

HORIBA

PI-200 Laboratory Process Raman Analyzer



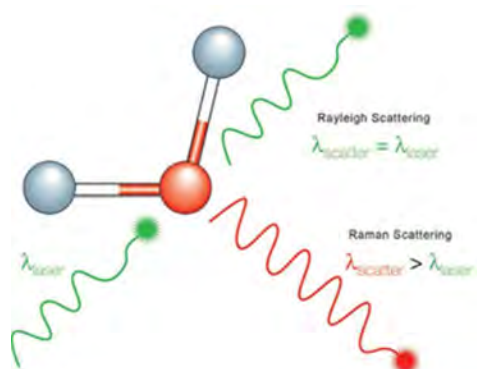
Raman Analysis with HORIBA Process Instruments

The HORIBA Process Instruments (PI)-200-L is a laboratory QC/QA analyzer with a fiber optic probe specifically designed to provide low levels of detection. The PI-200-L can analyze samples using an optional auto-sampler for streamlined automated analysis. The PI-200-L can be used for methods development and collection of calibration samples, that then can help reduce routine testing and increase efficiency within the laboratory.

Models developed on the PI-200-L can be transferred to the PI-200-SP or PI-200-I in process.

Why Raman Spectroscopy

Raman spectroscopy is a vibrational technique involving high energy photons based on the inelastic scattering of radiation in the visible or near-infrared region. Most scattering (Rayleigh scatter) has the same wavelength as the laser source. Elastic scattering occurs when the photon frequency doesn't shift or change its wavelength. Inelastic scattering (Raman) shifts the photon frequency which can then be used to get information about molecular chemistry.

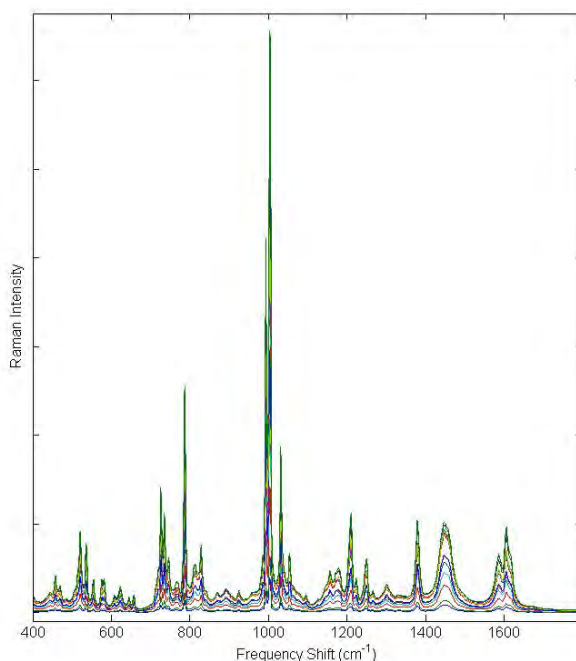


Raman bands result directly from molecular vibrations. These vibrations are very sensitive to changes in chemistry and structure. Each peak on the Raman spectrum corresponds with a different frequency of light absorbed by the sample which excited a vibration. These frequencies are unique to the molecule and the types of bonds it contains, the Raman spectra creates a “chemical fingerprint”.

Raman spectroscopy has several advantages over other analytical techniques.

- Is ideally suited for liquid samples.
- Can work with aqueous solutions.
- Is a non-destructive technique that does not require any sample preparation.
- Can differentiate chemical structures, even if they contain the same atoms in different arrangements.
- Fewer spectral peaks increase calibration stability by reducing interferences.
- Raman spectra are acquired rapidly.

Reformat Spectra



LPG Model Summary

PARAMETER	RANGE	r ²	SECV	SAMPLES
PROPANE	0.78 - 9.62	0.998	0.083	126
PROPYLENE	0.46 - 11.57	0.9993	0.08	121
ISOBUTANE	25.76 - 44.164	0.9996	0.105	124
N-BUTANE	8.01 - 15.88	0.998	0.063	125
TRANS2-BUTENE	8.49 - 15.09	0.999	0.06	122
1 BUTENE	3.53 - 11.5	0.9994	0.059	125
ISOBUTYLENE	3.86 - 11.5	0.9996	0.036	126
CIS2-BUTENE	4.63 - 9.18	0.9992	0.035	120
ISOPENTANE	1.19 - 12.32	0.999	0.101	125
N-PENTANE	0.08 - 0.94	0.99	0.028	130
1,3 BUTADIENE	0 - 0.531	0.999	0.0047	125
3 METHYL-1 BUTENE	0.251 - 7.59	0.99996	0.014	129
TRANS2-PENTENE	0.186 - 1.9	0.998	0.023	129
2 METHYL- 2 BUTENE	0.213 - 1.76	0.999	0.016	127
1 PENTENE	0.115 - 0.57	0.991	0.012	127
2 METHYL-1 BUTENE	0.22 - 1.26	0.997	0.015	130
CIS2-PENTENE	0.105 - 0.81	0.994	0.015	126



The HORIBA's Process Instruments brand is specifically designed for industrial process-control and monitoring applications. HORIBA specializes in providing a complete solution to address critical process control problems, which include collecting spectra from customers' samples, building the calibration models, and providing key model maintenance to maintain high predictive accuracy. Our ability to design excitation lasers for multiple wavelengths allows us to assess which is best suited for the application in mind, in order to circumvent the unwanted fluorescence effect.

Our patented laser (U.S. Patent No. 6,100,975), and spectrograph (U.S. Patent No. 6,028,667) designs allow for robust, compact, and stable Raman instrumentation. These have been refined over the past 20 years to minimize energy losses therefore improving the limits of detection to below 100ppm with some compounds in the single digit range. The laser is optimized for fiber optics illumination and collection via a flow cell with a sapphire window. Collected radiation is returned to the monochromator with a fiber optics slit which is mated to diffraction grating and 4-stage cooled CCD camera for detection. The HORIBA Process Instruments design is fast with minimum energy loss to maximize detection.

HORIBA unique features provided by Process Instruments:

- ☐ Chemometrics with multiple parameter predictions.
- ☐ Laser power up to 450 mW
- ☐ Automatic multi-point neon lamp wavelength calibration.
- ☐ Broad-spectrum white-light normalization to ensure chemometric model transfer.
- ☐ Automatic Wavelength tracking.
- ☐ System stability: $\sim 0.010 \text{ cm}^{-1}$ per month.
- ☐ SOLO and GRAMS compatible.
- ☐ 2-years standard warranty.
- ☐ First year Modeling included with ongoing Modeling Services and Training.



The liquid auto-sampler allows for unattended operation of the analyzer while cycling through a 42-sample rack.



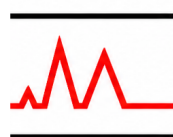
The LPG sampling attachment allows for sample bombs to be attached to the analyzer under pressure so that liquid samples can be analyzed.

Specifications

- Spectrograph
 - Aperture: f/2.0
 - Focal length: 135 mm
 - Resolution: $\sim 4\text{cm}^{-1}$ @ 785 nm excitation
 - CCD camera: Andor 1024 x 127 pixels, pixel size 26 μm
 - Camera cooling: 4-stage TE-cooling $< -82^{\circ}\text{C}$
 - CCD chip is deep depleted and back illuminated for higher NIR-quantum efficiency
 - Ruled Grating with 1200 lines/mm.
 - Spectral coverage (adjustable): ~ 250 to 2650 cm^{-1} (785 nm excitation)
 - High performance, anti-reflection, aberration-corrected optics
 - Spectrograph, temperature controlled ($\sim 33^{\circ}\text{C}$) for added stability
 - Image curvature at exit plane < 0.5 pixel over full height of CCD array
- Laser
 - Power $> 450\text{ mW}$
 - 785 nm standard; other wavelengths available upon request
 - Laser life expectancy: > 4 years
 - Wavelength accuracy: $\pm 0.1\text{ nm}$
 - Wavelength stability: $- < 0.011\text{ cm}^{-1}$ drift per month
- Calibration
 - Automatic for both x-axis and y-axis
 - Temperature control for Laser and Spectrograph
- Raman probe
 - Incorporating 10^{-8} Rayleigh filtering
 - Fiber coupling with slit array: $100\mu\text{m} \times 3.3\text{ mm}$ tall
 - Fiber optic probe length: 5m
 - $200\mu\text{m}$ diameter excitation fiber, $400\mu\text{m}$ collection fiber
 - Focal length: 5 mm
- Power requirements: 4amps
- Outputs available: TPC-IP, serial Modbus, and 4-20mA
- Certifications: Lasers CE and CDRH-certified
- Computer requirements: Windows Desktop PC or laptop

Applications

- Natural Gas Monitoring
- Crude Unit Monitoring
- LPG Monitoring
- Atmospheric Unit Monitoring
- Light Naphtha Isomerization
- Heavy Naphtha Octane Loss
- Reformate Monitoring
- Benzene Reduction
- Aromatics Monitoring
- P-Xylene Monitoring
- FCC Monitoring
- Alkylation Process
- Reaction Monitoring
- Light Gases Fractionation
- Gasoline Blend Monitoring
- Mid and Heavy Distillate Monitoring
- Jet Fuel Monitoring
- Diesel Blend Monitoring
- Hydrocracking Monitoring
- Waterflood
- Sulfate Monitoring



Equipamientos Analíticos S.A

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