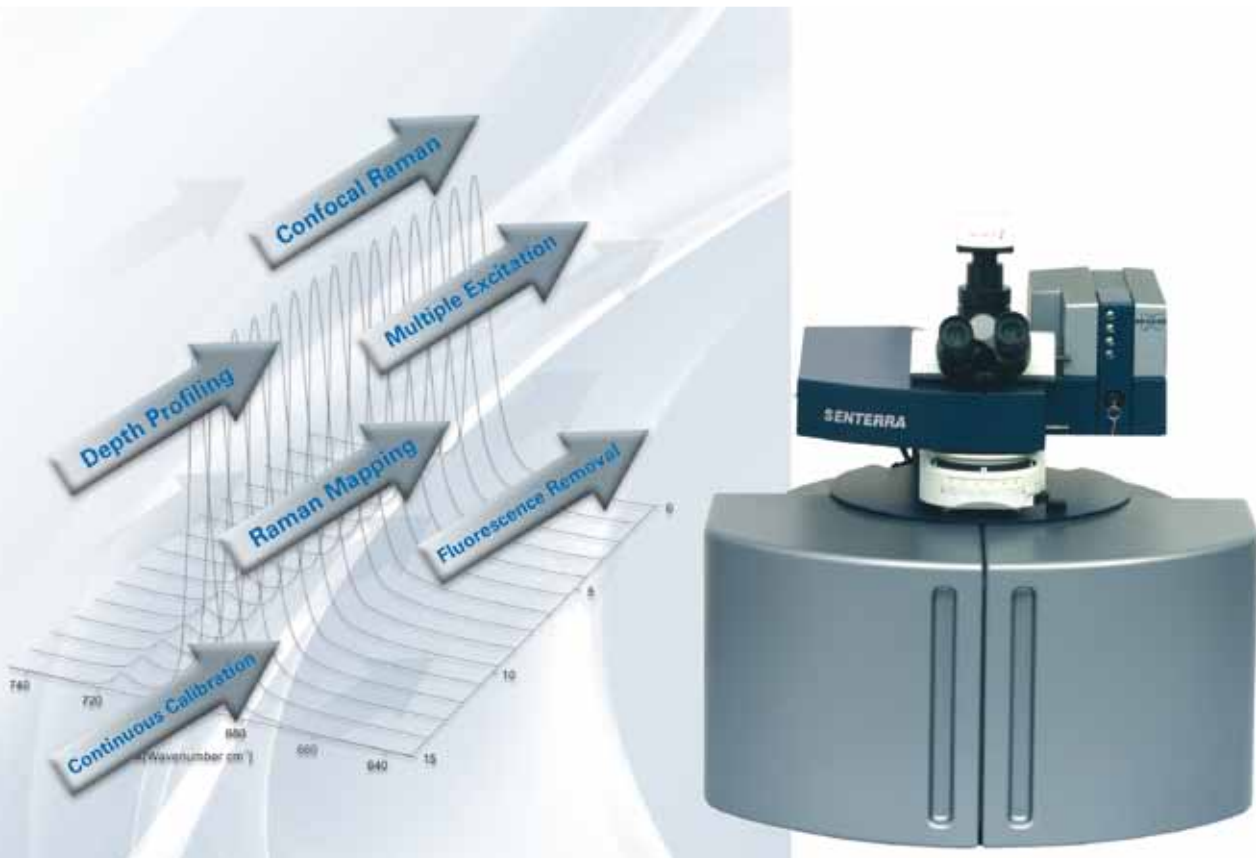




# SENTERRA

- Raman Microscopes

# SENTERRA, the only continuously calibrated Raman Microscope



SENTERRA Raman Microscope combines numerous novel and patented features such as permanent calibration, fluorescence removal 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.

# • More than one Step Ahead

Bruker's years of innovation and excellence in Raman spectroscopy have led the way to revolutionize Raman microscopy. The SENTERRA is a high performance Raman microscope spectrometer designed for demanding analytical applications in both - the R&D and routine laboratory.

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

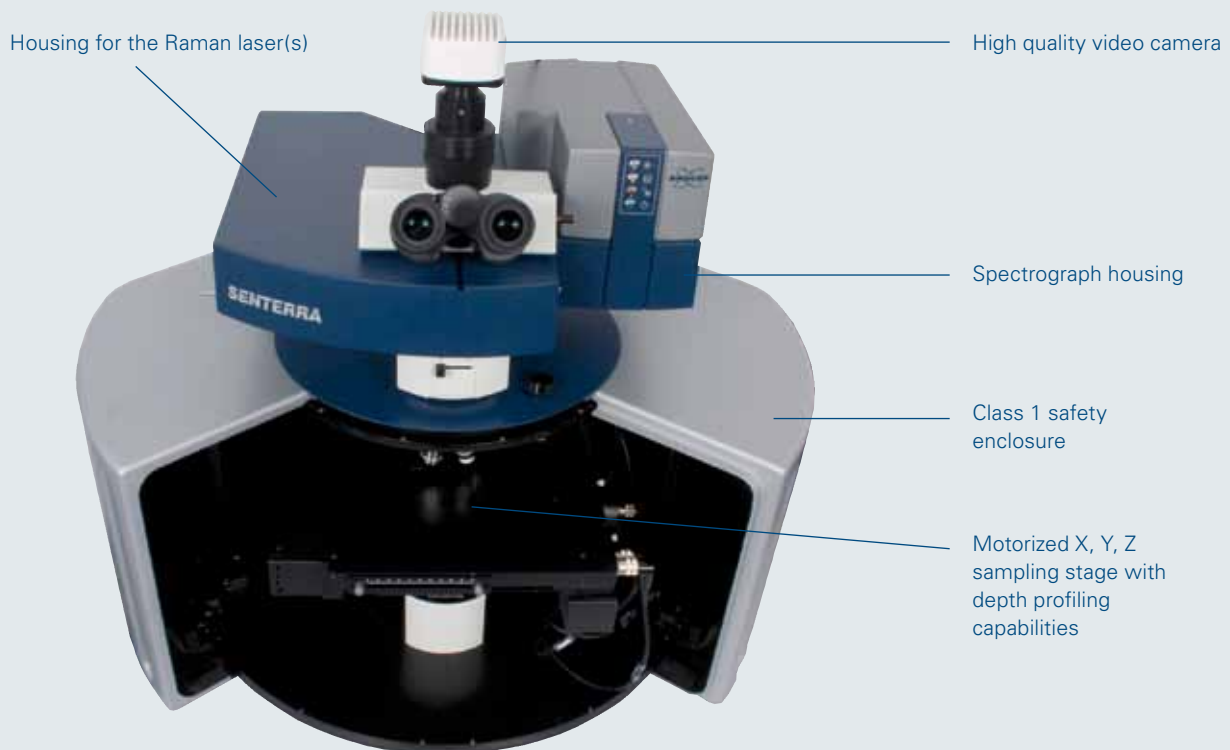
Switching between excitation lasers could not be easier. The user simply selects the laser of choice and SENTERRA will automatically position the spectrograph and excitation source.

- High wavenumber accuracy with Sure\_Cal® (pat.)
- All-in-one, compact, confocal design
- Removal of fluorescence background with Concave Rubberband Correction (pat.)
- Confocal depth profiling with FlexFocus™(pat.)
- Up to 4 excitation lasers <sup>1</sup>
- Computer controlled xyz mapping stages with autofocus
- Validation according to GAMP, PhEu, USP, 21 CFR part 11
- Class 1 laser safety enclosure standard
- Automatic instrument response correction with NIST standards

<sup>1</sup> In combination with RamanScope III

## 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.

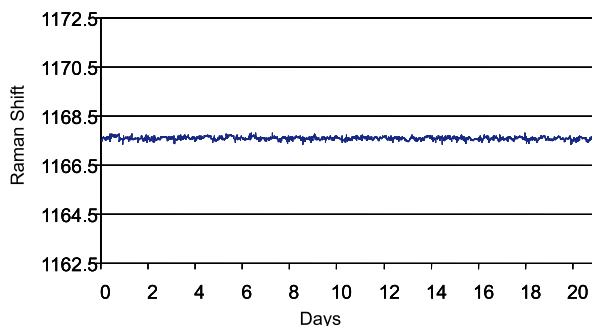


# ● Patented Innovations for Superior Performance

## Sure\_Cal<sup>®</sup> High wavenumber accuracy

Wavelength stability is a crucial issue for 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<sup>®</sup> 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. Due to this Sure\_Cal<sup>®</sup> 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  $0.1 \text{ cm}^{-1}$  over the lifetime of the instrument without user calibration or maintenance. Each acquired Raman spectrum is automatically calibrated.

### Sure\_Cal<sup>®</sup> Automatic Continuous Calibration



Sure\_Cal<sup>®</sup> 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  $0.1 \text{ cm}^{-1}$  over more than 20 days continuous data collection!

## FlexFocus<sup>™</sup> Confocal Microscopy on Demand

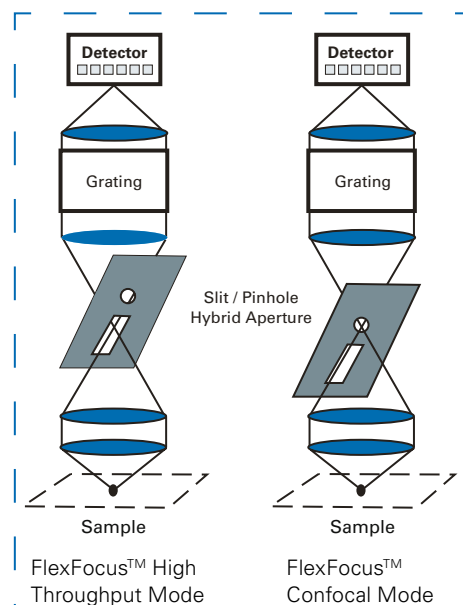
Taking into account the pros and cons of both traditional confocal and pseudo confocal methods, a novel method combining the best of both principles called FlexFocus<sup>™</sup> was implemented into the SENTERRA.

It utilizes a hybrid aperture containing an array of pin-holes and slits that serve 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<sup>™</sup>, the problems of the traditional confocal approach is eliminated, while maintaining optimal confocal performance when needed.

Using FlexFocus, a depth resolution of better than  $2 \mu\text{m}$  is obtained with a 100x objective and the  $50 \mu\text{m}$  pin-hole. Lastly, by utilizing a single mount to have access to the high throughput and confocal modes of operation, the number of moving parts as well as the beampath is minimized and the throughput is therefore enhanced.

### FlexFocus<sup>™</sup> Confocal Microscopy on Demand



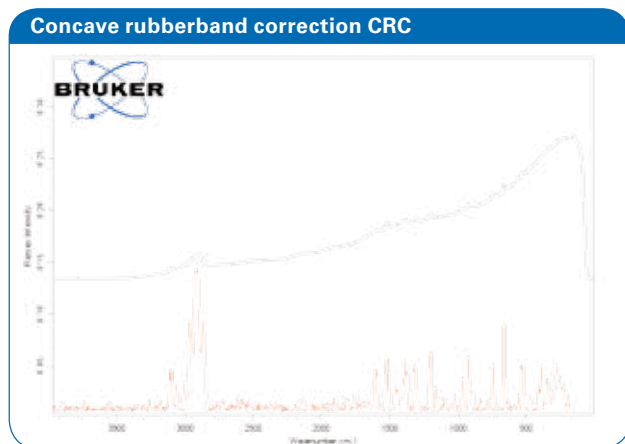
# ● Expandable Features

## Fluorescence Removal

The SENTERRA offers powerful tools to overcome unwanted side effects such as fluorescence. With the SENTERRA sample fluorescence can be avoided to produce high quality Raman spectra by the automated selection of the appropriate excitation laser. For utmost suppression of fluorescence, a long wavelength Raman laser with 1064 nm is available in combination with a FT-Raman module.

Fluorescence can frequently be minimized by the use of the quenching effect. The confocal design of the SENTERRA assures that quenching can be used efficiently. A bleaching function provided by the OPUS software allows the use of quenching prior to the measurement.

In addition, the advanced and patented software tool "Concave Rubberband Correction" allows reproducible and artifact free correction of any background independently from the excitation line used.



Sample: extract from plant

The upper (blue) spectrum shows fluorescence background of a plant extract with 785 nm excitation.

The lower (red) spectrum shows the result spectrum after treatment with the Concave Rubberband Correction.

## Flexibility

Bruker 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 structured samples a powerful autofocus is available.

The SENTERRA may be used as an upright and inverted confocal Raman microscope. The inverted set up is ideal for biochemical applications such as living cell examination featuring full Raman capabilities with confocal Raman mapping and depth profiling or multiple laser excitation. The inverted design of the optical microscope provides convenient access from the top as required for biological investigations. In addition, full functionality for optical image contrast enhancement of an inverted microscope such as darkfield, polarization, fluorescence or DIC is assured.



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 typically used in arts for the Raman analysis of paintings as well as ancient books and documents.

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

By adding the FT-Raman microscope RamanScope III module to the frame of the SENTERRA Raman microscope, up to 4 excitation lasers can be used and sample excitation is extended to the near infrared (1064 nm).



The SENTERRA can be coupled with the FT-Raman microscope RamanScope III providing sample excitation from the visible to the near infrared (1064 nm).

### 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 via the high quality CCD camera and/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.

OPUS, an easy-to-use spectroscopy software, is the powerful user interface between SENTERRA and you. The SENTERRA wizard guides you step-by-step through the measurement procedure.

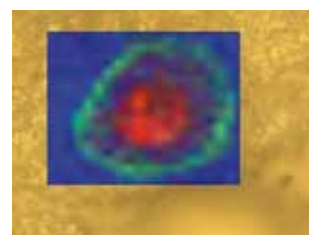
### Full spectrometer control and data processing

All essential functions of the SENTERRA and relevant parameters 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. The change of components such as laser and gratings is just a click in the parameter menu.

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, the autofocus keeps the sample in the focus. Many 2D and 3D plot options for visualization of the data are available as well as multivariate analysis tools.



visible image of the region of interest



2D Raman mapping revealing 3 components in false color

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

### Raman Libraries

More than 20,000 Raman spectra featuring extensive collections of organics, inorganics, polymers, minerals, fibers, forensics, semiconductors, dyes and pigments as well as natural compounds are available. Unique algorithms for the search of characteristic spectral patterns are included in OPUS, accomplishing fast identification of measured components by their spectral similarity to any of the references.

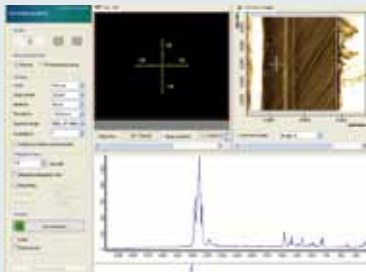
### Validation

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 part 11, GAMP as well as US Pharmacopeia and European Pharmacopoeia is available for the SENTERRA.

# ● Applications

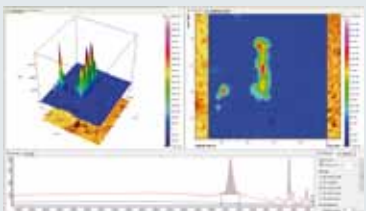
## Software

### SENTERRA Wizard



The powerful SENTERRA Wizard provides a guided measurement procedure with full access of all measurement parameters and live spectrum display.

### 2D/3D Data evaluation & processing



2D and 3D hyperspectral visualization of measurement results including statistical and chemometrical evaluation.

### Spectral libraries



More than 20.000 Raman spectra including polymers, (in)organics, minerals, pigments, etc. are available for identification by spectral libraries.

The high degree of automation of the Senterra allows you to fully concentrate on your application without tedious tweaking of instrument parameters and hardware. Regardless of whether you intend to add a further excitation line or an extension for automated measurements on a well plate, the SENTERRA will grow with your needs for future applications.

Uncompromized spectroscopic performance by using state-of-the-art components and high flexibility are the keys to a vast variety of applications such as for example:



### Materials Science

- Polymers
- Coatings
- Paints & pigments
- Paper
- Composites
- Corrosion
- Catalysts
- Nanotechnology
- Building material
- Phase transition & crystal phases
- Interfaces solid/liquid - liquid/gas - gas/solid
- Semiconductors
- Thin film solar cells
- Carbon nanotube, graphene, DLC and other carbon related fields
- Reverse engineering



### Chemicals incl. bio-and petrochemicals

- Identification
- Failure analysis
- Trouble shooting
- Contaminant analysis
- Distribution of components
- Particles



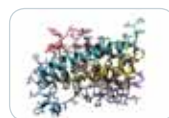
### Mineralogy & Geology

- Identification of minerals
- Phase transition



### Pharmaceuticals

- Polymorphism
- API distribution
- Content uniformity
- Long time testing of formulations



### Life Science

- Bacteria identification
- Tissue analysis
- Protein structure
- Medical implants



### Forensics

- Evidence analysis
- Illicit drug analysis
- Detection of explosives
- Proof of authenticity of document

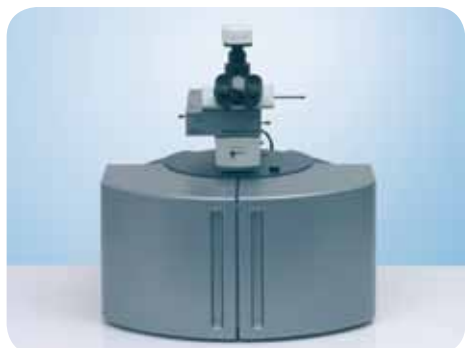


### Art, Cultural Heritage, Gemology

- Discrimination of fake and genuine artifacts
- Preservation
- Degradation

# • Support, Training and Service

## Further Bruker IR & Raman microscopes



**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 micro analysis.

## Application Support

Bruker 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.



**LUMOS** stand-alone FT-IR microscope with full automation.

## Service

Bruker FT-IR and Raman 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.



**HYPERION** Series for FT-IR Microscopy and Imaging.

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

**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.

[www.bruker.com/optics](http://www.bruker.com/optics)

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