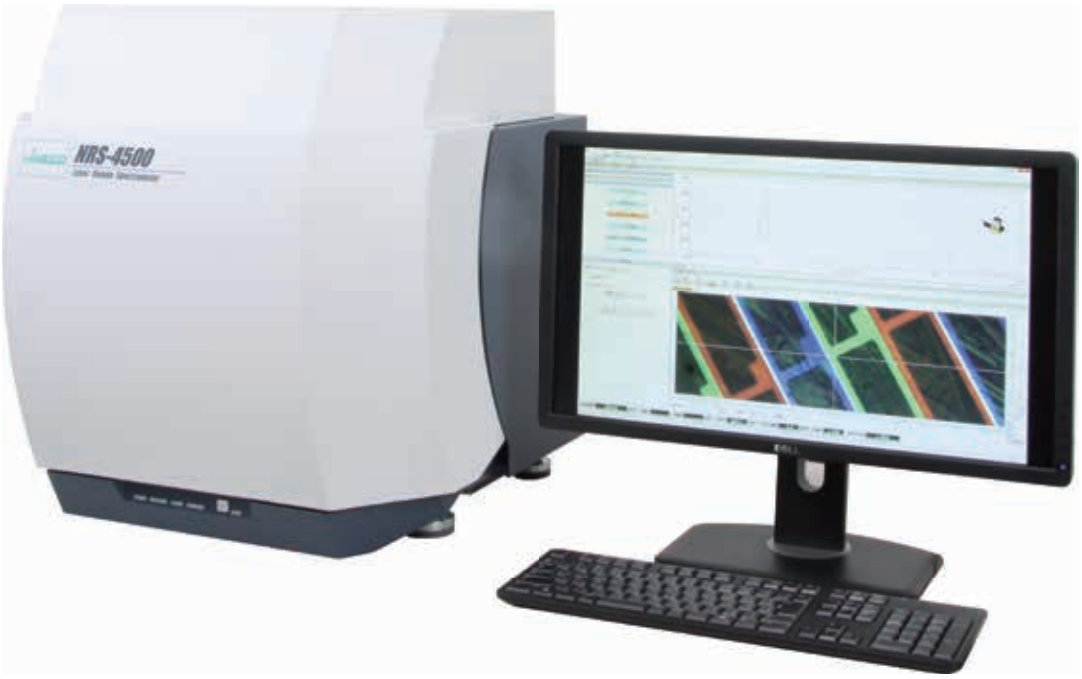
Raman Imaging & Spectroscopy

NRS-4500 Raman Spectrometers



JASCO

Performance
Innovation
Reliability


CAUTION
LASER
EMISSION
OUTLET

Dispersive Raman spectroscopy is quickly becoming the analytical technique of choice for a wide range of micro-analysis and the characterization of materials, offering greater spatial resolution and simpler sample preparation than FTIR Microscopy. JASCO developed the next generation NRS-4500, allowing researchers of all skill levels to harness the power of Raman with unparalleled speed and sensitivity.

With a variety of functions designed to automatically optimize the optical system, the user no longer faces the challenges of optical and measurement adjustment, and can focus on results. The NRS-4500 combines usability and high performance, expanding potential applications of Raman in fields from QA/QC to teaching and cutting-edge research.

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The NRS-4500 Dispersive Raman

The NRS-4500 brings together the critical elements necessary to make Raman spectroscopy accessible, not only to experienced spectroscopists, but also to first-time users.

Purpose-Designed Optical Bench with Laser Image Observation

The purpose-built micro-spectrometer is not built around a light microscope, this results in a completely rigid optical base to prevent flexing for more accurate alignment. The NRS-4500 includes direct observation of the laser spot to ensure the measurement is perfectly aligned to the target sample with an XY spatial resolution to as little as 1 µm (Z=1.5 µm). Moving the sample position and switching between observation and measurement modes is completely automated while the Class 1 laser safety cabinet remains closed.

Standard Configuration with 532/785 nm Lasers with Matching Edge Filters

The NRS-4500 starts with a standard configuration that includes 532/785 nm lasers with matching edge filters, with many selectable options for additional laser wavelength, with an optional third laser position. The laser wavelength is selected automatically together with the corresponding rejection filter. The optical system, including the laser and Raman path are automatically aligned for optimal throughput and resolution. Four software-selectable gratings with direct-drive rotary encoder offer a high resolution spectral range from 8000 to 50 cm^{-1}.

Addional Laser Choices, Including a New 457 nm Laser for Improved Fluorescence Reduction

The NRS-4500 has new and patented methods to reduce sample fluorescence. Included are options for a wide choice of laser wavelengths from 405 nm through 785 nm and 1064 nm. A recently added development is a 457 nm laser option that offers higher Raman signal, improved spatial resolution and much lower fluorescence for many different sample types compared to the conventional 532 nm 633 or 785 nm lasers. Selection of a different excitation laser wavelengths is only one of the ways the NRS-4500 minimizes fluorescence interference.

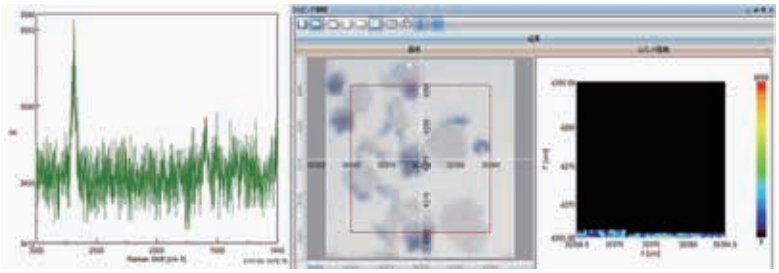
Patented Fluorescence Rejection Algorithm

The Fluorescence Rejection algorithm (patented) included with the Spectra Manager™ Suite of Raman analysis software can effectively minimize or eliminate fluorescence, regardless of the laser wavelength used. See page 13 for details.

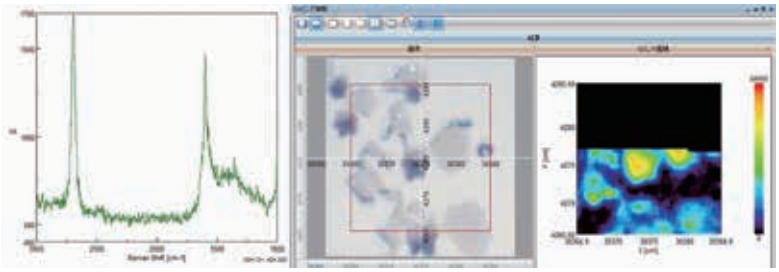
Quick Raman Imaging (QRI)

Conventional Imaging vs QRI
Sample: Graphene

Using the same measurement conditions, the imaging speed of QRI is 50 x faster than conventional mapping.



Conventional Imaging with CCD



QRI Imaging with EMCCD, high speed stage and digital filtration

QRI increases the data acquisition speed by up to 50x compared with a conventional mapping stage and also offers a significant improvement in sensitivity. QRI achieves this gain in speed and sensitivity with:

- A high-speed XYZ automated stage with 0.1 µm
- A high sensitivity electron-multiplied CCD (EMCCD) in place of the conventional CCD
- Enhanced post processing algorithms for faster data analysis including digital filtration and spectral averaging

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QRI System

The QRI system includes a fast stage, EMCCD and a high speed imaging program with digital filter and spectral averaging.

Detector Option: EMCCD Exposure as fast as 1 ms

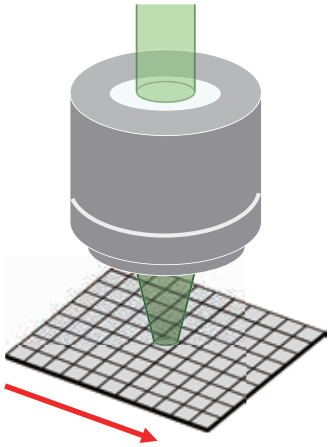
High Speed Stage

High Speed Imaging with QRI & Digital Filter

QRI

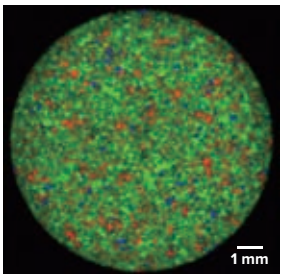
Imaging Large or Small Areas

QRI is flexible for measurement of large or small area samples at spatial resolution down to 1 µm. The high speed/high resolution stage, with 0.1 µm resolution step, provides extremely accurate measurement points at near the diffraction limit. The example of a large sample shown below is the component distribution analysis of a pharmaceutical tablet with 10 mm diameter. Using a 785 nm excitation 32,000 measurements were made in less than 16 minutes. Small samples can also be measured with excellent optical and spectral resolution. The example of a small sample is a bundle of titanium dioxide nanofibers with a total size of less than 5 µm, the shape of the fibers can be chemically imaged with fine detail.

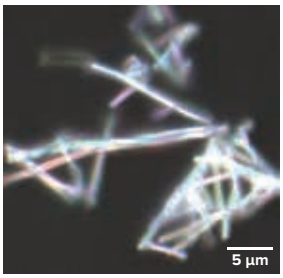


Large **Small**

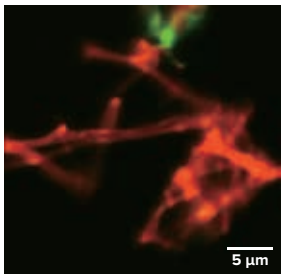
Pharmaceutical tablet



Red: Acetaminophen
Green: Ethenzamide
Blue: Caffeine

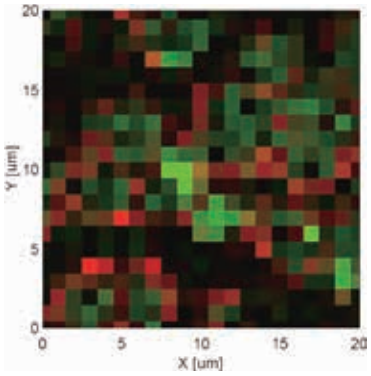


Titanium Dioxide Nanofibers

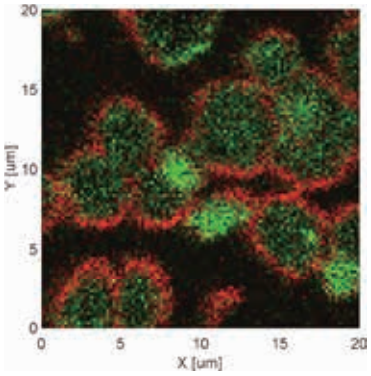


Red: Anatase
Green: Rutile

High Speed Imaging with Improved High Definition Using the QRI Auto-Stage with Five-Fold Decrease in Step Size



Previous Image
1 µm Step



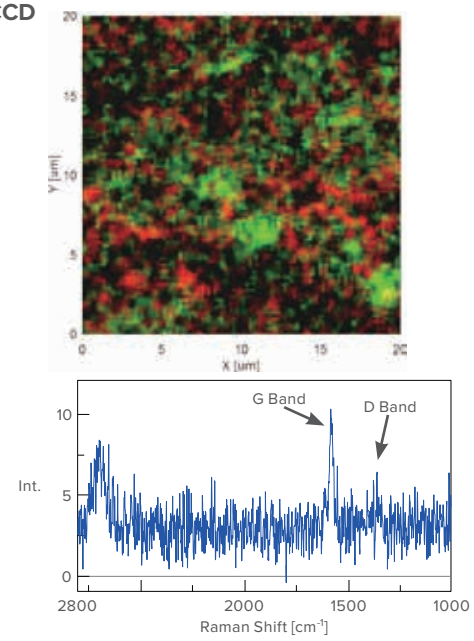
High Definition Image
0.2 µm Step

Digital Filter

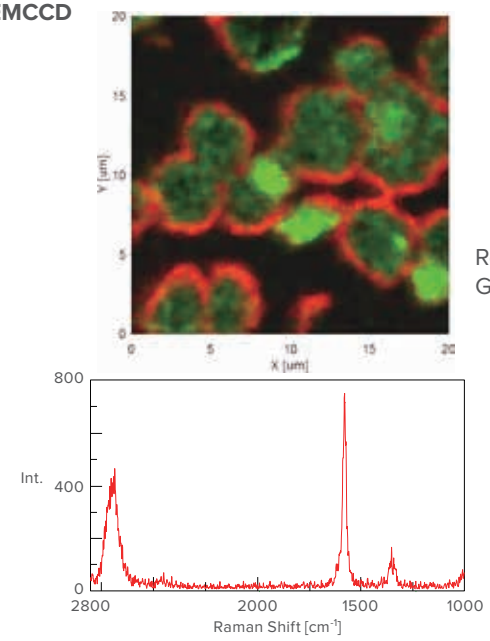
CCD vs EMCCD

Traditional CCD arrays offer a wide dynamic range but may lack sensitivity and speed especially when coupled with a high-speed imaging system. An electron multiplying CCD detector (EMCCD), not only increases sensitivity with the addition of signal amplification but also allows for up to 50x improvement in acquisition speeds. Depending on the application, an EMCCD can operate in both electron multiplication mode for enhanced sensitivity or in 'conventional' CCD mode for a broader dynamic range.

CCD



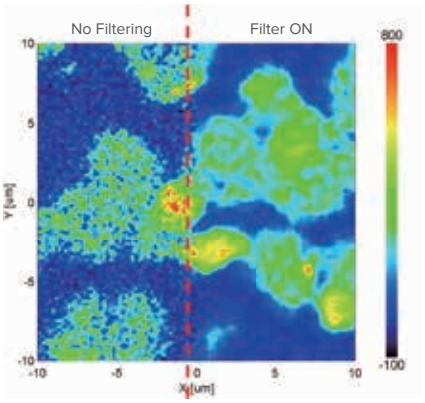
EMCCD



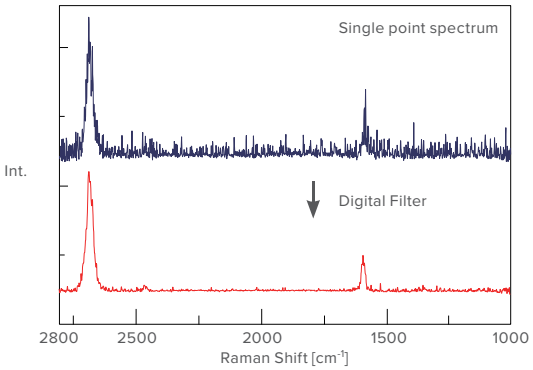
Red: D Band
Green: G Band

Enhanced Resolution with Digital Filter

Electronic digital filtering of the EMCCD response further improves the signal to noise by reducing the overall background noise levels. The fast imaging NRS-4500QRI Raman system includes 1.) A high speed high accuracy auto stage, 2.) An EMCCD detector and 3.) Electronic digital data filtration.



Intensity of 2750 cm^{-1} Raman shift

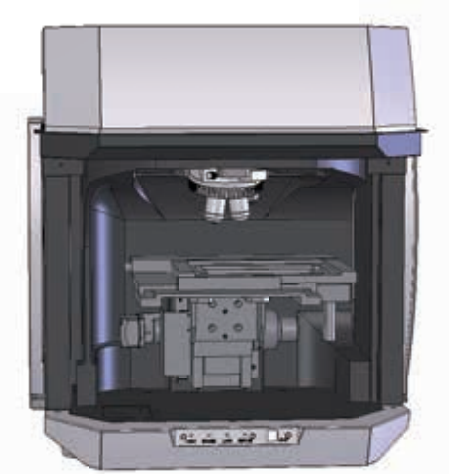


Flexible Stages and Sampling Options

Flexible Sample Compartment

The standard stage can be used for many types of measurements; however, for truly versatile measurements the standard sample stage may not offer a large enough working distance.

The automated XYZ mapping stage, with option of a longer travel sample stage (80 mm working distance) to accommodate a variety of sample heating /cooling stages, environmental chambers or gas cells.

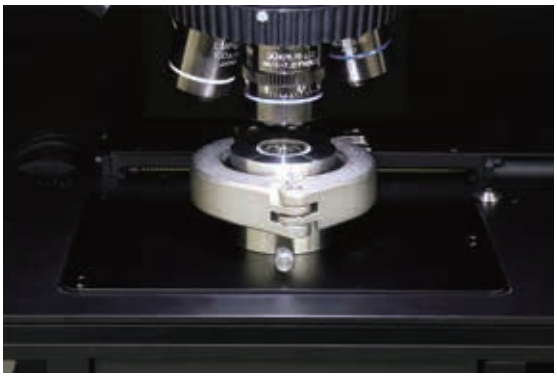


80 mm stage for larger samples and to accommodate an optional heated stage such as the Linkam cooling/heating stage.

Flexible Sampling Options

The NRS-4500 includes a wide choice of objective lenses for both micro and macro measurements. Optional long working distance objectives can be used with samples that are difficult to get close to, such as heating/cooling stages and other large sampling accessories.

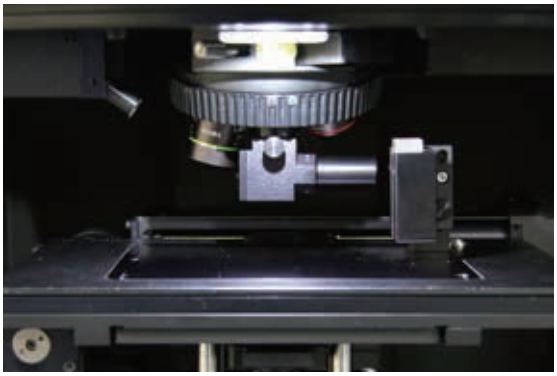
With options for macro sampling and fiber-probe measurements, the NRS-4500 has everything needed for virtually any type of Raman experiment.



Environmental Control Stage

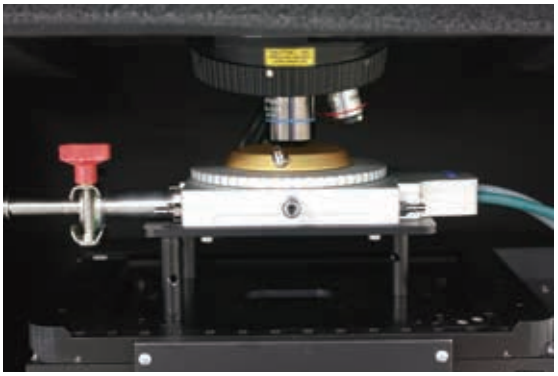
Macro Measurement Objective

The Macro Measurement Objective can be fitted to the objective carousel for measurement of powders, liquids and solids mounted in a special sample holder.



Macro Measurement Objective

Temperature Control & Imaging Analysis



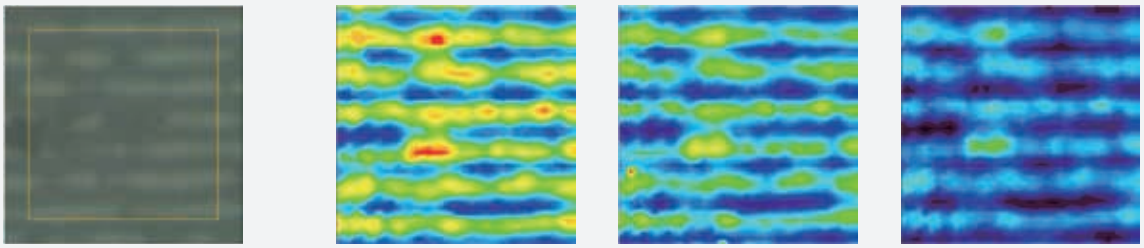
Heating/Cooling Stage

Heating/Cooling Stage

There are several optional temperature controlled stages for measurements in the range -196°C and up to 1500°C. Options are available for environmental control of vacuum, purge an d humidity. These optional stages often require the larger stage height offered by the 80 mm stage and long working distance objectives. Temperature control is made using the thermal measurement programs in Spectra Manager™.

Laminated Ceramic Capacitor

Example: Mapping analysis of the effects of temperature on the surface of a high performance ceramic capacitor using a high temperature heating stage.

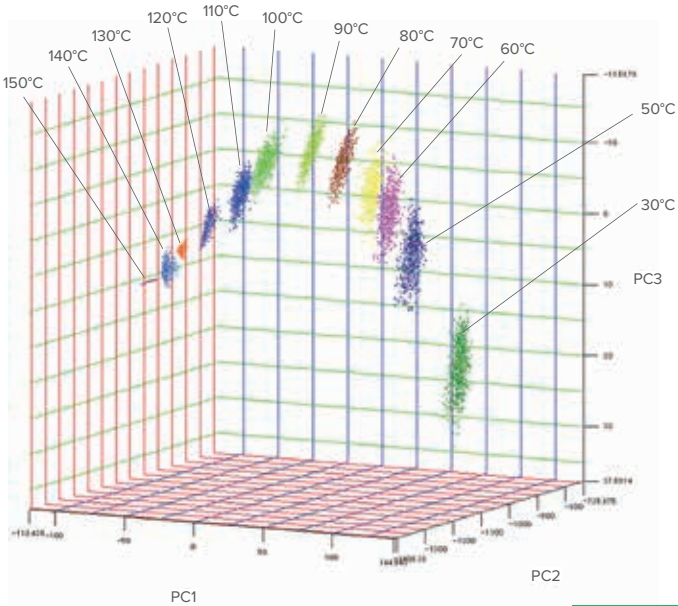


Objective View 50 x at room temperature | 30°C | 100°C | 150°C

Result of PCA Analysis

SpectraManager™Suitespectroscopymeasurement and analysis software not only provides user-guided spectral acquisition but also powerful 3D spectral analysis with integrated chemometric data analysis (PLS, PCA, MCR, etc.) for fast post-acquisition processing and data imaging.

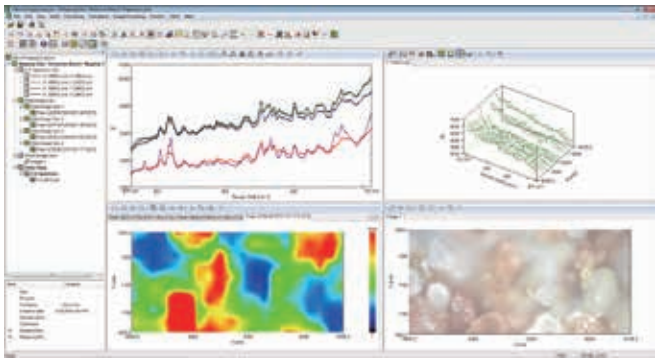
The data to the right represents a 3D display of the chemical changes in a ceramic capacitor as a function of temperature over a defined time interval.



Spectra Manager™ Software Suite

Instrument Control

Drivers are available to control every JASCO spectroscopy instrument, including FTIR, Raman, UV-Vis, Fluorescence, VCD, etc. Parameter dialogs allow easy editing of pre-saved parameter files. Data acquired from each instrument is automatically loaded into the analysis program, in order to free up the PC, and control software to acquire more data. Each instrument driver also has a module to allow for instrument hardware diagnostics and validation.

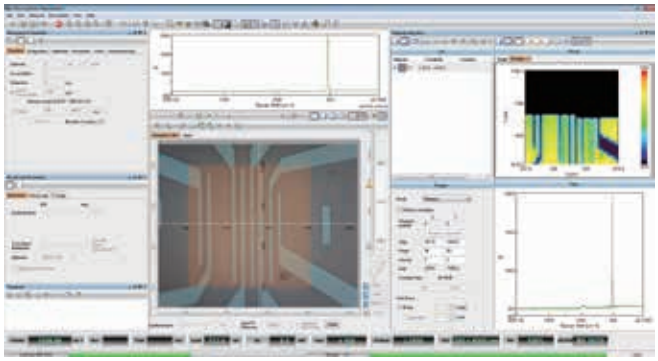


Flexible Display Features

User-friendly features include overlay printing in colors and patterns, autoscale mode, full control of style and font, plus customized toolbars.

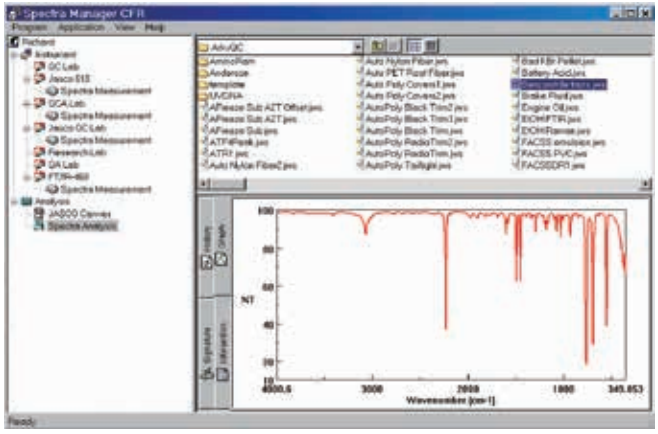
Data Processing and Spectral Analysis

View and process several types of measurement data files (UV/Vis/NIR, FTIR, Fluorescence, etc.) in a single window, using a full range of data processing functions. Features include arithmetic operations, derivatives, peak detection and processing, smoothing (several methods) and baseline correction. 2D Correlation analysis package allows for analysis and viewing of synchronous and asynchronous data plots between spectral techniques, such as IR and Raman.



Report Publishing

JASCO canvas allows the user to produce hard-copy layouts of data to meet individual reporting requirements.



A SINGLE PLATFORM FOR EVERY INSTRUMENT.

JASCO is the only manufacturer to develop a powerful, cross-platform 64-bit compatible Windows software package for controlling our complete spectroscopic portfolio of instrumentation. Spectra Manager™ is a comprehensive lab companion for capturing and processing data, eliminating the need to learn multiple software programs and allowing data from more than one instrument to be displayed together on the same platform.

Spectra Manager™ Spectroscopy Data Analysis

Powerful UserAssist Control for Experienced Spectroscopists and New Users Alike

UserAssist guides the user through setting up the NRS-4500 for a sample measurement. A simple sequence takes you through setup and optimization of measurement parameters with helpful advice and tips, such as a warning if the laser intensity is set too high. When each of the parameters have been set, the NRS-4500 automatically selects the laser, matching rejection filter and the grating for the appropriate resolution. It then focuses the sample and spectral measurement is performed.

Real-time UserAssist

Guided setup and sample measurement

Choose the sample area to be measured

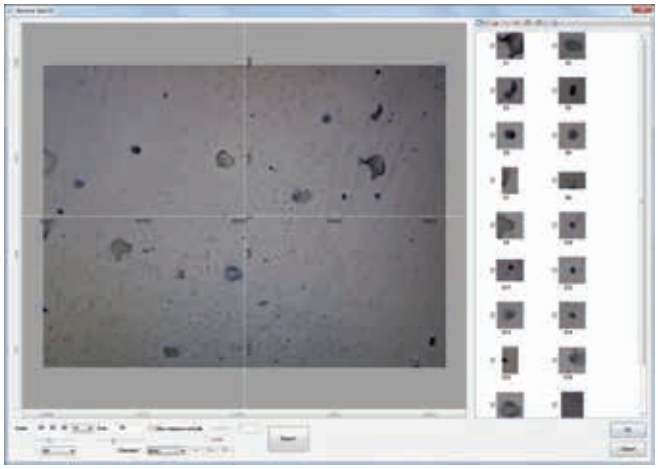
Select the laser and filter

Slider bar to set laser attentuation

Set the grating and wavelength range

EXECUTE

Guided analysis walking the user through every step from focusing on the sample, optimizing the method parameters based on sample type, through reporting the data.



Sample Search Function

The new Sample Search function is used with the automated XYZ stage. A newly developed algorithm is used to analyze the microscopic image and automatically select measurement positions based on the size, contrast and/or color of the target material selected by the user. Simply click the Measurement button to execute spectral measurements of all automatically identified sample positions.

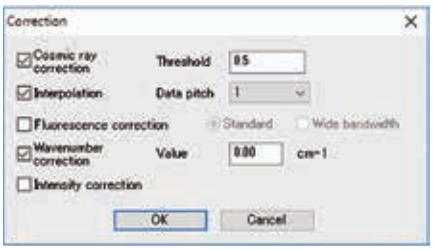
Real-Time Data Processing Functions

Spectra Manager™ includes a wealth of user-selectable options for data analysis, in addition to more standard functions: opening single or multiple spectra, zooming, normalization and a range of arithmetic data processing functions. There are a variety of Raman-specific tools and analyses that can be applied during and post Raman spectrum collection — via a post-collection processing alogrithm or independently, using the Micro Spectra Analysis software.

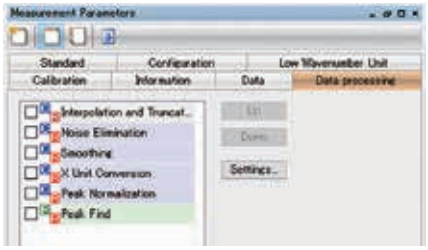
Useful Corrections for Raman Spectroscopy

There are a number of different spectral processing functions available for Raman spectra, some of which are required to eliminate interference that may obscure the Raman response. Other parameters can be used to enhance the Raman spectra, providing data for further calculation. The most common correction functions are listed below:

- Cosmic Ray, Fluorescence, Wavenumber and Intensity Calibrations
- Smoothing and Peak find
- Automated operations for routine use
- Expanded photoluminesence measurement



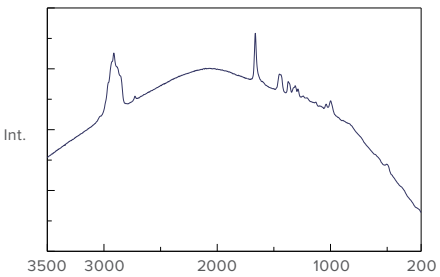
Selection of correction options



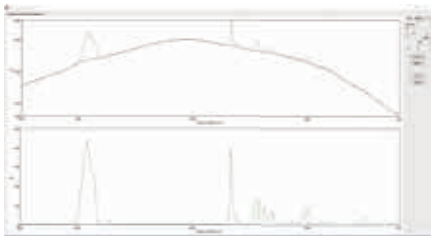
Automated data processing options

Fluorescence Rejection

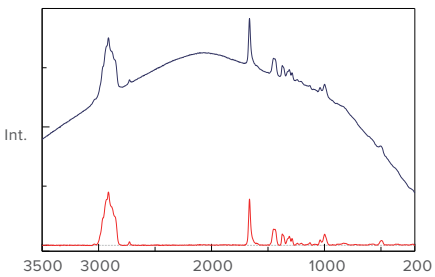
The NRS-4500 employs two physical methods for reducing fluorescence: a confocal aperture size to exclude measurement of the matrix surrounding the sample, and selecting a different excitation wavelength. An additional method used is the fluorescence rejection algorithm (patented), which can be seen below is highly effective at removing fluorescence either during or post data collection.



Acquired spectrum

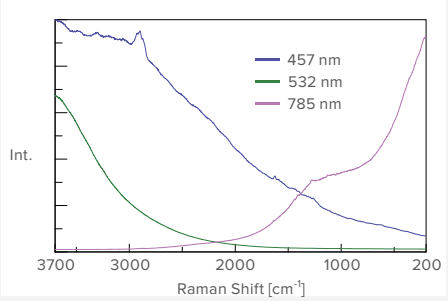


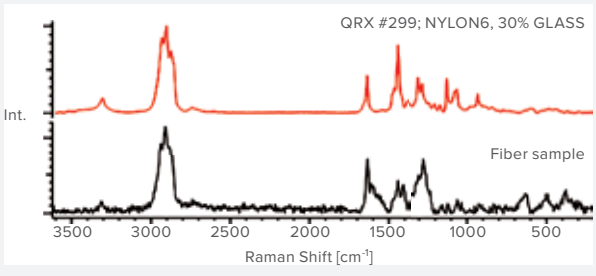
Applying fluorescence rejection using simple parameters



Corrected spectrum (red trace)

Above: Overlay showing data before and after fluorescence rejection. The background is completely eliminated without loss of data integrity or change in signal-to-noise ratio.



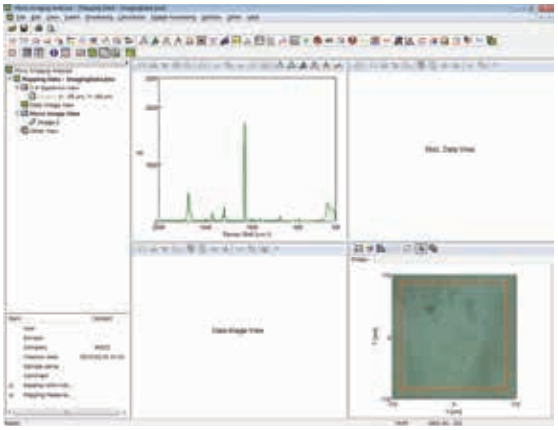


Improved Raman intensity results in better sample identfication.

Spectra Manager™ Spectroscopy Imaging Analysis

Chemical Image Identification and Functional Group Registry

To provide faster Raman image processing, the Imaging Analysis software includes a registry of functional groups or other relevant compound information based on peak height, area, or ratio calculations. After a peak calculation has been developed, it can be saved to the Component Registry for use in future analyses. The registry includes the peak calculation information and a description of the relevant vibrational motion. Registered functional groups can be monitored in real time to evaluate and image the map of a sample area.



Characterize peaks of interest

↓

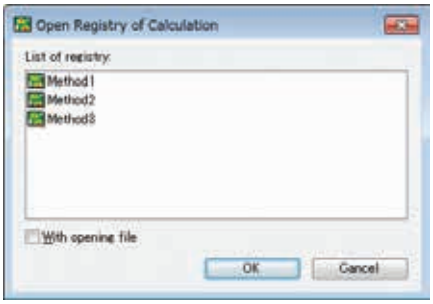
Assign names or functional groups

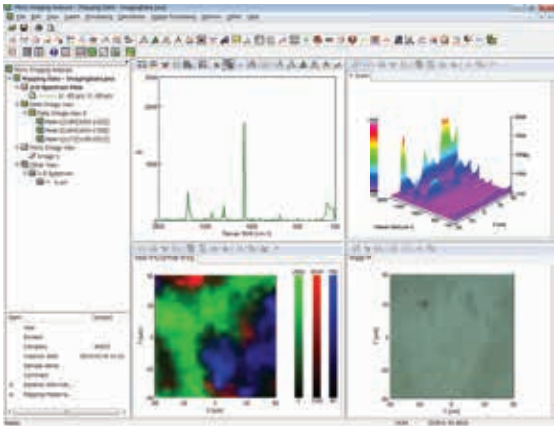
↓

Save components to a method in the registry

↓

Select components from the registry to provide color image of chemical functional group location

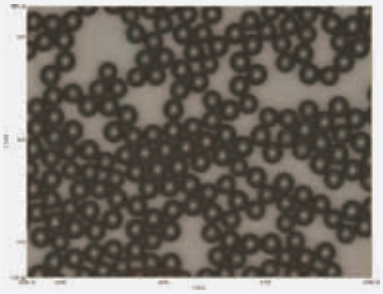




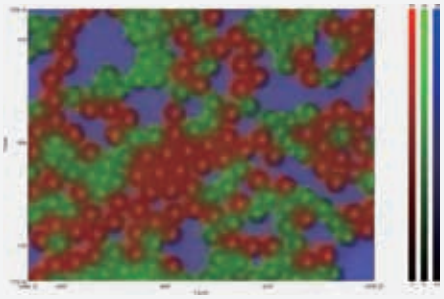
Creative Color Mapping

The large amount of spectral data obtained by Raman mapping/imaging operations can be overwhelming. Color image maps provide a simplified “picture” of the spectral data, based on the Raman peak intensity for selected functional groups. Image maps are developed from the mapping data by simply clicking on a specified registered calculation, based on the peak height/peak height ratio or the peak area/peak area ratio of selected Raman peaks. Up to 10 functional groups or molecular vibrations can be selected simultaneously to create descriptive image patterns of the sample being analyzed.

Imaging Measurement Result of Mixture Sample (Polystyrene and PMMA)



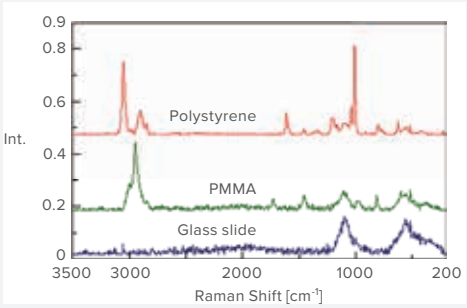
Observation view (using 20x objectives)



Overlay view of observation image and component distribution image
(Red: Polystyrene, Green: PMMA, Blue: Glass slide)

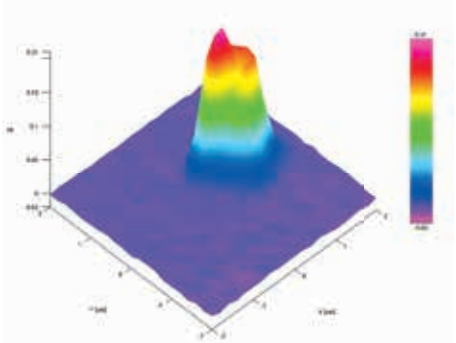
Objective: 20x objective lens
Imaging Area: 150x130 µm

Three main component spectra can be extracted by MCR analysis, and relative concentration distribution view can be created.

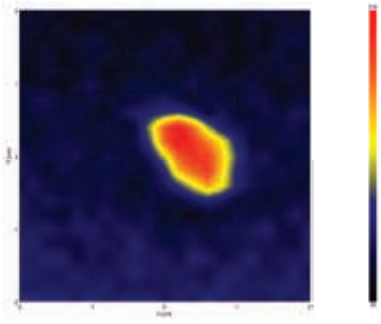


Color Data Display

There are numerous methods for display of the calculated image maps, including contour, false-color images, line images and 3D image maps. All of the displayed images can provide fine detail based on the high-resolution imaging function of the NRS-4500 Raman spectrometer.



3D color map of a 4 µm x 4 µm sample with excellent spatial resolution



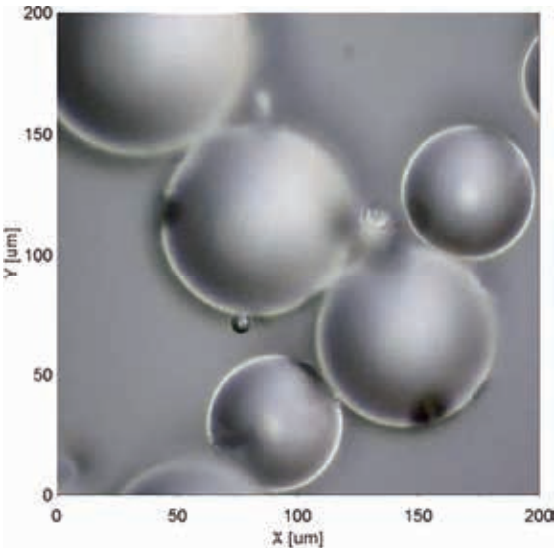
2D contour map of the same data showing the spatial resolution down to about 1 µm

Spectral Averaging & Observation

Poly Methyl Methacrylate (PMMA)

Objective View

Below is an example application of the measurement of PMMA with the standard CCD.

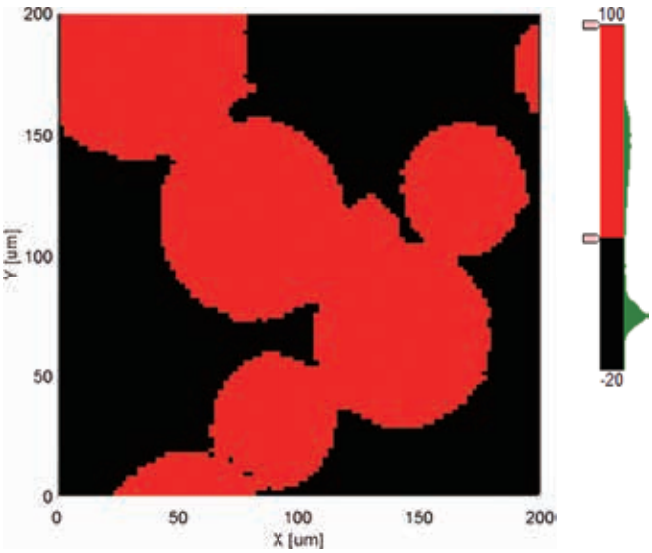


NRS-4500

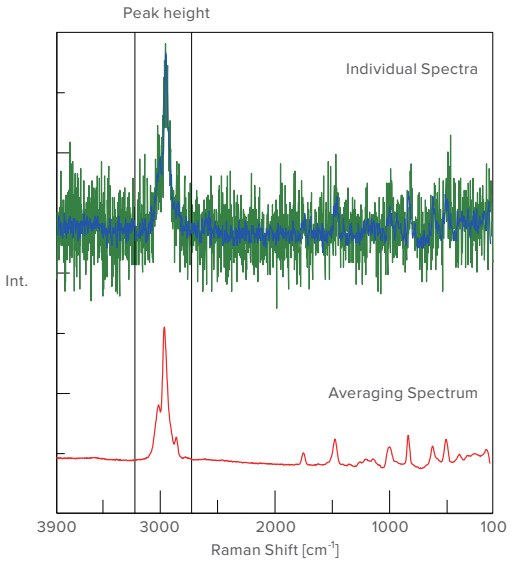
532 nm Laser 20 mW
900 gr/mm
BS
Objective x 20
Std Detector iVac DR 324
Area: 200 µm x 200 µm
Imaging Step: 2 µm
Exposure: 1 ms

Averaging Spectra

Spectral averaging improves the signal-to-noise by reducing noise levels as shown in the spectra below.



Peak height of 3000 cm^{-1} Raman shift showing a chemical distribution

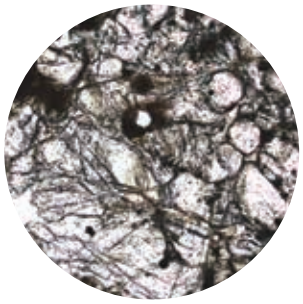


High Resolution Observation

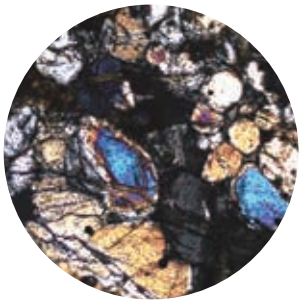
Polarized Light Microscopy and Differential Interference Contrast (DIC) Microscopy

Polarized Light Observation

Polarized Light Observation (PLO) exploits the differences in anisotropic properties to enhance the observation of materials with low contrast. PLO uses two polarized elements located in the optical path on each side of the sample being observed. It is particularly useful for samples such as biomolecules and biostructures, minerals, ceramics, mineral fibers, extended polymers, liquid crystals, etc.



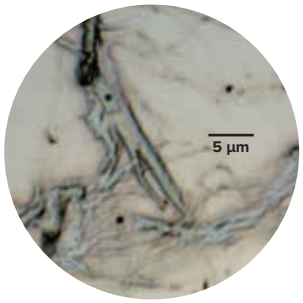
Parallel Polarizers



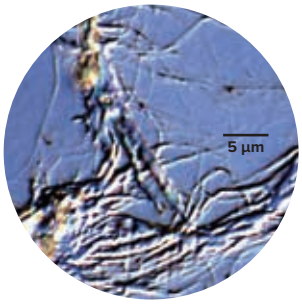
Crossed Polarizers

Differential Interference Contrast Observation

Differential interference observation (DIC) uses polarized light and a Nomarski-modified Wollaston prism to enhance the observation of images with low contrast. DIC uses phase difference of light to stereographically view very small step differences in the submicron order of a sample. Nomarski prisms are used to create bright and dark contrast from the differences in the two beams directly reflected at the sample's surface. This technique can be applied equally to low contrast biological and non-biological samples which have small unevenness in the surface.



Bright Field Microscopy

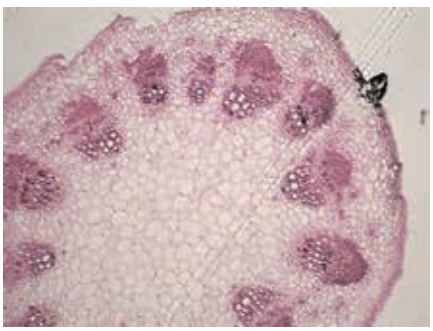


DIC Microscopy

High Resolution Observation and Improvements in Illumination

These images of a plant cell cross section show the improvements in illumination obtained with a new type of source used in the NRS-4500.

Previous Illumination of NRS-4100



Improved Illumination of NRS-4500

Sample: Cross section of a plant cell

System Configurations

The NRS-4500 is a flexible, fully configurable optical system. The system can be configured to any required specification, including laser and matching edge rejection filters, matching grating(s), optimal CCDs and a range of stage options. The following are several dedicated systems designed for a variety of commonly used QC and research applications:

Item	Description
Laser	532, 785 nm
Grating	Addition of 2400 (1800, 1200 gr/mm)
Includes	Carbon analysis program Auto-stage
Target Use	Carbon materials manufacture, graphene research, nanotubes, etc.

Carbon Analysis System

Features:

- Addition of 2400 gr/mm gratings which can measure G and D band at one time with high resolution.
- Also possible to add 1800 (1200) gr/mm gratings for measuring G and 2D band (such as Graphene)
- Assist function for carbon analysis
- Versatile analysis and measurement with highest resolution

Macro Measurement System

Features:

- Macro measurement mounting unit. (There are no obstacles for the samples when rotating the objective carousel)
- When working with larger samples, it is possible to adjust the length of the stand for the stage (option) to provide improved clearance

Item	Description
Laser	532, 785 nm
Includes	Macro measurement unit
Target Use	Analysis of foreign material, measurement of liquid samples, chemical manufacture, R&D (for routine measurement of liquids, consider the RMP-500)

Item	Description
Laser	457, 532, 785 nm
Includes	Auto-stage, automated objective carousel, optional Sadtler databases
Target Use	Analysis division, QC department, technology center, etc.

Impurity Analysis System

Features:

- Multiple lasers to avoid fluorescence interference
- Auto-stage and objective carousel for preventing contamination
- 457 nm laser suited for measuring biological samples
- KnowItAll® Informatics with 1,300-compound Raman spectra library

Academic/Teaching System

Features:

- Typical 532/785 nm laser combination
- Multiple gratings
- Manual stage
- Standard Spectra Manager™ software with UserAssist and Sample Search
- Fully automated setup and alignment

Item	Description
Laser	532, 785 nm
Gratings	400, 900 gr/mm
Includes	Auto-stage, additional objectives
Target Use	University or college

Item	Description
Laser	457, 532, 785 nm
Additional lens	Macro measurement unit 20x long working distance objective
Includes	Auto-stage, heated stage, E-grade edge filters, thermal control measurement; CFR if available
Target Use	Reaction studies

Pharmaceutical Research and Development

Features:

- Multiple lasers to avoid fluorescence interference
- Macro measurement unit for measuring liquid samples or sediments in drug solution
- Contactless analysis through glass bottles by using a 20x long working distance objective
- Thermal change measurements using Linkam accessories
- Imaging analysis of tablet samples with multivariate analysis
- Analysis of crystal polymorphism using E-grade edge filters

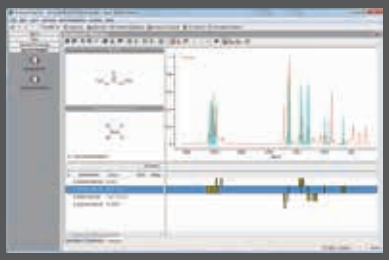
KnowItAll® JASCO Edition Spectral Search

Sadtler's KnowItAll® Informatics System JASCO Edition is included with NRS-4500 Raman Imaging instruments. This comprehensive data search database and analysis software includes the following features:

- Search by field including, spectra, peaks, property/name, structure (SearchIt™)
- Identify components in a mixture (Mixture Analysis™)
- Interpret bands in an infrared spectrum (AnalyzeIt™)
- Draw chemical structures (DrawIt™)
- Unrestricted lifetime access to the Sadtler data library including 650 Raman spectra
- Search JASCO's own data library including 650 Raman spectra of organic and inorganic compounds
- Free access to Sadtler databases, including 15,000 Raman spectra (HaveItAll®), for 90 days after software activation
- Build searchable databases that include physical properties, meta-data and more (Database Building Option, included as standard)

SearchIt™

Search against reference databases as well as your own imported spectra. Searches are customizable and driven by powerful algorithms. Searchable fields include name, structure, substructure, properties, and analytical data, such as spectra and peaks.



AnalyzeIt™

Interpret the bands in an infrared spectrum. Simply load a spectrum and click on a peak of interest to generate a list of possible functional groups at that position. AnalyzeIt features over 200 functional groups and hundreds of interpretation frequencies.

Mixture Analysis™

Determine the components in a mixture. Just transfer the spectrum to be analyzed, the software searches and compares the samples to reference databases of known compounds and predicts the possible mixture of components.

Instrument Validation Program

The NRS-4500 has an instrument performance validation program included with the Spectra Manager™ software suite. The validation program is used to verify instrument performance to meet regulatory requirements based on industry standards. The test procedures included in this program are compliant with USP and EP protocols.

Optional Software Programs

Spectra Manager™ includes a wide range of additional software applications; some examples of more commonly used applications are shown here. For details of additional applications, please contact us.

Carbon Analysis

The physical properties of carbon are closely related to its structure. Raman spectroscopy is a powerful technique for the evaluation of carbon based materials. Compared with the X-ray diffraction, dispersive Raman is not only sensitive to structural changes but also allows for the evaluation of amorphous materials, such as crystals. Normally, a Raman spectrum of a carbon material will have peaks at Raman shifts of 1580 cm^{-1} and 1360 cm^{-1}. The ratio of the intensity of these two peaks ($R=I_{1360}/I_{1580}$) is used as an index indicative of the degree of crystallization. The Carbon Analysis Program is used to estimate the carbon structure after the spectrum has been pretreated with the Curve Fitting Program.

Interval Measurement & Analysis

The interval scanning program is used to acquire spectral data during a time course measurement. This program is commonly used for long-term observation of spectral changes during reactions. Both full spectrum and changes in intensity changes at a specified wavenumber can also be monitored. The spectral data can be displayed in 2D or 3D plot. Time course data based on peak height, peak area or peak shift at a specified wavenumber can be calculated. A variant of this application, ***Temperature Control Interval Measurement*** can be used to measure Raman spectra in time intervals as a function of temperature together with Linkam Heating/Cooling Stages. This program is typically used for kinetic measurements of samples such as chemical reactions, polymer curing, and acceleration testing with increased temperature.

Two-Dimensional Correlation Analysis

The 2D correlation analysis program performs a time domain Fourier transform of time-resolved spectra, for example from interval scan measurements, then plots of the correlation intensities of the real (*synchronous correction*) and imaginary (*asynchronous correction*) portions are generated as contour heat maps. Analyzing the correlation spectra of each plot provides an estimation of the chemical and/or structural changes in a sample. By combining these results with other types of spectral analysis, including Near-IR, Raman, UV-visible or Circular Dichroism, 2D correlation can provide an analysis of peak assignments, lattice vibrations or the relationship between intramolecular vibrations, color or chiral information.

Polysilicon Crystallinity Evaluation

The Polysilicon Crystallinity Evaluation program calculates the Volume fraction, Vf, for a Raman spectrum based on:

$$Vf = \frac{(I_{510}+I_{520})}{(I_{480}+I_{510}+I_{520})}$$

after the spectrum has been pretreated with the Curve Fitting application. The calculation can be applied to single spectra, mapping data and interval measurement (time series) data.

Stress Analysis

This program calculates the amount of stress in a sample based on the difference between the peak wavenumber of a reference and of the sample. When lattice spacing between atoms changes due to internal stress, the peak position changes. If a force is applied to a substance producing strain in the crystal, the distance between the lattice changes. This phenomenon is observed in a Raman spectrum with a shift of the Raman peak. For example, using a silicon crystal, a peak shift of 1 cm^{-1} corresponds to an applied pressure of 2.49 x 10^2 MPa. When measuring the stress of silicon using the 532 nm laser, a slight change in peak position can be accurately detected by measuring the emission line of Neon (wavelength of 540.056nm; absolute wavenumber at 18516.6 cm^{-1}) that appears at 277 cm^{-1} simultaneously with the measurement of the sample's Raman spectrum. Reference data for calculating the stress value of an evaluation sample can be selected from arbitrary coordinate data in the same file or data collected using the mapping function.

Chemometrics Packages

Multivariate analysis is widely used for multicomponent mixtures. Various types of multivariate analysis algorithms are available such as CLS, PCR and PLS. These are typically recommended for the quantitation of analytes in complex matrices, while PCA and MCR are suitable for classification of multicomponent samples. The chemometric techniques can be applied to single point spectra, mapping data files, as well as time interval measurement data.

Additional Raman Instruments

The NRS series of confocal Raman microspectrometers includes three different optical configurations; the simple yet powerful NRS-4500, with a range of laser wavelengths, the sophisticated NRS-5000 series, with 300mm spectrograph, offering higher spectral and spatial resolution and the NRS-7000 series with 500mm spectrograph and poly-dispersive options. All include Class 1 laser safety and share the same comprehensive Spectra Manager™ Suite of measurement and imaging software.

NRS-5000 Series | Raman Microspectrometer

- Exceptional wavenumber accuracy with a high-precision rotary-encoder direct drive mechanism
- Automated X-Y-Z with joystick and mouse/keyboard control
- Spectra Manager™ Suite for measurement and confocal imaging
- Low wavenumber measurement, close to the Rayleigh scatter
- Auto-alignment of microscope laser introduction optics and Raman scattering light path
- Wavenumber calibration using an internal Ne lamp
- Unique Dual Spatial Filter (DSF) providing higher spatial resolution than conventional confocal optics, especially in the Z axis
- Patented Spatial Resolution Image (SRI) function for simultaneous observation of sample image, laser spot and aperture image

NRS-7000 Series | Raman Microspectrometer

- Research-grade model assuring high spectral quality
- Exceptional wavenumber accuracy with a high-precision rotary-encoder direct drive mechanism
- Low wavenumber measurement
- Auto-alignment of microscope laser introduction optics and Raman scattering light path
- Wavenumber calibration using an integrated Ne lamp
- Unique Dual Spatial Filter (DSF) for higher spatial resolution than conventional confocal optics
- Patented Spatial Resolution Image (SRI) function for simultaneous observation of sample image, laser spot and aperture image
- Full range of options including macro-Raman measurement unit and fiber-optic probes

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RMP-500 | Versatile Raman

The RMP-510 is a 'field-rugged' high resolution probe Raman spectrometer with a robust optical design and tolerance to being transported. The spectral performance is close to that of a conventional bench-top Raman system and offers many of the same features, such as interchangeable gratings for selecting wave number range and spectral resolution.

Spectra Manager™ Suite simplifies data collection and analysis. Sadtler KnowItAll® Informatics is included for library searching and creation of sample databases.

Specifications

Model	NRS-4500
Monochromator	
Monochromator	Aberration-corrected, Czerny-Turner mount single monochromator, f = 200 mm
Wavenumber Scanning Mechanism	High-accuracy direct-drive type (with rotary encoder) / Wavenumber repeatability: ± 0.2 cm^{-1}
Wavenumber Range	8000 to 100 cm^{-1} (standard) / 8000 to 50 cm^{-1} (option, requires 532 nm E-grade edge filter)
Resolution	2 cm^{-1} /pixel 0.7 cm^{-1}/pixel (option, 100 to 1350 cm^{-1}, 532 nm, 2400 gr/mm grating, 1650 pixel CCD)
Grating	Standard: 900 gr/mm Selectable from 2400, 1800, 1200, 830, 600, 400, 300 and 150 gr/mm (Max. 4 gratings can be mounted simultaneously)
Optical Alignment	Auto-alignment (laser light) / Raman light path auto-alignment function Automatic switching of imaging lens for optimized spectrograph illumination
Rejection Filter Switching	Automatic filter switching mechanism (up to 4 filters) as standard Edge filter: 5-year warranty
Detector	
Detector	Air-cooled Peltier CCD detector (Max. -60°C), 1650 x 200 pixel, 16 x 16 µm, Visible to NIR
Optional Detectors	Visible high-sensitivity type, NIR high-sensitivity type, High-resolution type, etc.
Laser	
Laser	Standard: 532 nm, 20 mW / Optional: 405, 442, 457*, 488, 514.5, 532, 633, 785*, 1064** nm, etc. * recommended / ** dedicated system with InGaAs detector Higher watt 532 & 785 available
Number of Mountable Lasers	Max. 3 lasers (3 internal or 2 internal with 1 external)
Microscope	
Sample Observation	High-resolution CMOS camera (3 megapixel)
Confocal Optical System	Standard
Spatial Resolution	XY = 1 µm, Z = 1.5 µm
Objective Lens	5x, 20x, 100x (Plan Achromat objective lens) Manual 6-position objective carousel (standard) / Electronic drive 6-position carousel (optional) Long working distance type, NIR type, water immersion lenses are also available as options
Sample Stage	Automatic XYZ stage with auto-focus function
Imaging Measurement	Automatic stage imaging with auto-focus, XYZ 0.1 µm step, 3-D imaging
Laser Safety	Class 1 Interlock mechanism by software and hardware, laser optical path protection
Macro Measurement	Optional carousel type macro-measurement unit is an available option
Fiber Probe	Optional
Other Hardware Options	Dichroic mirror, polarized observation, differential interference contrast, transmitted illumination
Software	
Standard Program	Micro Spectra Measurement, Validation, Spectra Analysis, Micro Imaging Analysis, wavenumber correction, sensitivity correction, fluorescence correction, JASCO Canvas
Imaging Program	Sample search function, multiple focus function, focused view, 3-D structure observation, peak calculation, PCA mapping, refractive index correction (optional)
Correction Program	Auto-fluorescence, sensitivity and wavenumber correction (Ne lamp and standard sample included)
Optional Program	Interval measurement, thermal change, imaging, stress and carbon analyses
Additional Information	
Anti-Vibration Table*	Air source for anti-vibration table: nitrogen gas for air source, secondary pressure 0.25 - 0.3 MPa
Dimension and Weight	Main unit: 550 (W) x 610 (D) x 800 (H) mm (door closed); approx. 80 kg Power supply: 220 (W) x 320 (D) x 70 (H) mm; approx. 3 kg AC 100 V ±10 V, AC 200 V ±20 V, 140VA

*recommended but not required

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BNRS4500-1707 Printed in Japan

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