





HORIBA

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Explore the future

The Science of Raman Spectroscopy

What is Raman Spectroscopy?

What Is The Raman Effect?

Raman spectroscopy is a powerful **analytical technique** used to study the vibrational, rotational, and other low-frequency modes in a system.

Named after Indian physicist C.V. Raman, who discovered the effect in 1928, this method involves the inelastic scattering of photons, known as **Raman scattering**.

When a molecule scatters incident light, most photons are elastically scattered (Rayleigh scattering), but a small fraction are inelastically scattered at different wavelengths, providing insights into the molecular vibrations and chemical composition of the sample, the result of Raman effect.





What Does Raman Spectroscopy Measure?

Raman spectroscopy measures the vibrational modes of molecules, which can provide detailed information about the sample's:

- molecular structure,
- chemical composition,
- physical state.

Specifically, it can detect functional groups, molecular interactions, and crystallinity, among other things.

By examining the Raman spectrum, scientists can identify molecules, determine their concentration, and study molecular dynamics.

How Does Raman Spectroscopy Measure Samples?

Raman spectroscopy makes measurements by shining monochromatic light, usually from a laser, onto a sample.

When the laser light interacts with the molecular vibrations within the sample, it causes the photons to **scatter**. The scattered light is collected and analyzed to determine the frequency shift from the incident light, which corresponds to the energy difference caused by the molecular vibrations.

This frequency shift is unique to specific molecular bonds and structures, allowing for detailed molecular analysis.



A light history of Raman spectroscopy at HORIBA.



Early 20th century

Jobin Yvon and Its Contributions

The advent of lasers in the 1960s revolutionized the field of Raman spectroscopy, providing intense, monochromatic and coherent light sources that enhanced the sensitivity and resolution of Raman

optical spectroscopy, was founded in 1819 in France.

HORIBA and Raman Spectroscopy (Integration of Jobin Yvon)

HORIBA, a global leader in analytical and measurement technologies, has a significant part to play in the development and advancement of Raman

A significant milestone in HORIBA's history was the acquisition of Jobin Yvon in 1997.

Advancing Raman Technology with **Breakthrough Solutions**



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HORIBA's Leadership and Expertise in Raman Spectroscopy

As a leader and expert in Raman spectroscopy, HORIBA offers a comprehensive range of Raman spectrometers designed to meet the needs of various scientific disciplines. Their instruments are utilized in many fields, such as chemistry, materials science, biology, pharmaceuticals, and environmental science.

HORIBA's Raman spectrometers are characterized by their high sensitivity, resolution, and ease of use, enabling researchers to obtain detailed molecular and structural information with minimal sample preparation.

We provide extensive training, application support, and technical assistance to ensure that users can maximize the potential of their Raman spectrometers.





In 1928, Raman observed that when light traverses a transparent material, a small fraction of it emerges at different frequencies than the incident light.

This discovery, known as the **Raman effect**, earned Raman the Nobel Prize in Physics in 1930.

Mid 20th century

Jobin Yvon's expertise in creating high-quality monochromators, spectrographs, and diffraction gratings established it as a significant player in the

field of spectrometry and a respected name in scientific research and industrial applications worldwide.





This merger enhanced HORIBA's portfolio by integrating Jobin Yvon's extensive expertise in optical spectroscopy with HORIBA's technological capabilities.

It allowed HORIBA to develop more advanced Raman spectrometers and solidified its position as a leader in the field.

HORIBA advances Raman spectroscopy with innovative, patented technologies and smart solutions. High-tech instruments offer real-time monitoring, high spectral resolution, and efficient data analysis, making them essential tools for



Raman for everything

Raman spectroscopy brings numerous benefits to various fields of study.

Energy - Battery and Fuel cells

HORIBA's Raman spectroscopy solutions provide a detailed analysis of materials essential for energy storage and conversion systems. This technology precisely characterizes electrode materials, electrolytes, and catalysts, revealing chemical and structural properties that impact performance and lifespan.

- Ex situ analysis with homogeneity analysis and cathode degradation assessment.
- In situ analysis for cathode testing.



Materials

HORIBA's state-of-the-art Raman spectroscopy solutions offer a detailed characterization of chemical composition, molecular structure, and physical properties. This is essential to understand the properties of materials at the molecular level, identify defects, monitor stress and strain, analyze phase transitions and optimize the performance of advanced materials used in various high-tech applications.

- Multilayer film thickness evaluation.
- Polymerization monitoring.



Environment - Microplastics

HORIBA's Raman spectroscopy solutions provide highly sensitive and precise identification of microplastic particles in various environmental matrices such as water, soil, and air. This technology provides nondestructive analysis, delivering detailed information about the chemical composition and size distribution of microplastics without altering the samples.

Life Science - Healthcare

HORIBA's Raman instruments are designed to enable detailed characterization of raw materials, intermediates, and finished products. In the pharmaceutical industry, this ensures compliance with regulatory standards, accurate formulation development, and effective quality control processes. For cosmetics, Raman technology aids in verifying ingredient authenticity, optimizing formulations, and monitoring product stability.

- Identification of materials in all forms (tablets, powder, etc.).
- Outlier spot analysis.
- Determination of polymorphisms in Active Pharmaceutical Ingredients (API).

Semiconductors

HORIBA's Raman technology and powerful software for thorough data analysis, semiconductor allows researchers and manufacturers to characterize the chemical composition, crystalline structure, and stress/ strain, identify defects and impurities that are critical for the development and optimization of semiconductor technologies.

- Wafer uniformity assessment.
- Crystallinity distribution, composition determination. •
- Layer and stress measurement.
- Defect inspection and identification.





Life Science - Biology

HORIBA's Raman instruments and sophisticated software enable researchers to visualize and guantify cellular components, monitor dynamic biochemical changes, and investigate tissue morphology without the need for labeling or staining, and comprehensive data analysis. This is crucial to understand complex biological processes and disease mechanisms, with many applications in medical diagnostics, cancer research, drug development, and regenerative medicine.

- Viruses differentiation.
- Label free tissue analysis.

 Ideal technique for characterization of <10 µm sized particles. • Full morphological and chemical characterization. • Full solution, from filtration to final report.



• Drug internalization, cell sorting, drug interaction, etc.

HORIBA's portfolio

Where cutting-edge technology meets precision and versatility.

HORIBA's portofolio

Our Raman instruments are designed to deliver unparalleled performance, offering detailed insights into sample

Whether you're in academia, industry, or research, our Raman spectrometers provide the appropriate spectral resolution, real-time monitoring, and user-friendly software to meet your analytical needs.

Affordable Sensitive Bench-top Raman Spectrometer

Compact and Rugged

- Small footprint minimizes lab space and easily transportable.
- Large sample compartment for easy sample handling

Best in Class sensitivity

- High Quantum Efficiency Back-illuminated CCD (- 50°C cooled)
- Full Raman shift range for accurate identification

Simple and Safe

- Class 1 compartment for maximum safety
- Refined software interface

Versatile design

- Large choice of accessories
- Standard fiber port for probe-based measurements



XploRA PLUS



Multiple lasers and gratings

- Up to 3 internally mounted lasers in VIS-NIR range
- 4 gratings from low to high spectral resolution

High end optical microscope

- DarkField, Polarisation, Differential Interference Contrast (DIC), etc
- Epifluorescence imaging

Easy to use system

- Full system automation
- One-click operation

LabSpec 6 **Spectroscopy Suite**



App-based software Power

Simplicity

High performances app, such as ParticleFinder Chemometric data analysis of big data sets with MVAPlus



Quality & Compliance 5 calibration methods included Regulatory compliance including FDA's 21CFR part 11



Getting There Further!

Ultra wide spectral range

- From 200 nm to 2 µm
- Unlimited number of lasers / up to 4 detectors

Ultra high spectral performance

- Spectral resolution down to 0.1 cm⁻¹
- Ultralow Frequency cut-off down to 5 cm⁻¹

Highly adaptable

- Free space microscope for huge samples and helium cryostats
- Inverted microscope option for live cell imaging





NanoRaman

Accessories to answer all your needs



NanoGPS tags Micro-correlative solution Relocate your Points-of-Interest and correlate multimodal information

Achieve Raman measurements in a large range of conditions:



Calibration Objective



















Getting There Easier!

Getting There Faster!

Automation

- Up to 5 lasers from 325 to 785 nm from 30 cm⁻¹ to 1.6 µm
- SmartID[™], automatic objective recognition

Ultrafast imaging

- SmartSampling[™], to map up to 100x faster
- QScan, Light Sheet confocal imaging

Intuitive software

- Easylmage[™]
- _XSTaiN



Breaking the resolution limit with a tip!

All AFM modes available

• Provides morphological, mechanical, electrical, magnetic, electrochemical information

Co-localized AFM-Raman measurements

- Simultaneous AFM and Raman microscopies
- Easy to correlate measurements



- Nano resolution achievable
- Grain boundaries/defects investigation

SuperHead fibered probe



Temperature and environmental control stages

HORIBA Support in any situation

Training with experienced professionals



HORIBA offers comprehensive training support for their products, ensuring that users can operate their equipment efficiently and effectively.

The training programs, designed for various skill levels, cover all scientific instruments and techniques from HORIBA, providing hands-on experience, theoretical knowledge, and practical applications. This ensures that participants gain a deep understanding of the equipment and can maximize its capabilities in their respective fields.

Support

HORIBA provides extensive customer support services (including on-site assistance from skilled technicians and engineers, software upgrades, helpdesk services and access to comprehensive support documentation) to ensure optimal performance and longevity of their products.

HORIBA Store

The HORIBA Store offers a wide range of products to enhance the performance and usability of your HORIBA instruments. It provides access to detailed product information, training courses, and maintenance contracts to ensure users can fully utilize their HORIBA equipment.



HORIBA THE HORIBA STORE

HORIBA Raman Academy

HORIBA's Raman Academy offers extensive resources for those interested in Raman spectroscopy, whether beginners or experts. The academy provides educational content on the fundamentals of Raman spectroscopy, application notes, articles, and demonstrations of instrument capabilities.

Additionally, it offers hands-on training at HORIBA labs or on-site at user facilities. This comprehensive educational support is designed to enhance the knowledge and skills of users, helping them to effectively utilize Raman spectroscopy for their research and applications.

www.ramanacademy.com





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