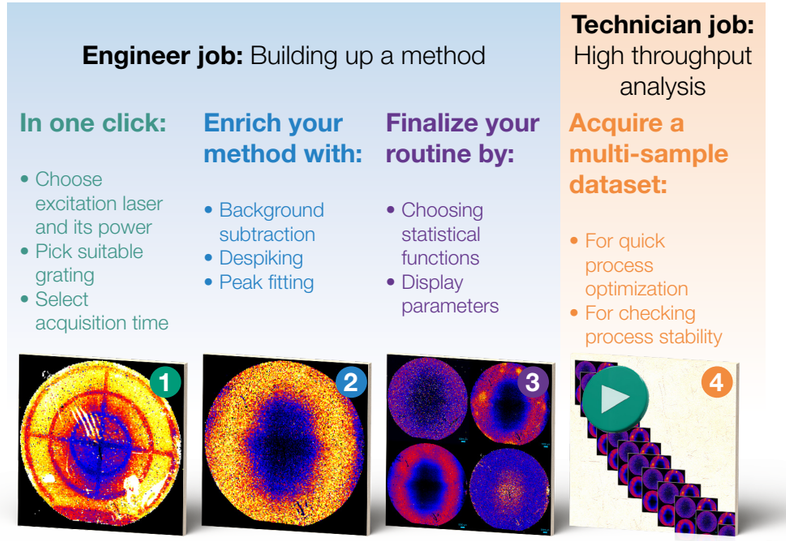
Software features to speed up data collection and interpretation

Methods: Easy recipe building for highly efficient characterization

Methods will allow you to fully automate your entire Raman/PL **characterization routine** (acquisition, data processing, display, and analysis) providing high throughput that is manageable by metrology technicians.

The "methods" building process is simple and intuitive : the process or metrology engineer can optimize each operation and in one click insert it into the recipe/method. Individual operations can be conveniently reordered, added or removed.

This customization module is also aided by "**templates**" which is a way to save and recall a set of hardware configurations and software options.

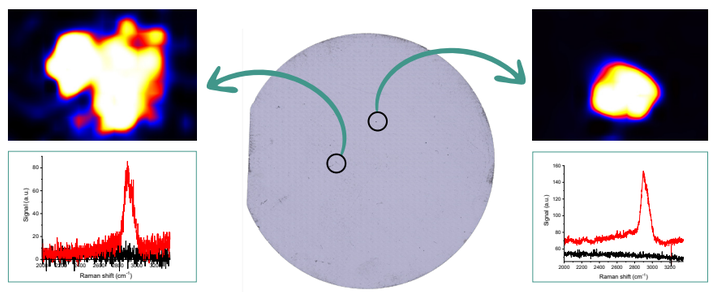


ParticleFinder PF3: Automated particle characterization

PF3 rapidly locates and chemically characterizes **contaminants** on a full wafer.

PF3 automatically locates and Raman maps contamination particles. Also PF3 automatically identifies and classifies all detected impurities according to their chemical characteristics (organic, silicon, etc.).

Statistics of morphological properties (area, perimeter, diameter, circularity, brightness, volume estimation, etc.) are also reported.



Valuable insights into the properties of semiconductor materials and devices

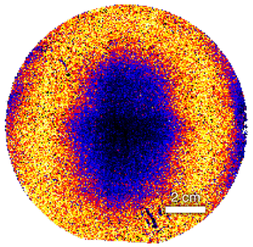
2D materials

The industrialization of **2D materials** and their emergence in electronic devices will not only depend on the **uniformity assessment** of their deposition on large wafers but also on overcoming the presence of **defects** which reduce the size of high-quality crystals, and on preserving quality through the processing steps.

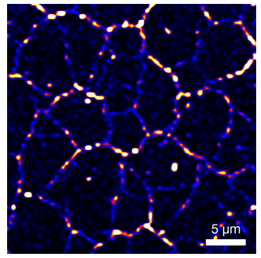
Raman/Photoluminescence characterization of Graphene and 2D Semiconductor:

***Application**: CMOS, electrodes, barriers*

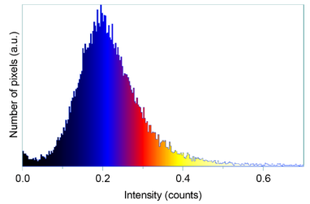
***Materials**: Graphene, Transition Metal Dichalcogenides, Hexagonal Boron Nitride (h-BN)*



Graphene Raman image of a 4" wafer



High resolution Raman image on defects



D/G distribution peak analysis

- Measurement of layer thicknesses
- Uniformity assessment: indication of graphene crystal quality and strain fluctuation; assessment of charge carrier concentration, stoichiometry and bandgap
- Defect inspection: indication of defect density (intrinsic); visualization and identification of contaminants

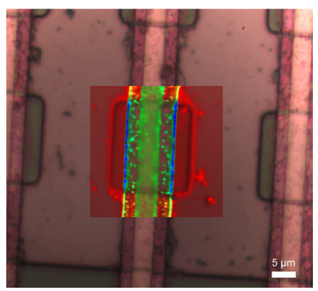
Group IV Semiconductor

Group IV elements (Si, Ge) have been historically used in the semiconductor industry, especially in the manufacture of planar and, more recently, three-dimensional (3D) structures (FinFET, Nanosheet FET, Gate-all-Around FET). Manufacturing processes are becoming more and more complex, and such complexity drives an evolution in characterization providing extensive information about **material properties** (stress measurements, crystallinity, phase extraction) allowing process stabilization at the R&D stage.

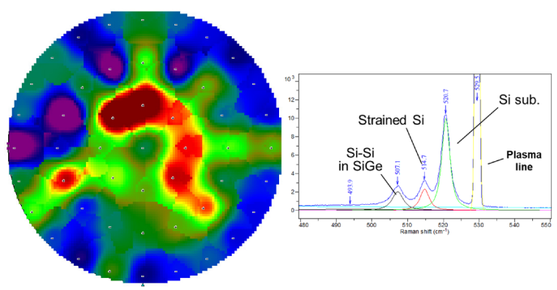
Raman characterization of Si and SiGe-based Semiconductor :

***Application:** 2D/3D transistors, photovoltaics*

***Materials:** Si, Ge, SiGe*



Raman image of a silicon chip with crystalline, poly and amorphous silicon regions



Stress distribution map derived from Raman data of a strained silicon layer on SiGe; Representative Raman spectrum

- Average stress and composition measurements (intentional and residual)
- Phase identification (crystalline, micro-crystalline, amorphous)
- Crystallographic defects detection

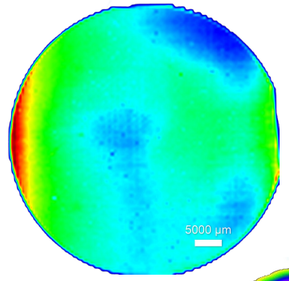
Compound Semiconductor

Compound Semiconductors enable the production of advanced power devices and active photonic devices such as light sources and detectors. Successful fabrication of such devices relies on the high quality of the underlying materials (SiC, AlGaN, GaN, GaAs, InGaAs etc.) and precise deposition of intended geometries on a wafer substrate.
Defects in materials such as imperfections in geometries, adversely affect yield and usually increase cost and development times of compound semiconductor devices.

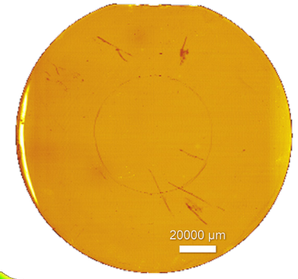
Photoluminescence characterization of compound Semiconductor:

***Application:** Displays, LEDs, laser diodes, quantum wells*

***Materials:** GaAs, InGaAs, InP, InGaN, GaP*

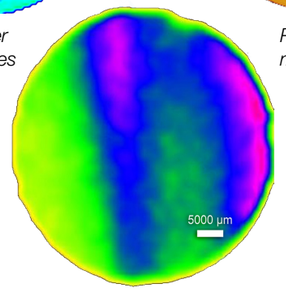


PL image of GaAs wafer showing inhomogeneities



PL image of an InGaAs based multiquantum well structure

- Detection of impurities
- Epitaxial layer growth uniformity
- Determination of the band-gap
- Average stress measurement (residual)

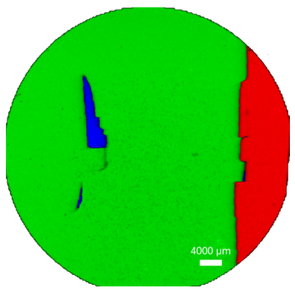


PL image of InGaAsP layer on InP-based wafer showing inhomogeneities

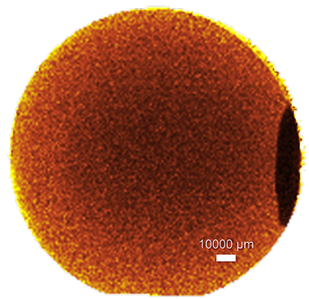
Raman/photoluminescence characterization of wide bandgap Semiconductor:

***Application:** Power devices*

***Materials:** Gallium nitride (GaN), Silicon Carbide (SiC), Gallium Oxide (Ga_2O_3)*



Raman image of SiC wafer showing different crystalline forms



Raman image of doping distribution across a SiC wafer

- Average stress measurements
- Crystalline structure
- Doping level
- Charge carrier concentration

LabRAM Odyssey - Semiconductor - Specifications

Dimensions	W × H × D (mm) = 1400 × 620 × 1410
Optical microscope	Open space microscope with white light reflection illumination, camera, 5×, 10×, 100× objectives as standard. Optional motorized objective turret.
Spectral range	Standard 200 nm - 2200 nm from sample to detector (achromatic, no change of optics required).
Imaging spectrometer	• Focal length: 800 mm. • Spectral resolution FWHM at 532 nm excitation wavelength ≤ 0.6 cm^{-1} with 1800 gr/mm and ≤ 0.3 cm^{-1} with 3000 gr/mm. • Spectral stability RMS: < 0.02 cm^{-1} RMS Measured on Si 520 cm^{-1} line. • Equipped with Open Electrode CCD (standard), optional EMCCD, optional InGaAs arrays detector (max. 3 detectors).
Spatial resolution	XY lateral resolution < 0.5 µm; Z axial resolution < 1.5 µm.
300 mm × 300 mm motorized stage	XY high precision encoded motorized stage (X = 300 mm, Y = 300 mm) with repeatability ≤ 1 µm; accuracy = 1 µm; resolution (encoder) = 50 nm; minimum motor step size = 10 nm. Z specifications: resolution (minimum step size) = 0.01 µm. Holders for 4" (100 mm), 6" (150 mm), 8" (200 mm) and 12" (300 mm) size wafers available. Vacuum compatible wafer holders.
Lasers	User selectable: 266 nm, 325 nm, 355 nm, 405 nm, 458 nm, 473 nm, 532 nm, 633 nm, 660 nm, 785 nm, & 1064 nm. Up to 6 motorized.
DuoScan™	DuoScan™ technology for fast Laser scanning and Macrospot imaging (typical macrospot dimensions 30 µm × 30 µm with 50× objective).

Worldwide Training and Technical Support

HORIBA France SAS (formerly Jobin Yvon), established in 1819, and now part of the HORIBA Scientific segment, is one of the world's largest manufacturers of **analytical and spectroscopic systems and components**. The HORIBA Scientific teams are committed to serving our customers with high performance products and superior technical support. Our staff of experienced application and service engineers, located around the world, provides full support for your instrument. Well equipped application laboratories allow for sample analysis and hands-on training for new and experienced users.

The HORIBA Group of worldwide companies provides an extensive array of instruments and systems for applications ranging from automotive R&D, process and environmental monitoring, *in-vitro* medical diagnostics, semiconductor manufacturing and metrology, to a broad range of scientific R&D and QC measurements. Proven quality and trustworthy performance have established widespread confidence in the HORIBA Brand, and its extensive array of instruments and systems for various applications, including semiconductor manufacturing and metrology, make HORIBA a top choice in the industry.

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