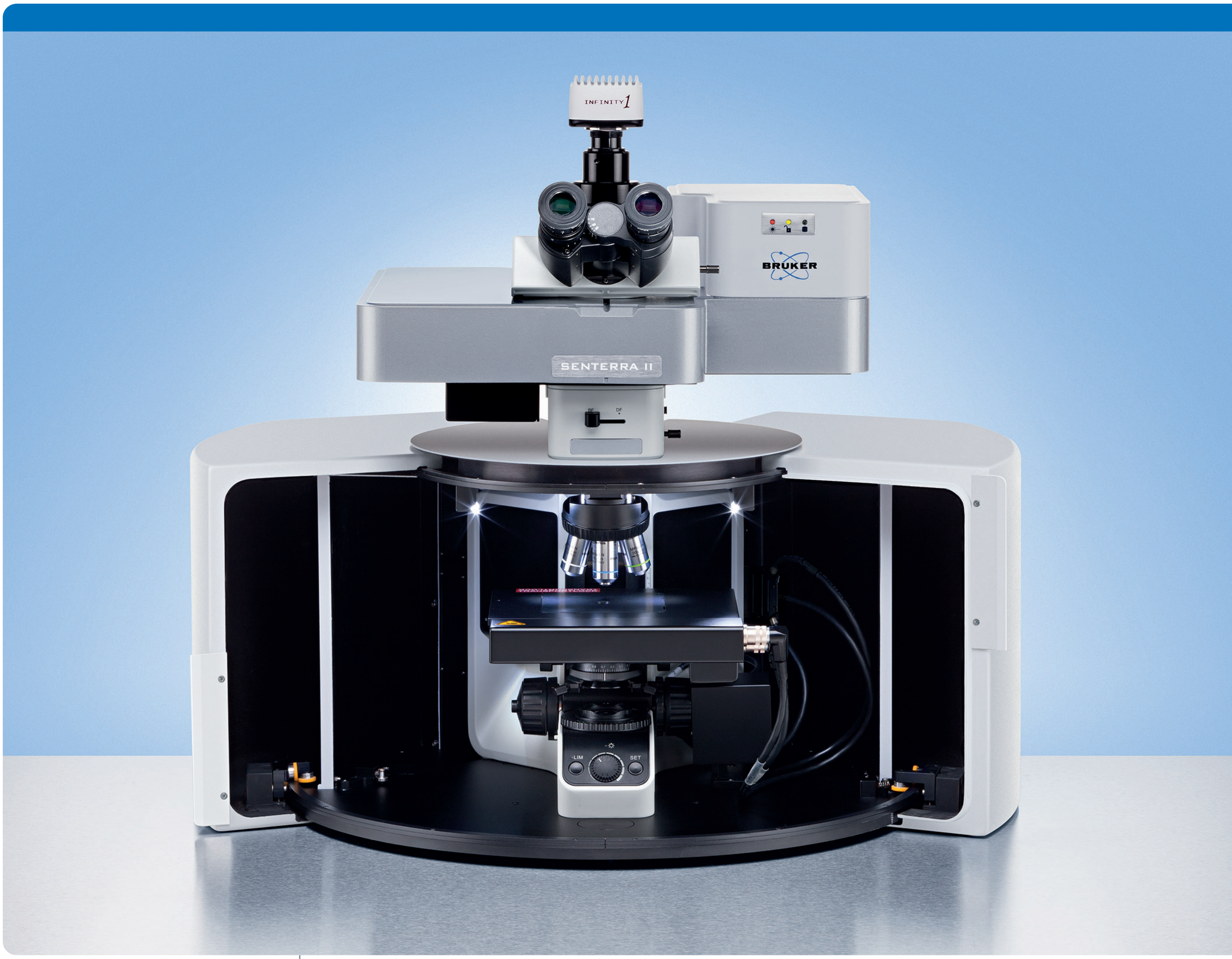


Raman Application Guide

Innovation with Integrity

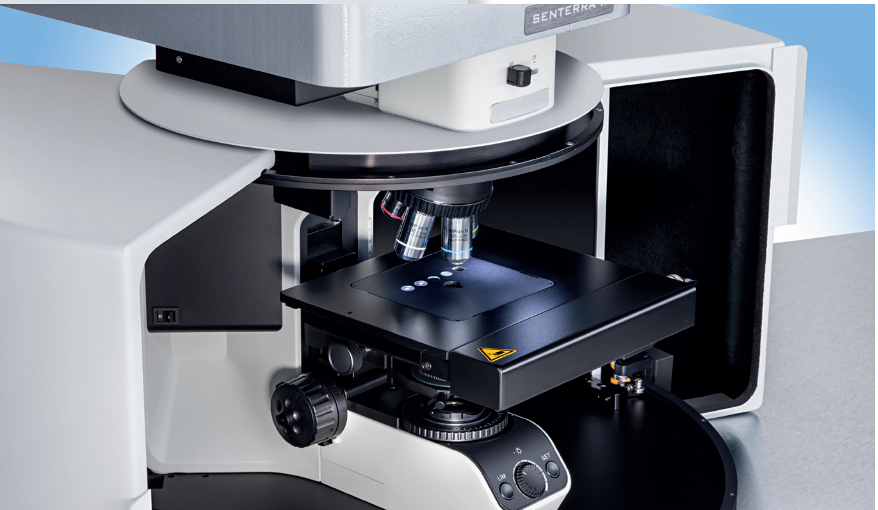
RAMAN

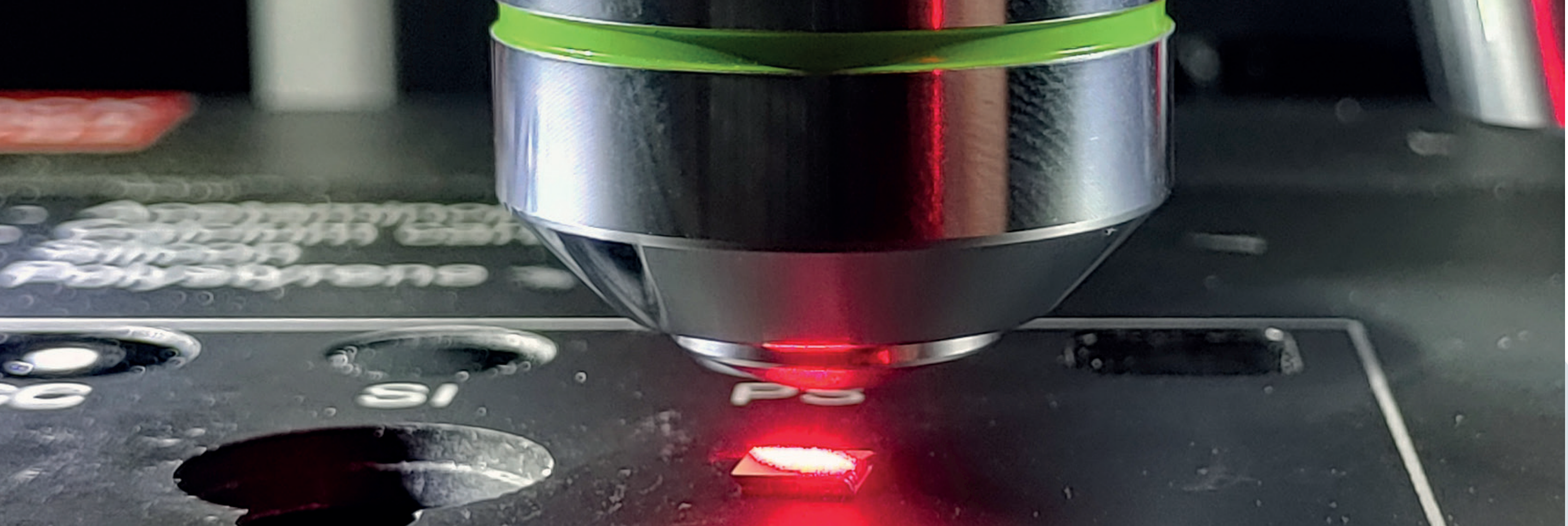
The Raman Application Guide

The impressive variety of applications in Raman spectroscopy, microscopy and imaging is an undeniable fact. As a result, selecting the appropriate Raman instrument setup for routine analysis is often easier said than done. To make things even more complex, research and development applications are a whole different playing field.

Our handy Raman application guide is meant to help you choose the ideal setup for the SENTERRA II Raman microscope. Our goal is to recommend a configuration for a given application but also to provide more background information. We explain why Raman and especially the SENTERRA II are a good choice and why is our hand-picked instrument setup the optimal fit for the application.

We want to emphasize that understanding Raman is not rocket science. With the help of this guide, you will be able to clearly and concisely communicate why the setup we have chosen best fits a customer's requirements and needs.





The Basic System

Our standard configuration of SENTERRA II is already an excellent solution **for most Raman users**. Its main features are the high level of automation and of course OPUS, the intuitive software that will allow all types of users (beginners, experts, researchers) to operate the SENTERRA II in a comfortable way.

If the user knows how to visualize the sample with a microscope, Raman spectra and Raman images are just a few clicks away.

The standard configuration provides the two most used excitation wavelengths 532 nm and 785 nm. It covers the full spectral range for both excitation wavelengths by a single shot and with 4 cm^{-1} resolution, which is sufficient for most applications.

The included motorized x, y, z-stage is vital for convenient operation, as it allows performing automated imaging measurements with very high positioning accuracy in all three dimensions.

Although this is already a well-rounded configuration, we highly recommended R291-DB as an additional option since it unburdens operators from switching manually between Raman and white light mode on the microscope. 20x and 50x objective lenses are included in the standard configuration. Nevertheless, it would be worth to consider adding a 100x objective lens if there will be sample with small feature, e.g. sub-micrometer.

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance

The All-Rounder

This "All-Rounder-Configuration" is designed for **scientific users** who require powerful Raman microscopy and routinely face a variety of different samples, e.g. in troubleshooting or analytical service labs. It is built upon two main features: First, an increase in spectral resolution to 1.5 cm^{-1} to resolve even closed-by Raman peaks and second, the addition of another popular excitation laser wavelength, either 488 nm or 633 nm, respectively.

Furthermore, the included software package O/RIM/S2 will enable your system to measure up to 130 spectra per second to quickly generate large Raman images.

Simply put, the all-rounder configuration is prepared for any sample. The microscope offers more choices in magnification and illumination to improve visual quality. The A697-S adapter for the objective lens and the Unilab II Raman fiber probe provide enhanced flexibility to measure liquids in cuvettes, or large samples that will not fit on the microscopic stage.

A typical Raman image showing the distribution of contents in a false color plot.

Please note, that if the user wants to measure a large frame Raman imaging and/or studies samples with a weak Raman response, the R210-2U upgrade of laser power is helpful to provide meaningful data for such samples. To round off this flexible configuration, the vibration isolating system S565 will allow the SENTERRA II to be set on a trolley or cart to be moved between operation sites. To reflect the hardware's versatility on a software side, the software package O/SR-N and the all-in-one Raman database provide the means to identify even unknown samples rapidly and reliably.

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R220/S2
  Extension to 633nm excitation for SENTERRA II, 20mW, polarized
- R208/S2
  Extension to 488nm excitation for SENTERRA II
- R300-1200/S2
  Upgrade for high spectral resolution
- R300-1800/S2
  Upgrade for high spectral resolution

Microscope
- R291-DB
  Automatic switch for Raman / white light selection
- R291-TU
  Transmission instrumentation for SENTERRA II or Ramanscope III
- A697-S
  Adaption for mounting a microscope objective
- R291-TO
  Trinocular head with binocular eye pieces and mount
- S565
  Vibration Isolation System, active regulation

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Fiber Probe
- R261-532-S
  Unilab II Probe - 532nm
- R261F300/50-002
  Fiber optic cable FC/PC, 1.8m (for SENTERRA II)
- R573-I
  Interlock/Safety Kit
- R255-S
  Port for Fiber Optic Probe
- R261-O
  Unilab II objective holder

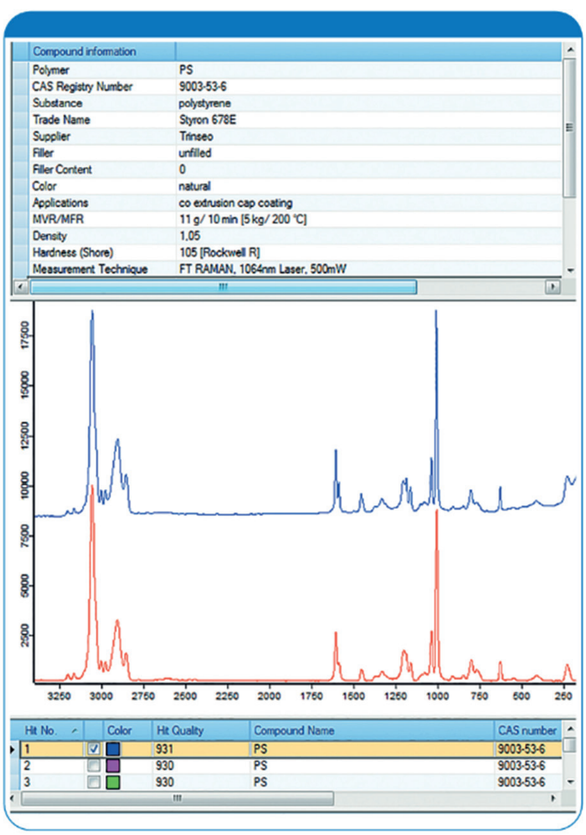
Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/OBJ
  OPUS/OBJECT Software package
- O/SR-N
  OPUS/SEARCH, Software Package for comprehensive search
- 1869428
  Raman library - complete collection

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II

• Polymers & Plastics

Although currently not as widespread as IR, Raman spectroscopy adds a lot of complementary and unique information to the analysis of polymers. The basis for that is the "rule of mutual exclusion", which means that Raman is sensitive to molecular vibrations that do not show up in an IR spectra. A typical example are the backbone vibrations of a long polymer chain, which can only be observed by Raman.

The SENTERRA II Polymer configuration recommendation leverages this unique information for many different applications. Basically, the included standard 532 nm and 785 nm lasers are the optimal setup for polymer analysis, as colorless materials are easily analyzed by 532 nm, whereas 785 nm excitation is a good option to avoid fluorescence interference in colored polymers.



Bruker cooperates with the renowned Polymer Institute Luedenscheid to provide an always up-to-date high quality Raman spectral reference library.

Please note, if users are dealing with heavily fluorescent samples, analysis might still be challenging and even an even longer laser wavelength needs to be configured. Therefore, early advice and feasibility tests are important.

One of the biggest advantages is the non-destructive and especially non-invasive nature of Raman measurements. In addition, Raman spectra can be taken beneath the surface for depth profiling. With this, it is much easier to analyze and monitor polymer films or layered polymer materials used without altering, destroying, or excessively preparing the sample material. On top, this configuration includes the R297-100A objective lens to provide the optimal spatial resolution to analyze thin layers.

On the software side, the Bruker Raman database of polymers, R-KIMW+, contains over 650 spectra from polymers and additives, which is a powerful tool in characterization of polymer materials.

Raman Spectroscopy

- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer

Microscope

- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens

- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Software/PC

- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/SR-N
  OPUS/SEARCH, Software Package for comprehensive search
- R-KIMW+
  Bruker Raman Polymers, Plastics and Additives Library
- 1846133
  Raman library of polymers and Processing Chemicals

Accessories

- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II

• Semiconductors & Crystalline Structures

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

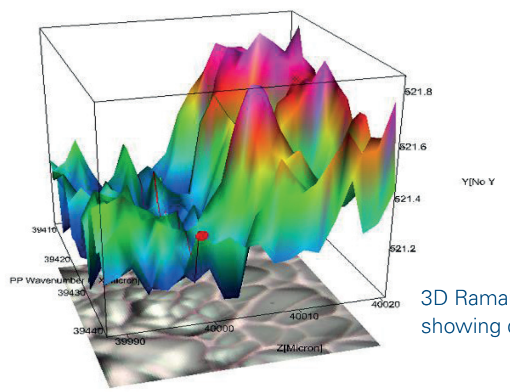
Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/PRO
  Protein Dynamics, software

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II
- A699-TR
  Microscopic sample stage

Raman spectroscopy and microscopy can serve greatly in the characterization of semiconductors and crystalline structures. They provide information about allotropic type, degrees of crystallinity, amorphous structures, crystal lattice defects, material stress and purity.

Here Raman truly shines, as many inorganic compounds show characteristic modes in the low-wavenumber region, also known as the solid-state vibrational modes (typically 50-200 cm^{-1}), which are hard to detect with IR spectroscopy.

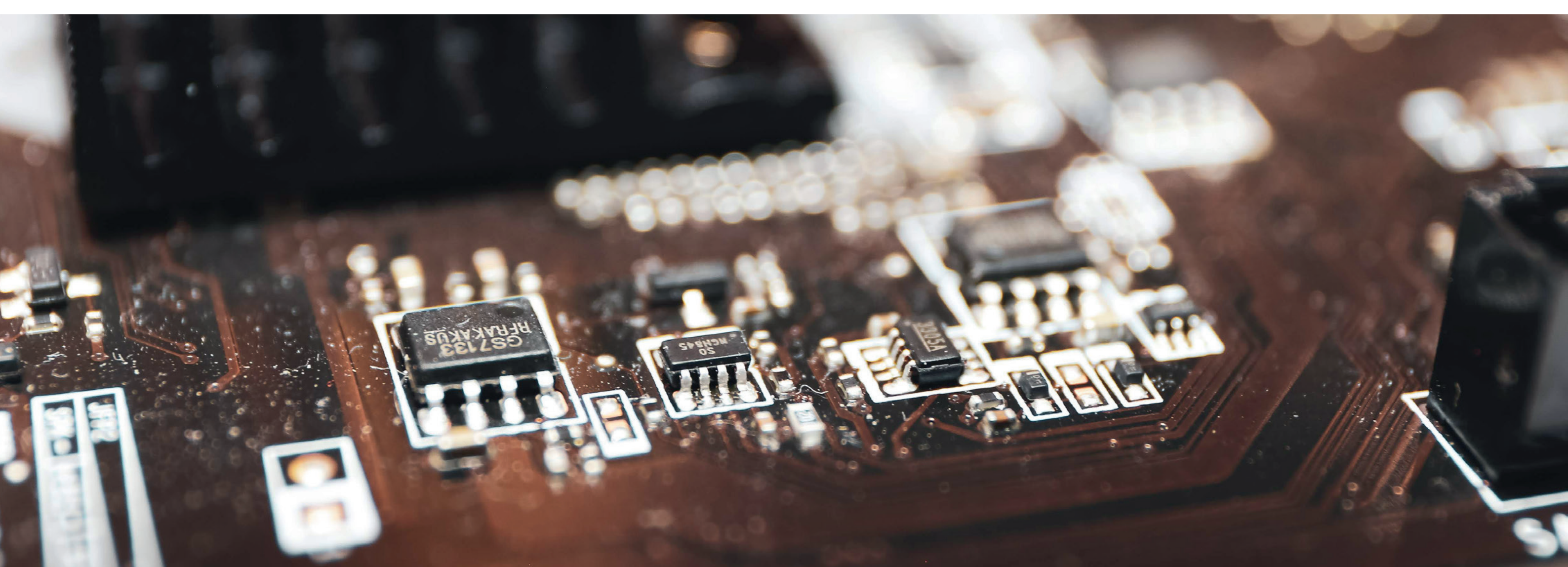
If users are planning to monitor material stress, precise measurement of the peak shift is mandatory. To illustrate, we take a closer look at the monitoring of stress in silicon wafers, where 100 MPa of physical stress will only cause a 0.2 cm^{-1} shift of the Raman peak. Obviously, it is vital to plan the calibration of the instrument accordingly for such experiments, as misalignment or a missing calibration might produce meaningless or even misleading data.

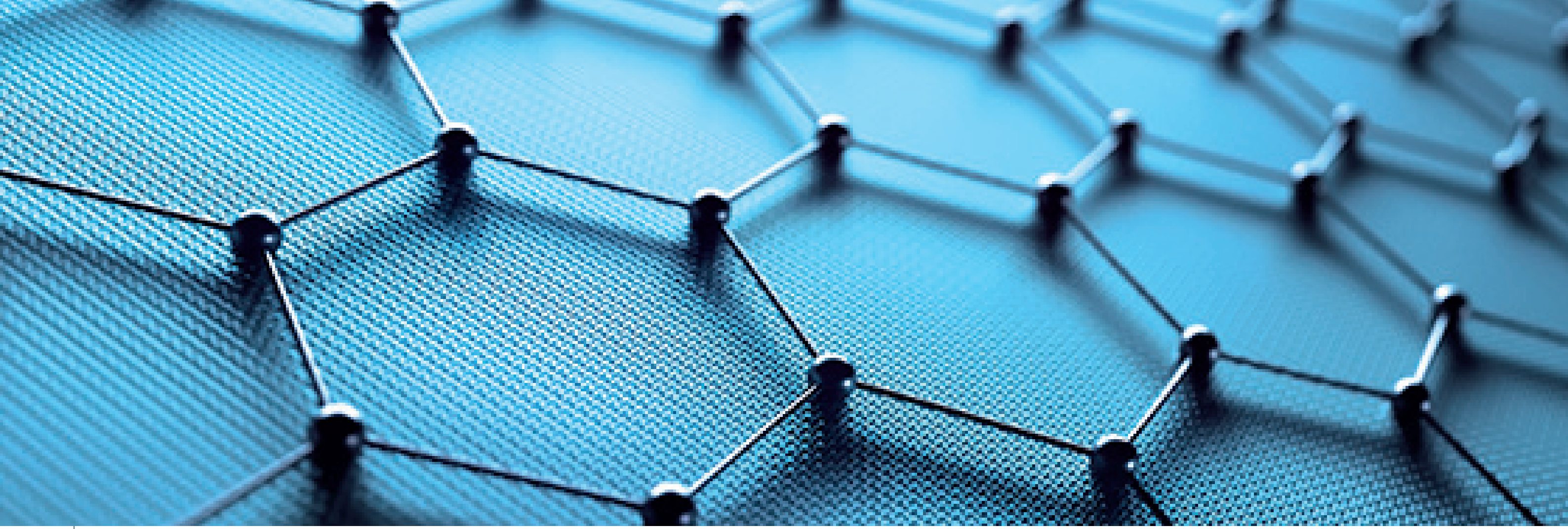


3D Raman image of polycrystalline silicon showing different crystallization zones.

Bruker's patented SureCal™ technology provides a Raman instrument that always produces precise and reliable data, and the calibration process is fully automated. And as the SENTERRA II is always calibrated, there is no need to dismount samples between experiments to recalibrate.

For these kind of applications, R300-1200/S2 upgrade and 100x objective lens are a must to achieve the optimal spectral and spatial resolution, respectively. If temperature-depended experiments like crystallinity studies at high temperature are of interest, A699-TR and O/PRO should always be included.





Graphene & Carbon

Graphene is an allotropic form of carbon consisting of a monatomic layer of carbon atoms. It has remarkable electronic, thermal, optical, and mechanical properties. It is now commercially applied in various product, e.g. Li-batteries, meta materials, coatings, sensors, and electronic elements.

Raman microscopy is a simple and easy-to-use characterization method for graphene. It can be used to analyze small graphene units with high spatial resolution and provide abundant information about the number of layers, defects, dopants, tensile stress, and the edge-type of graphene samples.

That makes Raman microscopy **the most powerful analytical tool** for graphene studies. We want to emphasize explicitly: There is no alternative to Raman when it comes to graphene analysis. And thanks to its unique properties, graphene and its oxide composites are nowadays used in Surface Enhanced Raman Spectroscopy (SERS) to improve the quality of spectra.

532 nm is the standard excitation wavelength for graphene characterization, and 785 nm is as well often reported as optimal excitation for graphene-based SERS or other complex materials. Furthermore, R300-1200/S2 upgrade and 100x objective lens are needed for the optimal spectral resolution and spatial resolution.

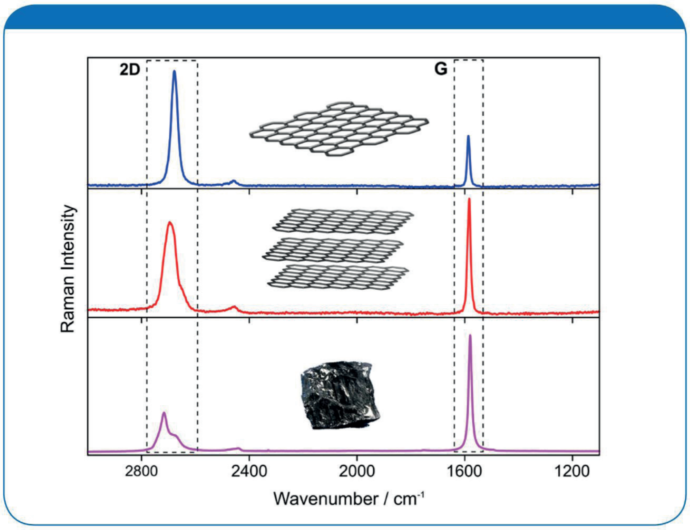
Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II



Raman is super sensitivite to carbon allotropes and easily distinguishes diamond from graphite from graphene. It even allows to differentiate the number of graphene layers!

• Forensics

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R220/S2
  Extension to 633nm excitation for SENTERRA II, 20mW, polarized

Microscope
- R291-DB
  Automatic switch for Raman / white light selection
- R291-TO
  Trinocular head with binocular eye pieces and mount
- R291-TU
  Transmission instrumentation for SENTERRA II or Ramanscope III

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

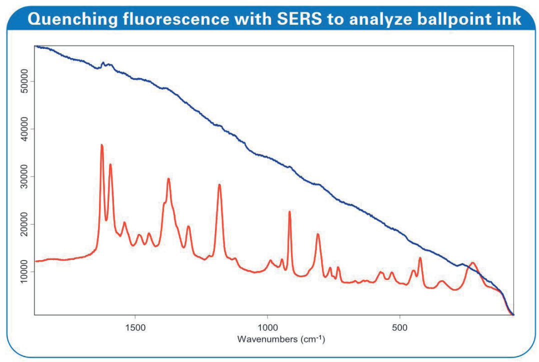
Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/SR-N
  OPUS/SEARCH, Software Package for comprehensive search
- 1869428
  Raman library - complete collection

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II

Raman spectroscopy has been applied to many different forensic analytes and quite often, trace evidence from forensic/crime is microscopically small and hard to analyze by conventional methods. In such cases, Raman microscopy is a versatile technique that is extraordinarily capable.

Even if the samples are only 1 µm in size, the SENTERRA II can still test and identify them without damaging the sample and the extension to 633 nm excitation will allow users to apply the system to a broad range of forensic scenarios.

Thanks to the functional structure of the software and its data format, the user has a real ace up his sleeve. The visual images and Raman data are captured and stored in a single file within the OPUS software, which is GLP and 21CFR part 11 compliant, and ready for an immutable evidence trail.



SENTERRA II and SERS can help quench fluorescence in difficult forensic samples like this document forgery case.

Please note that interference from fluorescence once limited the application of Raman spectroscopy in the identification of colored samples. However, modern Raman spectroscopy has escaped the reputation of merely being a "complementary technique" in forensics and finds broad application.

As sample identification and differentiation are the main tasks for this system, the upgrade of R300-1200/S2 is not necessary in most cases. However, a complete and well-kept collection of Raman spectra is a powerful tool for forensic users. Therefore, #1869428 Raman library is highly recommended. On request, Bruker can provide a collection of Raman libraries including over 32,000 entries.

Battery Research

Unsurprisingly, almost all parts of a modern Li-Po-battery can be subjected to an in-depth Raman analysis. It allows battery engineers to access the chemical information needed to improve the performance and durability of electrodes and electrolytes for an optimized battery setup.

In general, Raman provides a wealth of information about the processes that take place in a battery, both ex- and in -situ. Raman owes this broad applicability primarily to the materials used in a modern battery. Especially carbon allotropes like graphene and carbon nanotubes are excellent candidates for Raman analysis.

For these "trending" anode materials, Raman spectroscopy has been the go-to-method for decades. As pointed out earlier, Raman microscopy is by far the most powerful analytical tool for graphene studies, period.

It offers clear information about crystalline structures, number of sheets in layered graphene, the lithium insertion / deinsertion (intercalation) process in the lattice host.

As the Raman signal can be acquired through a transparent window, the technique can monitor the battery during the charge/discharge process. This is also known as in-situ Raman spectroscopy and is widely recognized as a crucial tool for battery researchers. For such in-situ studies of both, electrolytes, and electrodes, we recommend the #1853115 electrochemical as a popular Raman platform.

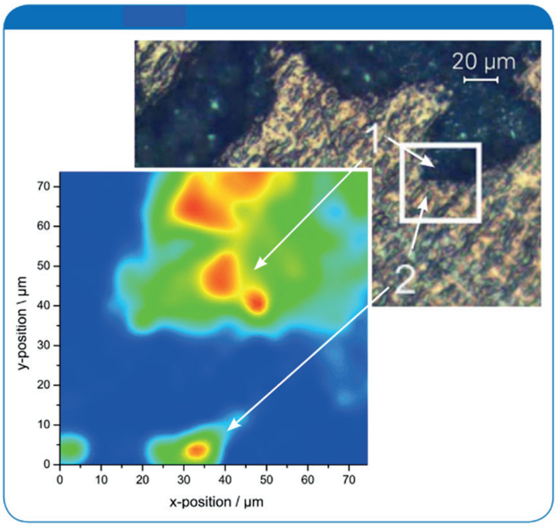
Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II
- 1853115
  ELECTROCHEM.CELL ECC-OPTO-STD-AQU
- 1853116
  Adaption of ECC-Opto-Std



Raman spectroscopy covers almost all aspects of battery research from cathodes, to anodes to Electrolytes.
In this example, a copper plate was coated with lithium carbide. The Raman image shows hidden Li2C2 hotspots, that were not visible in the visual image.

• Art & Archeology

Raman Spectroscopy
- R200-L/S2 *SENTERRA II Raman Microscope Spectrometer*
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope
- 1878832
  Gantry with extended range Z-Axis for SENTERRA II Raman Microscope
- R573-I
  Interlock/Safety Kit
- R291-DB
  Automatic switch for Raman / white light selection
- R291-TO
  Trinocular head with binocular eye pieces and mount

Objective Lens
- R297-50L
  Microscope Objective 50x, NA=0.50
- R297-10
  Microscope Objective 10x, NA=0.3
- 1848954
  OBJEKTIV 20X NA=0.45 WD=8.3 NEAR-IR

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- BBART-1
  Art library

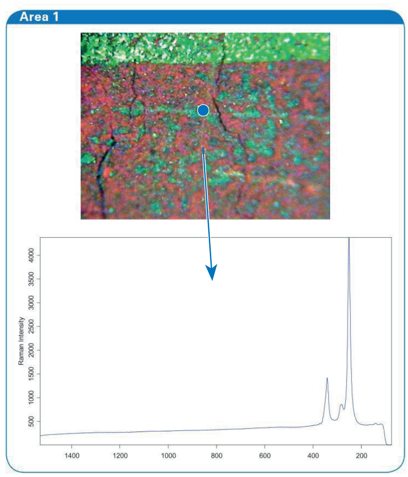
FT-Raman
- RFS27
  MultiRAM
- D418-T/R27
  Ge detector (liquid N2 cooled)
- R513-2000/R
  Nd:YAG LASER, diode pumped, P=2000mW
- F452
  Laser rejection filter
- R201
  extension to 50 cm^{-1} stoke shift
- R353/R
  Input port for E3
- R356-1/R-S
  Exit port for laser radiation x6
- R205-S
  Ramanscope III module

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II

In cultural heritage and art restoration, Raman spectroscopy is an already established technique and offers definite advantages over FT-IR spectroscopy. It is generally non-contact, non-invasive and non-contaminative and offers the capability of depth profiling.

However, depending on the samples, fluorescence can be issue. To minimize fluorescence, the use of long wavelength excitation in the near IR region (e.g. 785 nm) is a desirable solution. The SENTERRA however also offers an exclusive Bruker solution for utmost fluorescence mitigation: the use of FT-Raman. In combination with Bruker's FT-Raman line-up (MultiRAM or RAM II module), FT-Raman with 1064 nm excitation wavelength can be utilized on SENTERRA II. **By using FT-Raman, fluorescence is exceedingly well avoided.**

In particular, dyes can be very poor Raman scatterers that also exhibit particularly strong fluorescence. For these and similar materials, surface-enhanced Raman scattering (SERS) can help to improve the signal-to-noise ratio and thus enable the identification of a dye. Depending on the SERS material, users need to choose laser wavelength accordingly (typically 488 nm and 532 nm).



Please note, that in the field of art and archaeology, samples are often large pieces which will not fit on a conventional Raman microscope. The #1878832 gantry option provides extremely large space for samples, while the Raman microscope retains complete functionality and therefore is superior to make-shift solutions that use fiber probes or handheld Raman devices.

Additionally, a dedicated Raman spectral library for art materials is available, that allows identificatio of unknown paints, colors, pigments, etc.

This ancient nepalese mural was investigated with a Raman Probe. The SENTERRA II comes with multiple mobility options to accomodate bulky art & archeology samples, such as, a fiber probe, a gantry and a trolley.

Geology & Mineralogy

Raman spectroscopy is a promising complementary technique in geology and mineralogy. It is rapid, requires little or no sample preparation and is non-destructive. Raman spectroscopy is mainly used for distinguishing different minerals as the spectra change as a function of the chemical composition and the crystal structure.

Analysis of inclusions are useful to interpret the geological environment in which minerals are formed. By visualization and characterization of an inclusion's chemical and crystal structure, deep insights into geological processes can be gained. Raman's non-destructive nature is a real game-changer when liquid and gaseous inclusions are to be identified and characterized.

To broaden the scope of the SENTERRA II in this configuration, we recommend looking into the A565-S1 Diamond compression cell from S.T.Japan, as a tool for simulating the high-pressure environment of inclusions. The obtained data can be used to evaluate the residual pressure in inclusions.

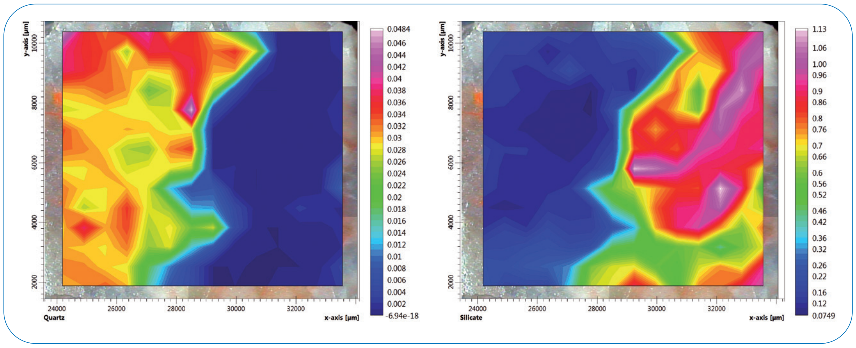
Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II
- A565-S1
  Diamond compression cell "S.T.Japan, EX'Press"



In geology and gemmology Raman is an amazing tool to characterize the composition of minerals, ores or precious stones.
In this case a mineral sample was examined for its composition and the respective contents highlighted in a Raman image (Quartz + Laumontite).

• Biology & Clinical Studies

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R208/S2
  Extension to 488nm excitation for SENTERRA II
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope
- R291-DB
  Automatic switch for Raman / white light selection
- R291-TU
  Transmission instrumentation for SENTERRA II or Ramanscope III
- R291-DU
  Darkfield instrumentation
- R291-DTU
  Darkfield instrumentation

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-A
  Adaptation of a bright field objective
- R297-50D
  Microscope Objective 50x, NA=0.75

Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package

Raman methods deliver extensive chemical and compositional information and are not disrupted by the presence water. It is precisely this advantage over FT-IR experiments that has led to the rapid growth of Raman (micro) spectroscopy in bio and life sciences.

As vibrational spectroscopy allows biochemical and structural information to be obtained without chemical labeling, it doesn't need tedious sample preparation. Additionally, using a confocal microscope provides the capability of revealing chemical distribution in three dimensions with diffraction-limited spatial resolution. Therefore, the SENTERRA II is a promising tool for cell imaging, tissue imaging, cancer diagnostic, etc.

Let us take an obvious example. As you know, there are thousands of chemicals in a single cell, and naturally most of them contribute to the Raman spectra of said cell. As a result, cells are often studied by statistical methods that need a carefully calibrated device as well as additional measures to avoid any kind of systematic error influencing the statistic results. Traditionally, this can result in many limitations regarding the experimental procedure and a lot of repetitive reference measurements.

Luckily, our SureCal™ technique provides a Raman instrument that always produces precise and reliable data and makes the experimental procedures much simpler.

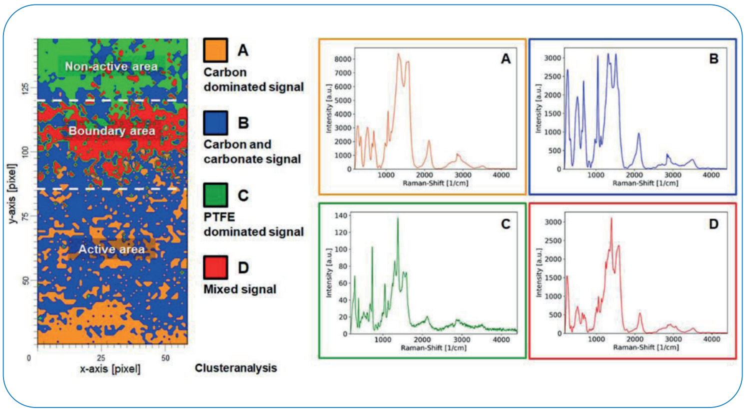
This configuration includes an additional 488nm laser, which is often used for resonance Raman sensing and SERS on bio-molecules. Furthermore, darkfield illumination is configured, as it is often required for cell samples. The inverted Raman microscope is often favorable in handling tissue and cells in aqueous environment. SENTERRA II can also be configured with an inverted microscope on request, without compromising any functionality.

Catalyst Studies

Analyzing Catalysts under reaction conditions is vital to assess a catalysts stability and performance, and Raman spectroscopy is one of the most promising techniques to study reaction mechanisms.

The unique advantages of Raman spectroscopy allow in situ Analysis at high temperatures (1000°C) or in reactive, aqueous environments. With a broad selection of accessories provided by Bruker, users can customize temperature, humidity, pressure, and gaseous environment for in situ analysis.

The catalyst configuration recommendation features an upgrade for high spectral resolution to allow monitoring of minor change in Raman spectra, as well as # 1850527 Catalytic Reaction Cell and the corresponding software module for temperature control.



The works of Jovanovic et al used Raman to characterize the active area of a catalyst and determine its composition. [DOI:10.1149/1945-7111/ab8ce1]

Raman Spectroscopy

- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope

- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens

- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-20L
  Microscope Objective 20x, NA=0.40
- R297-50L
  Microscope Objective 50x, NA=0.50

Software/PC

- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/PRO
  Protein Dynamics, software

Accessories

- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II
- 1850527
  Catalytic Reaction Cell CCR 1000 (Linkam)
- 1884492
  ADAPTATION SET CCR 1000 TO SENTERRA II

Microplastics & Nanoplastics

Raman Spectroscopy
- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer

Microscope
- R291-DB
  Automatic switch for Raman / white light selection

Objective Lens
- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3

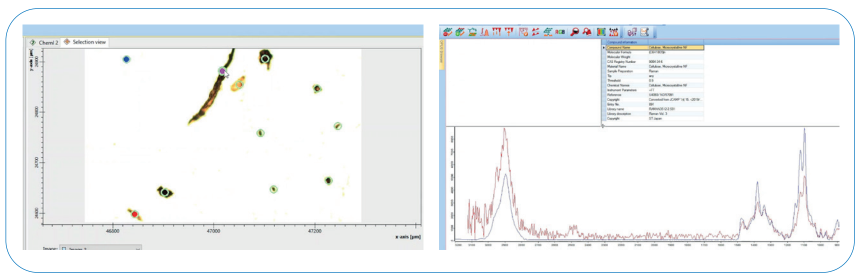
Software/PC
- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/OBJ
  OPUS/OBJECT Software package
- O/SR-N
  OPUS/SEARCH, Software Package for comprehensive search
- RI
  BRUKER/MERCK FT-Raman Library
- R-KIMW+
  Bruker Raman Polymers, Plastics and Additives Library
- 1846133
  Raman library of polymers and Processing Chemicals

Accessories
- A155-R
  Miniature Sample Holder (S.T.Japan)
- S106/S2
  Accessory kit for SENTERRA II

Microplastics analysis is currently a hot research topic. In environmental research, microplastics in sea water, rivers, and from air can be collected for monitoring. The plastic particles in drinking water is of interest for the food industry, as a study found tiny pieces of plastic in more than 90% of samples from the world's most popular bottled water brands.

For this research, IR microscopy should be the first choice as IR is capable to measure any kind of polymeric material, whereas Raman is more limited by fluorescence. The Raman microscope SENTERRA II, however, allows particle analysis in a smaller dimension scale. Therefore, it is a good complimentary method when a high spatial resolution is required. Furthermore, SENTERRA II shares the same OPUS software and data format with other Bruker FT-IR and Raman devices.

The microplastic configuration includes an upgrade of darkfield illumination and corresponding objective lenses. The reason is that darkfield provides optimal visualization of the particles. It is not required when working on reflective substrates such as metal-coated filters.



In this example, the microplastic contamination of drinking water was analyzed by Bruker's MP-ID Particle Finder. It is an automated particle analysis that can help you reduce analysis time tremendously.

• Pharmaceuticals

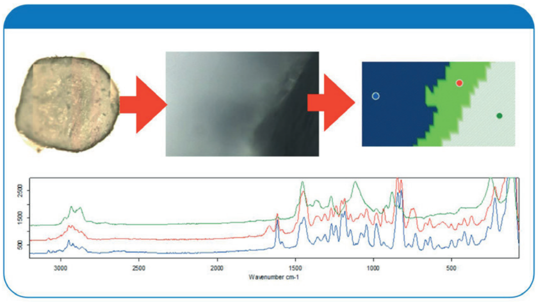
The Raman microscope SENTERRA II provides correlated spatial and chemical / physical information from a sample, therefore can be employed in various applications like API/excipients identification, distribution particle size analysis of APIs, foreign contaminant characterization, and monitoring of polymorphism.

The Pharma configuration recommendation includes a carefully selected setup of the three most used excitation lasers 532 nm, 633 nm, and 785 nm to provide Raman flexibility. As particle analysis is of particular interest to many Raman microscopy users in pharma, the software package O/OBJ is included to provide the necessary functionality. Furthermore, dedicated Raman databases of APIs and excipients are added to the configuration for identification tasks.

Since many Raman users in a regulated environment are interested in studies on polymorphism, the configuration includes an added extra spectral resolution level of 1.5 cm^{-1}. In combination with the temperature-regulated stage A699-TR and the software package O/PRO it is really easy to monitor changes in API crystallinity.

By allowing fast and non-destructive analysis, without complex sample preparation and costly consumables, Raman spectroscopy not only save the precious time and energy of the analysts, but also reduces the cost of the laboratory.

As key supplier to pharmaceutical industries Bruker offers profound experience in serving customers in regulated environments. The SENTERRA II is incorporates completely automated instrument test procedures and is fully compliant to GMP, cGMP, GLP and 21 CFR part 11.



This pharmaceutical pellet consists of an API and an outer functional coating. Raman analysis revealed the presence of an intermediate layer that originated in a side reaction that occured during production.

Raman Spectroscopy

- R200-L/S2
  SENTERRA II Raman Microscope Spectrometer
- R210-2U
  Upgrade of 532nm excitation from 20mW to 50mW
- R220/S2
  Extension to 633nm excitation for SENTERRA II, 20mW, polarized
- R300-1200/S2
  Upgrade for high spectral resolution

Microscope

- R291-DB
  Automatic switch for Raman / white light selection
- A697-S
  Adaption for mounting a microscope objective

Objective Lens

- R297-100A
  Microscope Objective 100x, NA=0.9
- R297-10
  Microscope Objective 10x, NA=0.3
- R297-20L
  Microscope Objective 20x, NA=0.40

Software/PC

- O/IR8+
  Spectroscopy Software Package
- CS81/29+
  Data System, High-Performance
- O/RIM/S2
  OPUS/RAMAN IMAGING, software package
- O/OBJ
  OPUS/OBJECT Software package
- O/PRO
  Protein Dynamics, software
- O/SR-N
  OPUS/SEARCH, Software Package for comprehensive search
- I26931
  Bruker Raman library of natural fibres
- 1865113
  Raman spectra database of APIs (active pharmaceutical ingredients)

Accessories

- A155-R
  Miniature Sample Holder (S.T.Japan)
- A699-TR
  Microscopic sample stage
- S106/S2
  Accessory kit for SENTERRA II

Validation

- O/VAL
  OPUS/VALIDATION
- S010/SYS
  System validation manual
- R995-PCO/S2
  Validation plate with integrated ASTM 1840

Bruker Optics is ISO 9001 and ISO 13485 certified.

Laser class 1 product.

Technologies used are protected by one or more of the following patents:
DE 102004025448; DE 19940981

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