

MultiSpec® Raman: Raman Spectrometer for Process and Laboratory

MultiSpec® Raman Systems comprise stable Laser Sources with efficient detection in process proof 19" spectrometer housings. Developed to ensure 24/7 operation in industrial environments, the spectrometer system combines high stability for measurement task in process and laboratory. Completed with matched

accessories, such as fiber-optic probes, Process Software MultiSpec® Pro II and Process Communications system, the high selectivity of the Raman effect can be exploited to monitor the efficiency of production processes, classify materials and ensure product quality.

[Applications in Process or Laboratory]

- Chemical
- Pharmaceutical
- Geological
- Semiconductors
- Forensics
- Biological
- Nanomaterials
- Polymers

[Installation in explosion proof atmospheres]

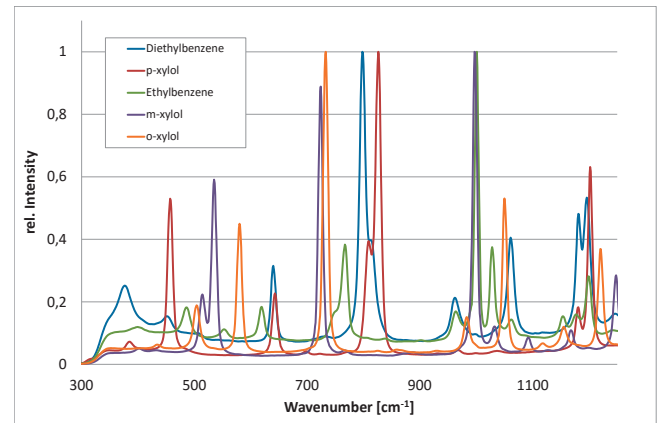
To ensure safe operation in explosive atmospheres, the laser power can be limited to a maximum level to achieve optical intrinsic safe operation according to 60079-28. If higher power levels are required, alternative protection strategies are available.



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[MultiSpec® Raman with Probe]

[Raman Spectrum]



[Features]

- Raman analyzer for process applications
- Available for Installation in explosive atmospheres
- Installation according to Laser Class 1
- 785 nm excitation wavelength
- Optional: 2 and 4 channel operation
- Temperature-stabilized laser source
- Optical probes for different measurement setups [liquids, solids, measurements through glass]
- Short measurement time [depends on application]
- MultiSpec® Pro II Raman process software
- Optional software process interfaces [OPC, PROFIBUS, etc.]
- Optional software modules for chemometrics and data analysis
- Monitoring of Laser operating hours
- 19" rack-mount standard

[System Design]

MultiSpec® Raman Process Spectrometer System

As the spectral sensitivity of the measurement system is crucial for the applicability of this technique [since only a small portion of the incident photons are Raman shifted] matching the individual components of the instruments is essential. This includes the spectral efficiency of the polychromatic setup, the quantum efficiency of the detector, the fiber

diameters used for the setup and finally the light source, which is determining the accuracy of the laser.

Taken all these factors into account, the spectrometer product line MultiSpec® has been expanded by a new instrument which is readily available for your application.

Laser Source

A temperature-stabilized semiconductor laser provides 50 – 500 mW of 785 nm excitation light. It is housed in a plug-in cassette with a FC/APC fiber-optic output connector at the front panel of the laser cassette which allows an easy connection to a fiber-coupled Raman probe. Four serial

interlocks prevent the accidental activation of the laser. A special circuitry supervises interlock status and monitors life time of cassette and laser.

Two external interlocks can be adapted by the customer to ensure safe operation of the system.

Spectrometer Module

The Raman system uses a high throughput, high-resolution spectrometer with a sensitive TE-cooled scientific CCD array for detection. In conjunction with state-of-the-art electronics developed by tec5, it allows accurate measurements

with unsurpassed dynamic range. The spectrometer input is a standard SMA fiber-optic connector located on the front panel of the MultiSpec® Raman spectrometer cassette.

Multi Channel operation

Multi Channel operation can be achieved optionally, with an 2 or 4 output channel Laser Cassette. In combination with a fiber-optic multiplexer, this enables the operation of 4 channels

and reduces the price-per-channel significantly. If one channel is used as a reference channel, the long-term stability of the system can be improved.

Fiber-Optic Raman Probes

Being the forefront of the spectrometer system, the probe accumulates the spectral information and confines it through a set of lenses and filters and prepares it to be relayed in optical fibers to the measurement system. To ensure optimum performance, the optical properties of the probes have been matched to the requirements of the spectrometer system to optimize the power budget.

There is a set of probes available to cover different measurement requirements:

requirements by a selection of flanges and materials.

The light for excitation and the detected light containing the spectroscopic information is guided to/ from the MultiSpec® Raman chassis by optical fibers, hence, offering highest flexibility for distributed installations. Additional probes and measurement heads are evaluated and matched to the spectrometer system. Please contact tec5 to discuss your probe requirements directly.

Immersion Raman Probe for Process

For application in industrial processes, an optimized immersion probe is available. This can be adapted to process



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[Raman Probe – LED + Interlock Connector]

tecRaman Probe

The tecRamanProbe for Raman spectroscopy combines flexibility and maximum performance in a compact and process-proven housing. It is characterized by straightforward operation and maximum adaptability to match multiple applications. Its key features are a highly efficient optical path in a robust. The tecRamanProbe can be used to measure solids or liquids in mobile or stationary applications. The probe can be adapted to Process DN 50 Inspection glasses

or can be used in laboratory environments with through cuvettes and flow-through cells or even PTFE tubing. The available tec5 Raman Measurement Box even allows measurements with Laser Safety Class 1 conditions. The combination of a MultiSpec® Raman system, the process-proven software MultiSpec® ProII and the Remote Raman Probe presents a complete solution for Raman spectroscopy either in a laboratory or in process lines.

[Features]

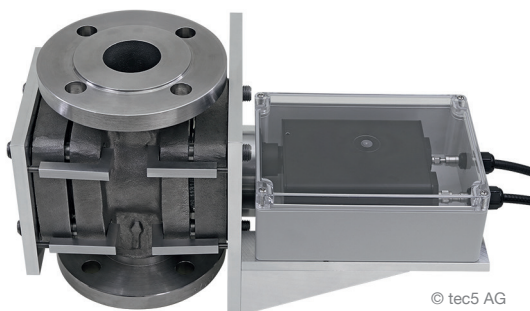
- High efficiency
- Measurement of solids and liquids
- Process version for adaption to DN 50 flanges
- Laboratory version with cuvette holder for standard cuvettes
- Laboratory version with holder for PTFE tubing
- Compact and robust housing
- For stationary or mobile use
- FC/PC [Laser] and SMA [Detection] connections for optical fibers

tecRaman



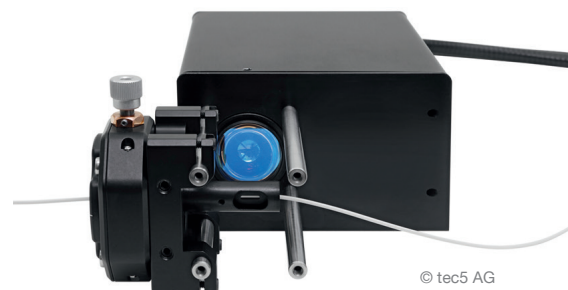
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[tecRaman Probe 785 Cuvette]



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[tecRaman Probe 785 Process DN 50]



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[tecRaman Probe 785 Tube]

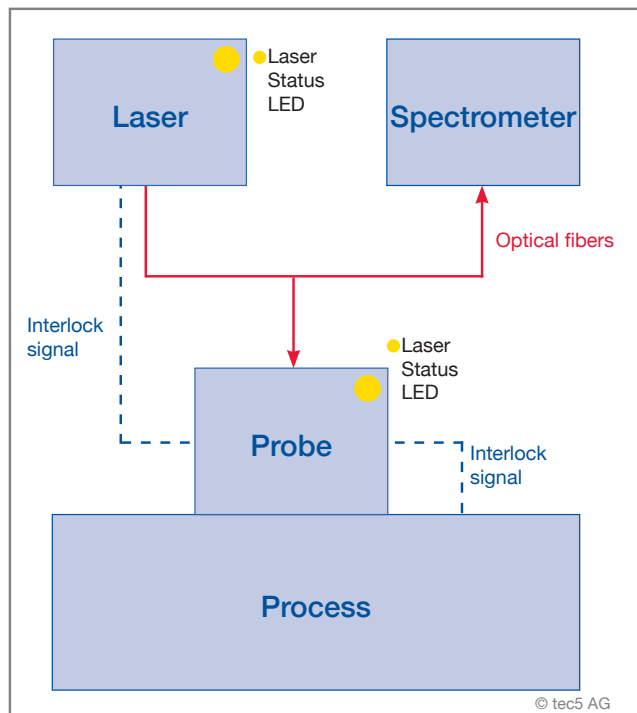
Laser Installation according to Class 1

High output power of the laser diode, which is required for an efficient data acquisition process in Raman spectroscopy limits the applicability of most systems. With the holistic approach of tec5, an installation according to Laser Class 1 is at your fingertips. An elaborated interlock concept can be used to ensure a Laser Class 1 installation of immersion

probes at plant. As the interlock is opened, for example, the cable is removed which features the connection between the probe and the process, the laser light is extinguished immediately. The Laser interlock is monitoring every connection point from the laser source via optical fiber cables, the probe and the point of measurement [e.g. process pipe].



[Raman installation for measurements in a probe chamber]



[Class 1 Laser Installation]

The Raman probe can also be used in combination with a measurement box [item no. 11-1159300-00] to enable cuvette-measurements [also flow through cuvettes] under Laser Class 1 conditions. The door of the box cannot be opened without

interrupting the interlock-loop and the probe cannot be unmounted without interruption of the same, both forcing the laser to be switched-off automatically.

Multichannel Configurations

In multichannel configuration, the laser power, adjustable between 50 mW and 500 mW, is split up to 4 channels. Each channel can be connected to a Raman probe. The scattered Raman light from the investigated specimen is guided to an optical multiplexer, which sequentially switches the Raman signals from each channel to the Raman Spectrometer Cassette. A fiber-optic piezo multiplexer is used, as it has a superior optical throughput compared to other multiplexing technologies. For each individual measurement point/measurement channel a Raman spectrum can be retrieved. A set of different modules for analyzing the data and communicating results to process control systems can be used. In combination with the 4-channel multiplexer the integration-time is increased by a factor of ten. The laser safety interlock system is serially expanded to support up to four tec5 Process Raman Probes.



[MultiSpec® Raman 4-channel with 2probes]

[Accessories]

Raman Measurement Box

For test measurements under laboratory conditions, a stainless steel measurement box is available, that contains the probe tip and sample. This box provides an interlock connector to ensure Laser Class 1 operation from measurements [item no. 11-1159300-00].

See the picture at the previous page:

[Raman installation for measurements in a probe chamber]

tecRaman Probe 785 Cuvette Holder

Feasibility studies and proof-of-concept measurements can be realized quickly and easily in combination with a cuvette holder, to combine a Raman immersion probe for process with a classical laboratory or flow-through cuvette.

[Software and PC Interfaces]

MultiSpec® Pro II Raman Process Package

tec5's spectroscopy software MultiSpec® Pro II is available in a Raman version that features wavenumber scaling and other specific tools to adapt the software to the requirements of Raman measurements. The tools include intensity correction, optional background spectrum subtraction and allow the use of the peak detection and data export functionality of the MultiSpec® Pro II software. Thus, automated process control by Raman spectroscopy is immediately available and easily configurable for standard applications.

The MultiSpec® Raman is equipped with an Ethernet interface for use in Ethernet or Gigabit Ethernet networks. The unit is also available with an USB 2.0 interface.

Process Communication

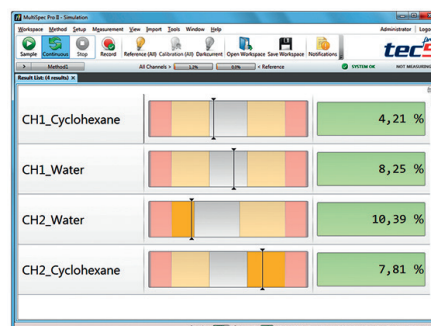
The MultiSpec® systems can be equipped with an OPC interface or various add-on I/O-boards [4 – 20 mA, digital I/Os, Profibus] for process communication to transfer results and status information [e.g. system error, system warning, out-of-range signal] to a process control system. Additionally, a remote control from an SPS or DCS is available to trigger maintenance measurement cycles or to stop continuous data acquisition.

Raman Connection Box

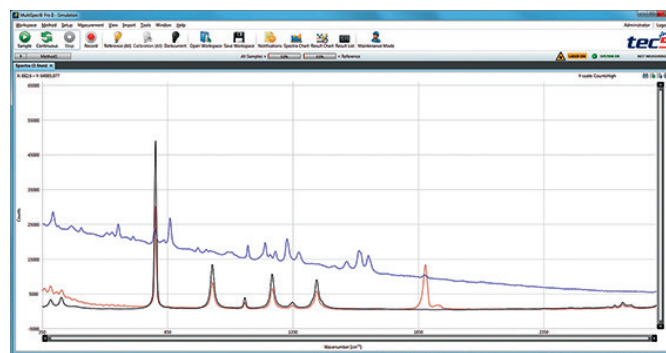
To enable installation in the field under rough environmental conditions, a Raman Connection Box [item no. 11-1159304-00], consisting of an IP65 housing for connection of two optical fibers, PMA connector for protective tube and interlock contacts is available.

Optical fibers and interlock cables

In order to separate the spectrometer system and the probes further than the standard fiber length attached to the probe, optical fibers and interlock cables are available as accessories.



[MultiSpec® Pro II Result View]



[MultiSpec® Pro II Raman Package]

[Technical Data]

Laser Excitation Source

Laser Type	Fiber coupled, stabilized multimode diode laser
Wavelength	785 nm
Output Power	50 - 500 mW, adjustable
Output Connector	FC-APC with 105 µm core diameter
Laser Class	3B [Class 1 installation possible]
Interlocks	4 [Key switch, probe connected, and 2 external]
Laser Lifetime	typ. 10.000 h

Spectrometer Section

Spectral Sensor	Diode array simultaneous spectrometer [no moving parts]
Detector Type	High dynamic range, scientific TE-cooled CCD detector
Spectral Range	[>150] 300 – 3100 cm ⁻¹
Resolution	7 cm ⁻¹ typ.
Integration Time	3 ms – 10 min [typ.]

Fiber Optic Immersion Probes

Probe Material [in contact with sample]	316L / sapphire / O-Ring sealed
Focal Plane	2.1 mm from front window [typ. - shorter distances <1.5 mm possible]
Length of Fibers	5 m [standard], other lengths available on request
Temperature Range	5-180°C
Pressure Range	-1 - 40 bar [without flange]
Interlock	Connector on the probe body
Laser Status	LED, yellow

tecRaman Probe

Probe Material	Anodized aluminum
Focal Plane	25 mm, 50 mm
Length of Fibers	2 m [standard], other lengths available on request
Connectors	FC/PC [Laser], SMA [Detection]
Operating Temperature	5 – 45 °C standard temperature range [contact tec5 for additional range]
Weight	1.75 kg
Dimensions [W x H x D]	100 x 60 x 140 mm

Miscellaneous

Power Supply	100 – 240 VAC; 50 – 60 Hz
Number of Channels	1 [standard]; 2 or 4 [optional]
Dimensions [mm ³]	133 x 449 x 376 [D: 419 with front handles]
Weight	11 kg
Operating Temperature	5 °C – 35 °C

[Alternatively, a user may take advantage of software development kits provided for the modular product range to fully program for any application.]

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