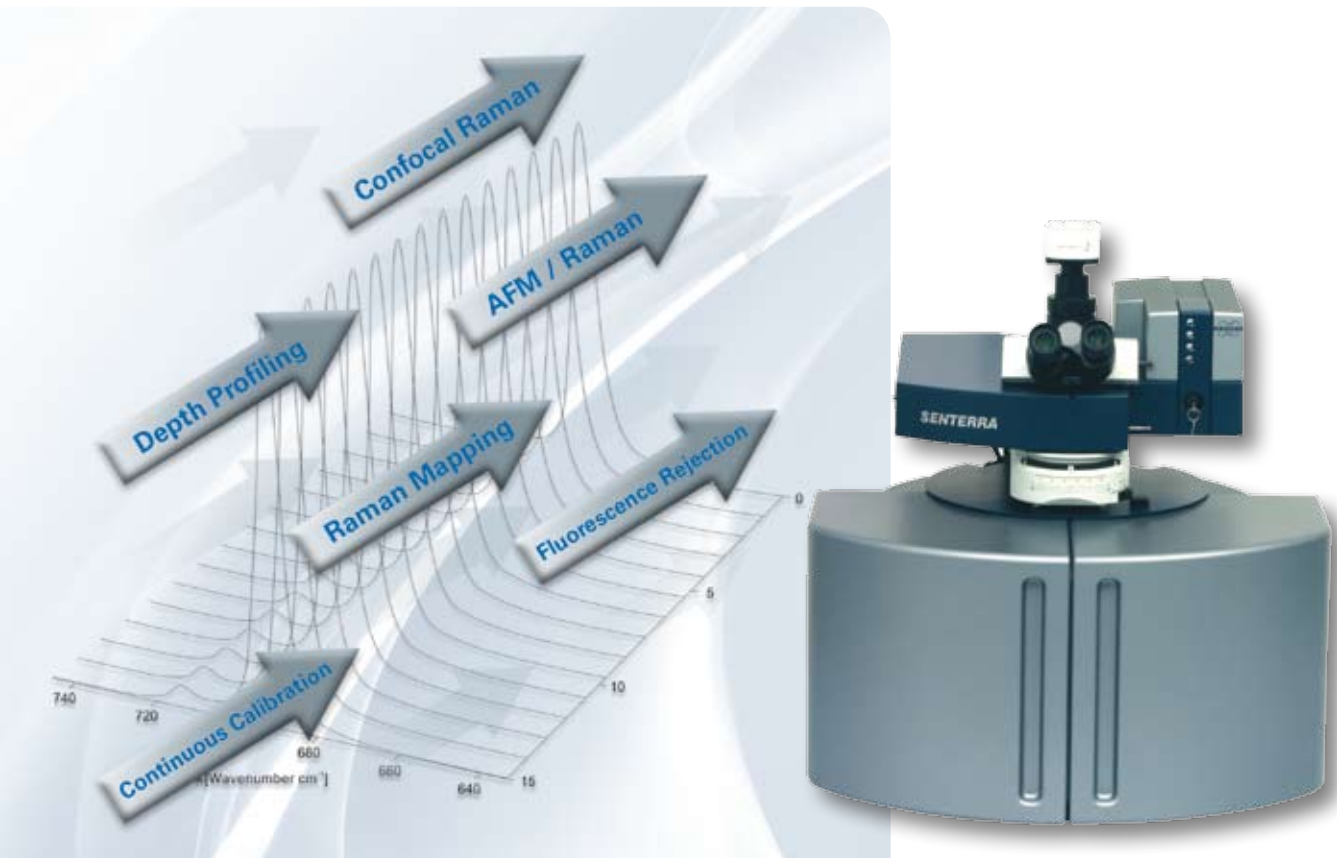




SENTERRA

- Raman Microscopes

SENTERRA, the only continuously calibrated Raman Microscope



SENTERRA Raman Microscope combines numerous novel and patented features such as permanent calibration, fluorescence rejection and on-demand confocal depth profiling. The most important innovation is certainly its continuous calibration method, as it eliminates daily calibrations with external standards, providing you reliable, reproducible measurements.

• A Revolution in Raman Microscopy

Bruker's years of innovation and excellence in Raman spectroscopy has led the way to revolutionise the Raman microscopy. The SENTERRA is a high performance Raman microscope spectrometer designed for most demanding analytical and research applications.

The SENTERRA Raman microscope incorporates many features that make it the ideal choice for the analytical laboratory.

Switching between excitation lasers could not be easier. The user simply selects the laser of choice and SENTERRA will automatically position spectrograph and excitation source.

- Permanent calibration with Sure_Cal®
- All-in-one, compact, confocal design
- Class 1 laser safety enclosure
- Multiple wavelengths: 830nm, 785nm, 633nm, 532nm and 488nm
- FT-Raman with 1064nm excitation
- Confocal depth profiling with FlexFocus™
- High spatial and spectral resolution
- Automatic instrument response correction with NIST standards
- Automatic Fluorescence Rejection using SERDS
- Open architecture allows coupling to inverse microscope, AFM and the z-stage for special applications

Compact Design

Most commercial Raman microscopes employ spectrographs that are separate from the microscope. Therefore, alignment and maintenance of these devices was time consuming. SENTERRA integrates a multi laser Raman spectrometer onto the confocal optical microscope. The spectrometer part is integrated in between the base and the binocular of the microscope. Due to this compact design, the beam path is kept very short, which accounts for the high stability and sensitivity of the system.

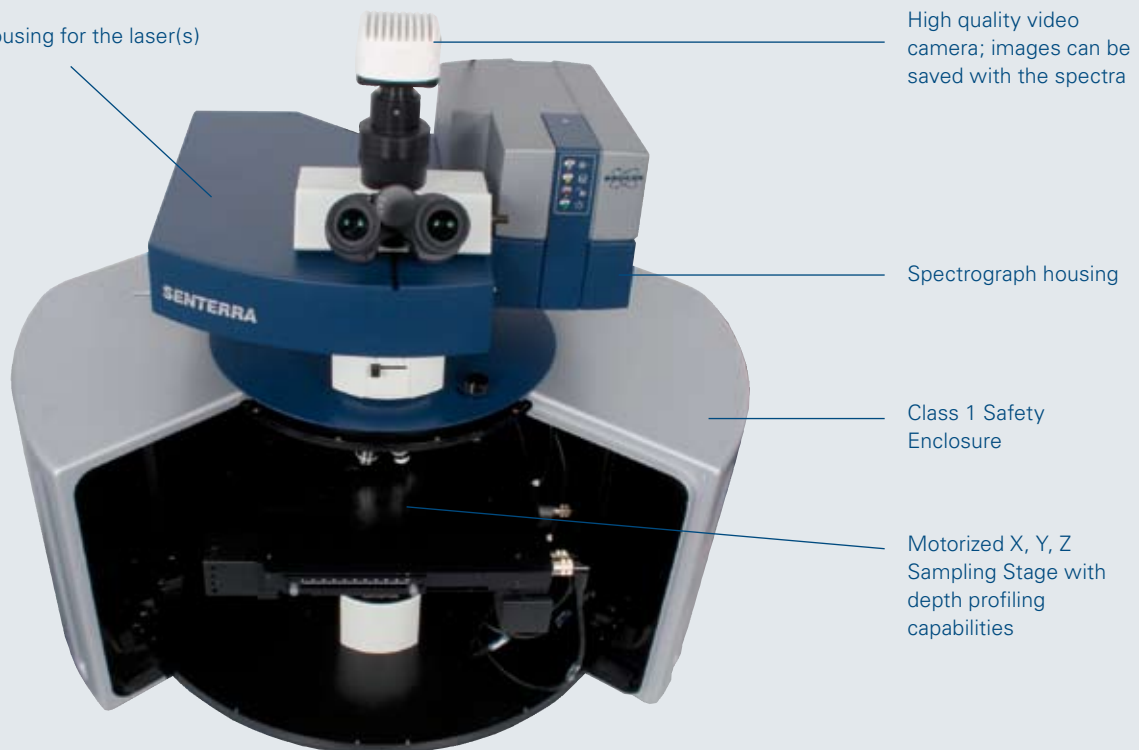
Housing for the laser(s)

High quality video camera; images can be saved with the spectra

Spectrograph housing

Class 1 Safety Enclosure

Motorized X, Y, Z Sampling Stage with depth profiling capabilities

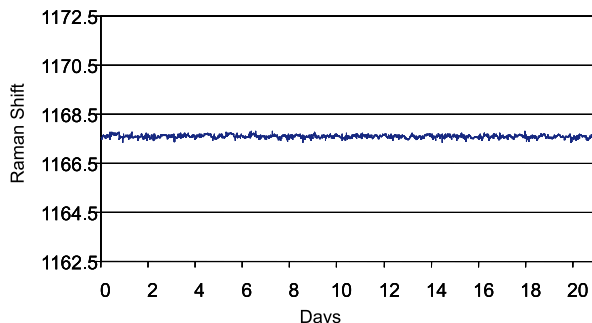


• Patented Innovations for Superior Performance

Sure_Cal® Automatic Continuous Calibration

Stability is a crucial issue for both, research applications for highly accurate determination of band shifts as well as for routine identification in the QA/QC laboratories. SENTERRA's patented Sure_Cal® method calibrates the system automatically with unmatched wavelength precision and accuracy. With each Raman spectrum the excitation line of the laser is also recorded. Beside this, the emission lines of a Neon lamp are measured. As a consequence changes of the spectrograph as well as changes of the laser excitation are recognized and the Raman spectra are automatically corrected with these. Due to this Sure_Cal® technology the SENTERRA is continuously calibrated and no daily calibration by external standards is required. The wavelength accuracy and precision is maintained to be better than 0.1cm^{-1} over the lifetime of the instrument without user calibration or maintenance. Each acquired Raman spectrum is automatically calibrated.

Sure_Cal® Automatic Continuous Calibration



Sure_Cal® allows the user to begin collecting data right away without worrying about calibrating the system. The wavelength is calibrated without needing any external standards. The measured Raman shift over many days is shown above. The wavelength accuracy is better than 0.1cm^{-1} over more than 20 days continuous data collection!

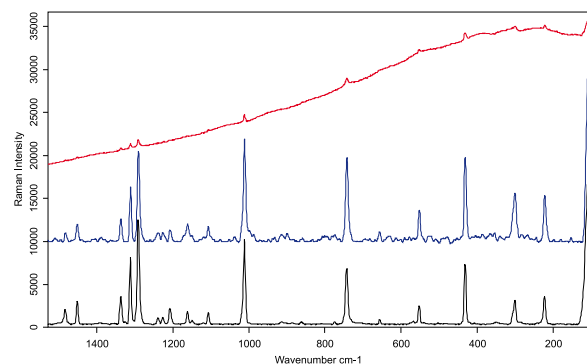
Automatic Fluorescence Rejection™ by SERDS

The SENTERRA incorporates the revolutionary and patented Automatic Fluorescence Rejection (AFR) method for eliminating fluorescence from many samples. So far, Raman spectroscopy has been a limited tool for sample analysis, because many samples exhibited fluorescence. With the SENTERRA, sample fluorescence can frequently be eliminated to produce high quality Raman spectra even on the most demanding samples.

SENTERRA offers a broad scale of means for overcoming fluorescence:

- Shifted Excitation Raman Difference Spectroscopy (SERDS), patented
- Concave Rubberband Correction (CRC), patented
- Selection of appropriate excitation laser
- Quenching of fluorescence by confocal Raman microscopy

Automatic Fluorescence Rejection SERDS



The upper (red) spectrum shows fluorescence background of carbazole with 785nm excitation. The middle (blue) spectrum shows the result spectrum after automatic fluorescence rejection. For comparison a Raman spectrum (black) of carbazole was recorded with 1064nm.

• Expandable Features

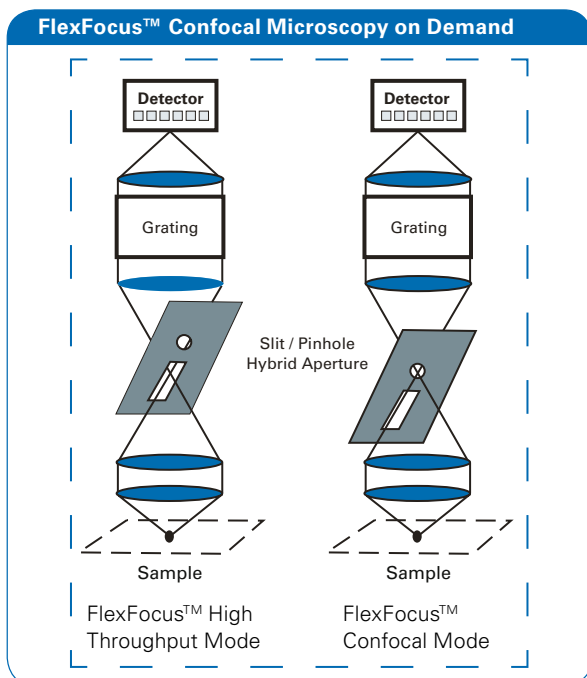
FlexFocus™ Confocal Microscopy on Demand

Taking into account the pros and cons of both traditional confocal and pseudo confocal methods, a novel method combining the best of both principles called FlexFocus™ was implemented into the SENTERRA.

It utilizes a hybrid aperture containing an array of pinholes and slits serving as both the confocal aperture and the spectrograph entrance aperture, providing both confocal or high throughput performance on demand. Because the confocal mode for all designs inherently has less throughput, it is highly desirable to have a system that can rapidly and easily switch back and forth from the high throughput and confocal modes of operation.

The selection of the slit in the software provides high throughput, whereas selection of the pinhole yields the high confocal mode of operation. With FlexFocus™, the problems of the traditional confocal approach is eliminated, while maintaining optimal confocal performance when needed.

Using FlexFocus a depth resolution of better than $2.0\mu\text{m}$ is obtained with a 100x objective and the $50\mu\text{m}$ pinhole. Lastly, by utilizing a single mount to have access to the high throughput and confocal modes of operation, the number of moving parts is minimized and the throughput is therefore enhanced.



Flexibility

Bruker Optics offers various accessories including mapping stages, heating/cooling stages, polarizers and depolarizers to enhance the capabilities of your Raman spectrometer. Depth profiles are performed automatically by using a very accurate motorized Z-drive. For the analysis of biological specimens the SENTERRA is also available on an inverted microscope.



For the investigation of biological specimens the SENTERRA can be coupled onto an inverted microscope.

For larger samples the SENTERRA can be configured as an open architecture Raman microscope. As the dimension of the sample is here not longer hindered by the microscope frame, this configuration is often used in arts for the Raman analysis of paintings and old books. For remote sampling fiber optics probes with video option are available which can be connected to the SENTERRA without impairing the microscopic sampling.



To study larger samples such as paintings, ancient books or statues, the SENTERRA can also be used on a motorized Z-stage instead of the microscope frame.

● OPUS Software

Advanced Optical Microscopy

As the SENTERRA is based on the Olympus BX series optical microscope, all the necessary tools for excellent sample visualization and contrast enhancements like Koehler brightfield illumination, polarized light, Nomarski differential interference contrast (DIC), darkfield and fluorescence are available. The standard trinocular viewer allows you to safely see your sample on the computer monitor or through the binoculars.

The standard aperture stop in the Koehler illumination provides the first and easiest method for enhancing contrast. Visible polarizers can be employed for birefringent samples. Darkfield illumination, phase contrast, and DIC can also be important tools for sample observation and characterization. Fluorescence illumination and observation is a very sensitive technique for samples that are autofluorescent or were specifically labeled before.

Atomic Force Microscopy (AFM)

To study the morphology and topography of any sample with a spatial resolution much below the diffraction limit of visible light, the SENTERRA is also available in a combination with an atomic force microscope. With this device a certain region of interest in a sample can be analyzed by AFM and Raman consecutively without any translocation of the sample.

Bruker NANOS is the only AFM scanning head that approximates the size and shape of a standard optical objective. It is mounted in the nose piece of the microscope, so that the user can easily change from AFM to any optical objective by a simple turn.



To combine Raman with AFM, the SENTERRA can be integrated into an AFM microscope. Bruker's AFM objective NANOS includes the scanning head and focus drive.

OPUS is an intuitive and flexible spectroscopic software for comprehensive control of the Raman microscope spectrometer, data acquisition, processing and evaluation.

Full spectrometer control and data processing

All essential functions of the SENTERRA are controlled by the OPUS software. The Raman spectrum and other related information such as the video images of the sample are stored within one file to ensure clear assignment.

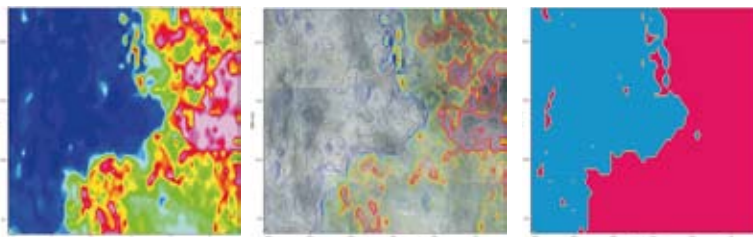
2D chemical Raman mapping and 3D depth profiling can be generated with full assistance of the live video package of OPUS. For the analysis of structured surfaces an autofocus is available. Numerous different 2D and 3D plot options for visualization of the data are available as well as multivariate analysis tools.

Sophisticated 3D Data Evaluation

- Classical Trace Computation
- 3D Cluster Analysis
- Principal Component Analysis (PCA)
- Artificial Neural Networks (ANN)
- Multivariate Linear Regression (MLR)

Dedicated software packages such as for temperature controlled measurements and for high throughput sampling are included in the OPUS software for the SENTERRA.

Superior Data Analysis



Left: Chemical map showing local distribution of an active pharmaceutical agent (API) on a tablet

Mid: Chemical map with API as contours on the optical photograph

Right: Chemometrical evaluation with cluster analysis showing the distribution of API and excipient

● Applications

Extensive Raman Libraries

More than 15,000 Raman spectra featuring extensive collections of organics, inorganics, minerals, fibers, forensics, semiconductors, dyes and pigments are available. Unique algorithms for the search of characteristic spectral patterns, are available in OPUS accomplishing fast identification of measured components by their spectral similarity to any of the references.

Validation

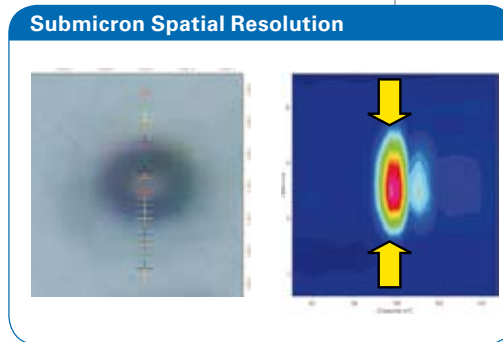
NIST certified standards are used to provide reliable correction of the instrument response function. Complete system validation including software and hardware according regulations such as 21 CFR part11, GAMP as well as USP and PhEu is available for the SENTERRA.

The SENTERRA is well suited for the most demanding research and analytical applications including:

- Pharmaceuticals (Polymorphism)
- Material Sciences & Nanotechnology
- Forensics
- Art Conservation & Restoration
- Mineralogy & Gemology
- Polymers & Plastic
- Life Science
- Photovoltaics

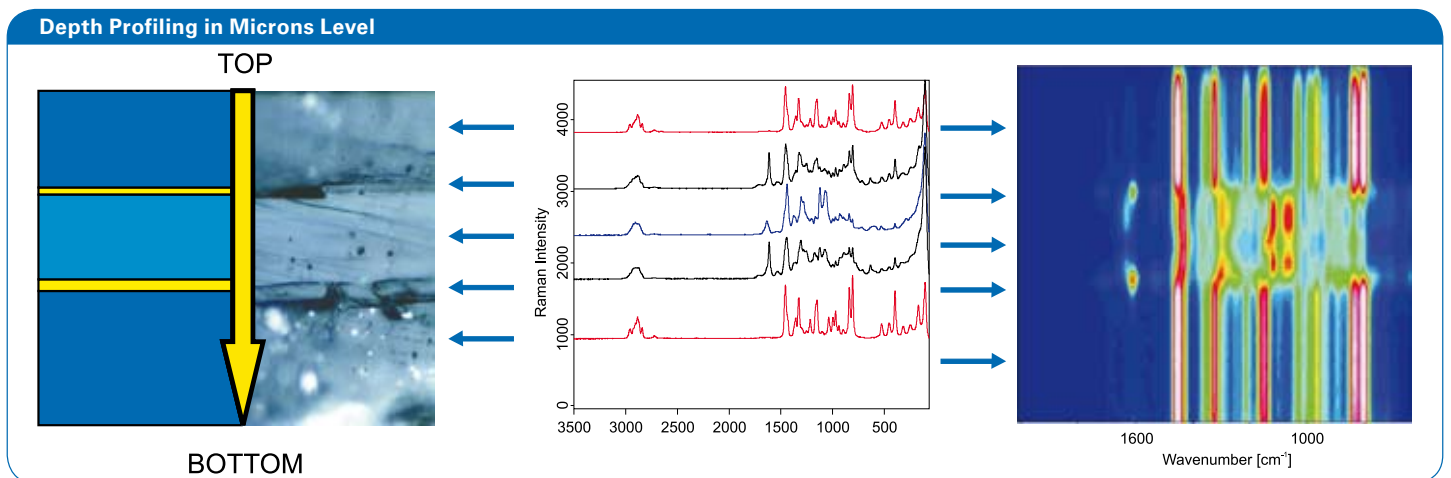
The optical and Raman spatial resolution is limited only by diffraction providing the highest quality mapping capabilities. The high wavelength accuracy also makes the SENTERRA a good choice, where only small band shifts shall be detected.

The SENTERRA provides confocal depth profiling with depth resolution to the physical limits.



Left: Optical photograph of a single polystyrene bead with diameter of ca. 700nm with assigned measurement positions; step width: 0.1µm.

Right: 2D spectral map of a single polystyrene bead with diameter of ca. 700nm showing lateral resolution of better than 1µm. The spectral range from 875 - 1125cm⁻¹ is shown.

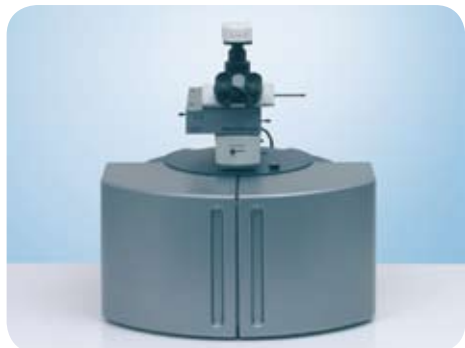


Confocal depth profile of a 5 layer polymer laminate

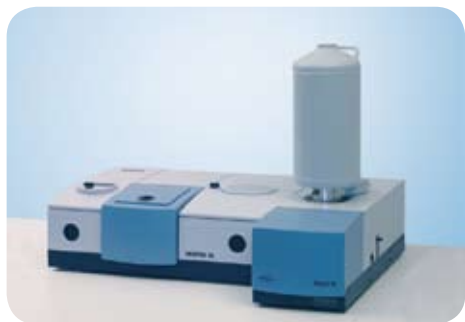
Left: Scheme of laminate with 5 distinctive layers and optical photograph, lateral view; **Mid:** Extracted Raman spectra from depth profiling showing Raman spectra of polypropylene – polyamide – polyvinylalcohol - polyamide – polypropylene; **Right:** 2D spectral map of a depth profiling of 70 consecutive Raman measurements (500-1,500cm⁻¹) showing 5 distinctive layers including two intermediate layers with thickness of 3 and 4 microns, thickness of laminate: ca. 70µm, step width for depth profiling: 1µm, 100x oil immersion objective

• Bruker Optics

Related Bruker Optics instrumentation



RamanScope III compact benchtop FT-Raman microscope for non-destructive microanalysis. The RamanScope III can be combined with SENTERRA to allow Fourier transform and dispersive Raman analysis.



RAM II FT-Raman module with up to two excitation lines (1064nm, 785nm).



HYPERION Series for FT-IR Microscopy and Imaging.

Support, Training and Service

Application Support

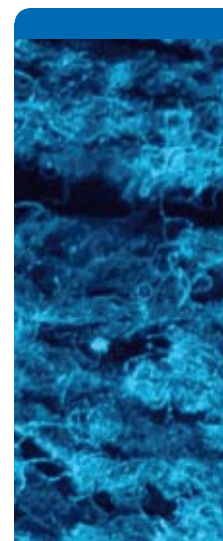
Bruker Optics is staffed mainly by scientists and engineers with in-depth knowledge of the instrumentation in the field. Our product specialists are available to offer advice concerning the use of sampling attachments, choices of optical components and software procedures. Furthermore, we at Bruker specialize in close co-operation with our customers in the development of spectroscopic techniques.

Training

Customer training courses are held on a regular basis for the benefit of the instrument users. Customized on-site training is also available from our staff of application specialists.

Service

Bruker Optics spectrometers are intended to provide years of trouble-free operation, but should a problem occur a network of Bruker companies and representatives around the world are ready to respond to your needs. Professional installations and a high standard of post-delivery service are commitments Bruker Optics makes to each of its customers.



Bruker Optics
is ISO 9001 certified.

Laser safety classification: LASER CLASS 1
Depending on accessories adapted the classification of the Raman spectrometers may equal the classification of the exciting laser and exceed class 1.

Technologies used are protected by one or more of the following patents: US 6141095; US 7102746

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