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Renishaw - the only choice for fully upgradeable Raman systems

This brochure details an extensive range of options and upgrades available for the Renishaw RM series Raman microscopes, providing a revolution in Raman instrument flexibility and customization.
Renishaw is the only Raman system supplier to offer a low-cost basic unit that can be fully upgraded to a high resolution spectroscopy and imaging system.

We are continually developing new upgrade modules. Please contact your local Renishaw supplier for further information about any of the products you see here, or to discuss any special requirements you may have.



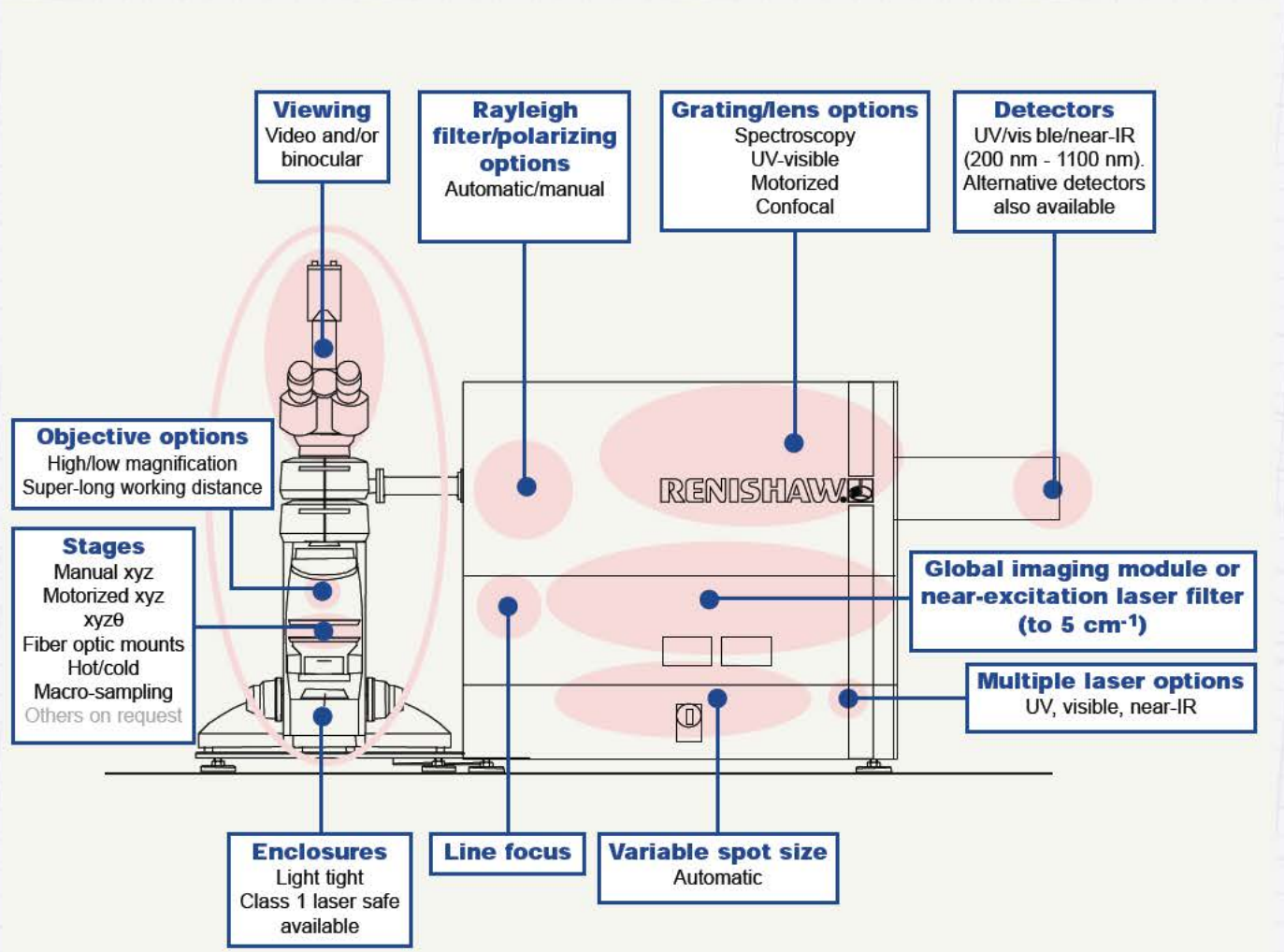






Renishaw RM series Raman systems are equipped with class IIIb (3B) or IV (4) lasers.

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Upgrade options

You choose.....

Entry level

- System 1000B low-cost/high-optical-efficiency
- Upgrade to complete automated UV/visible/near-IR system at any stage in the future
- Complete range of customization options

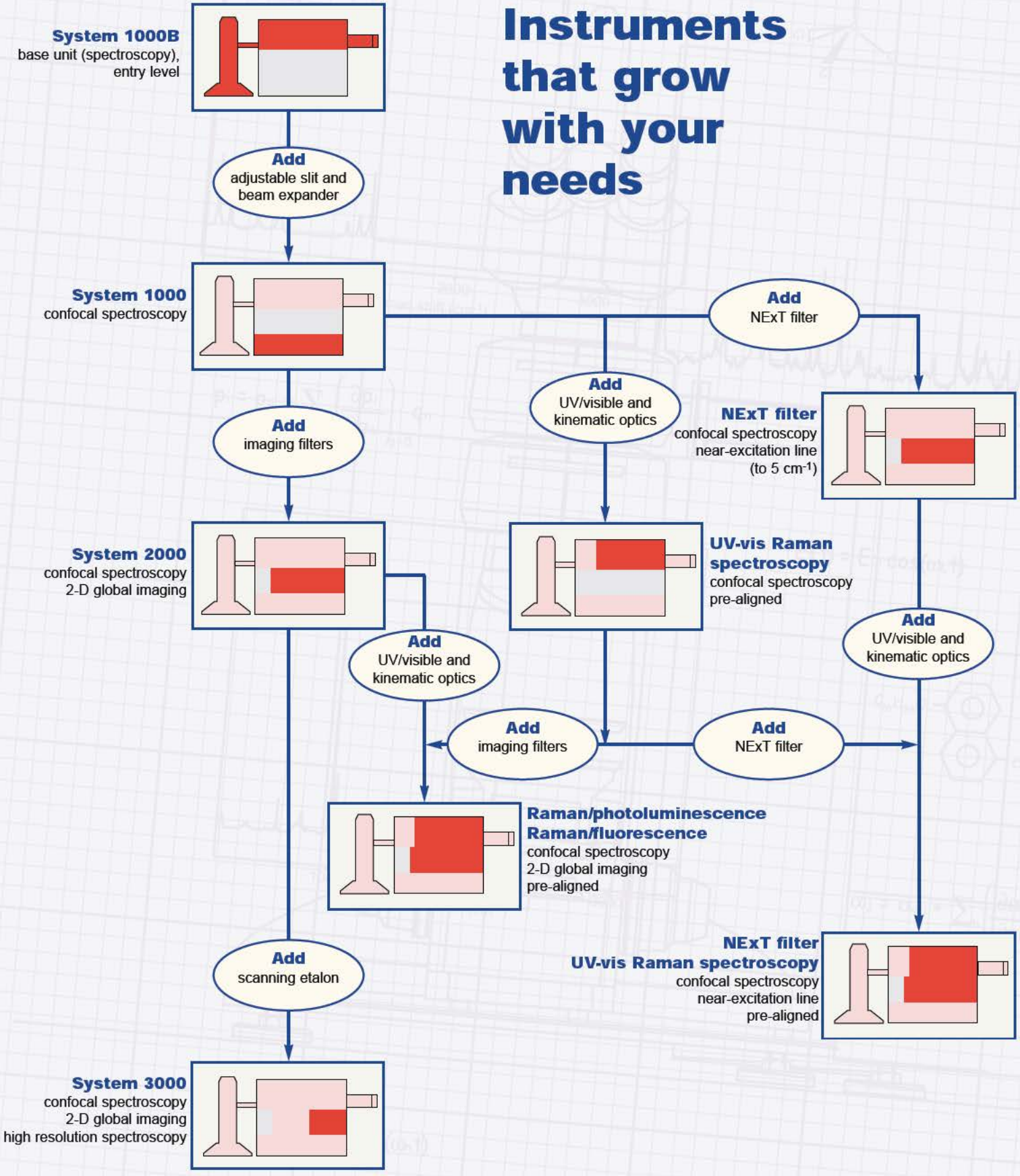
Or

- Start with multiple laser system and automated operation (research and industrial use)
- Add fully integrated hardware/software upgrades for improved control

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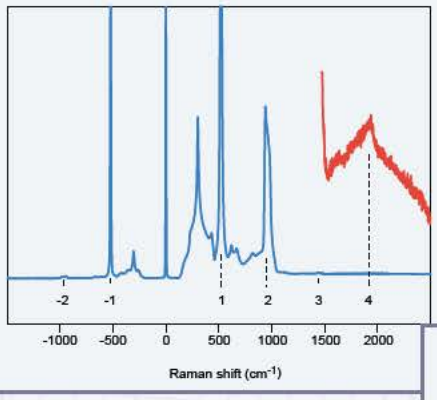
RM series Raman systems - full upgrade route

Instruments that grow with your needs



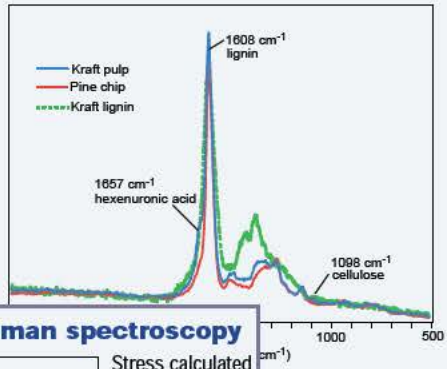
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Visible Raman spectroscopy



Room temperature visible Raman spectrum of Si showing 4th order peak (x1000).

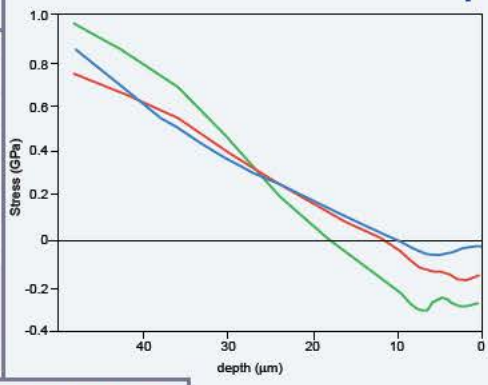
UV Raman spectroscopy



UV resonance Raman spectra shows the differences in structure between pine chip, unbleached kraft pulp, and kraft lignin used in paper manufacture.

Data courtesy of T. Vuorinen, Technical University of Helsinki, Finland.

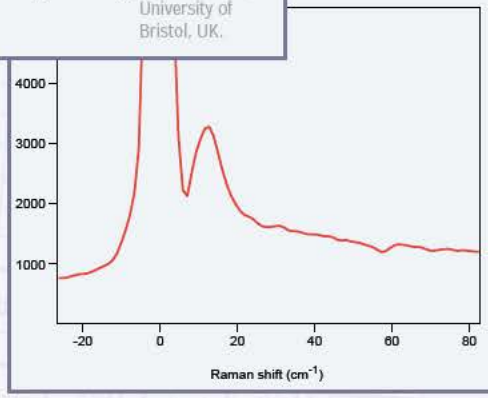
Confocal Raman spectroscopy



Stress calculated from the position of the first order diamond Raman peak at various depths below the surface of a film at three different points on a single facet.

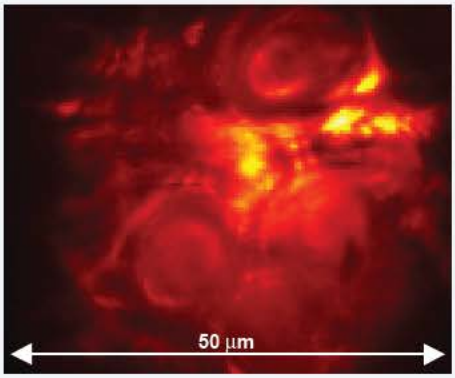
Data courtesy of J. Steeds *et al*, University of Bristol, UK.

NExT filter spectroscopy



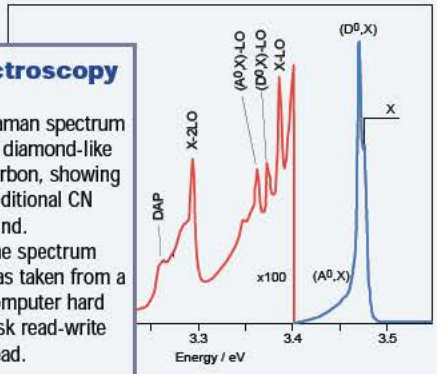
NExT filter spectrum of longitudinal acoustic modes of polyethylene.

2-D global Raman imaging



Raman image of handcream sample showing distribution of oil (yellow areas) in the emulsion.

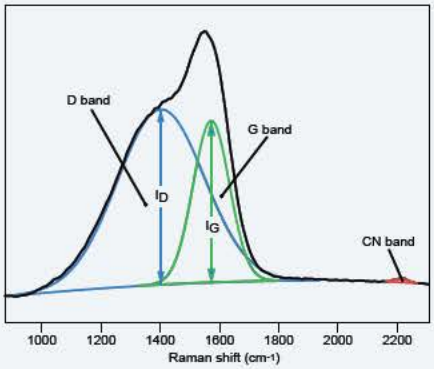
Photoluminescence (PL) spectroscopy



325 nm excitation PL spectrum of a 200 µm GaN layer on sapphire.

Data courtesy of H. Siegle *et al*., Technical University, Berlin, Germany.

Visible Raman microspectroscopy

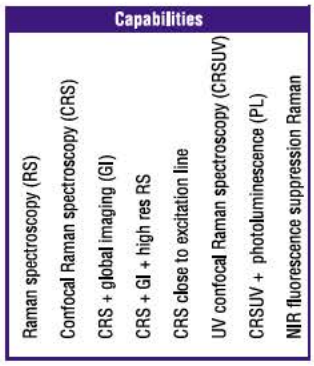


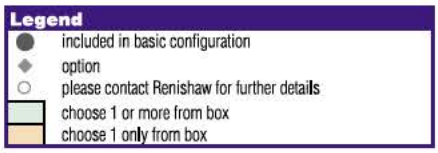
Raman spectrum of diamond-like carbon, showing additional CN band.
The spectrum was taken from a computer hard disk read-write head.

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Options and accessories at a glance...

The versatility of the RM series systems enables them to be used for a wide variety of spectroscopic studies. These charts summarize the options and accessories used for some of the more common tasks.





Core components	Base unit	CR01	Entry-level spectrometer
	Beam expander	CR02	Automatically variable spot size, improved spatial filtering and beam profile
	Adjustable slit	CR03	Adjustment for spectral resolution and confocal mode
	Microscope eyepieces	CR04	Direct sample viewing and focusing
	Video viewer	CR05	Sample viewing and image capture on computer monitor
	Scanning etalon	CR06	Enhanced spectral resolution Raman imaging (0.2 cm^{-1})
	Microscope enclosure	CR07	Light tight for safe operation in routine laboratories
	Microscope enclosure (Class 1)	CR08	Fully interlocked class 1 safe enclosure
Detectors	RenCam CCD camera	DE01	Housing, electronics etc.
	Standard front-illuminated chip	DE02	For general visible spectrum use
	Standard deep depletion chip	DE03	Enhanced efficiency in the near IR
	AIMO chip	DE04	Extremely low noise (dark current <0.005 at-70 °C)
	UV enhanced deep depletion chip	DE05	Enhanced efficiency in the UV
	UV enhanced AIMO chip	DE06	Extremely low noise. UV enhanced
Laser options	244 nm laser	LA01	Deep UV frequency-doubled Ar-ion laser (water cooled)
	325 nm laser	LA02	UV HeCd laser (air cooled)
	442 nm laser	LA03	UV HeCd laser (air cooled)
	488 nm laser	LA04	Ar-ion laser (air cooled)
	514 nm laser	LA05	Ar-ion laser (air cooled)
	532 nm laser	LA06	Frequency doubled Nd:YAG laser
	633 nm laser	LA07	HeNe laser (air cooled)
	785 nm laser	LA08	Diode laser (air cooled)
	830 nm laser	LA09	Diode laser (air cooled)
	Multiple laser baseplate	LA10	Mounts up to 3 lasers
Rayleigh filters	50 cm^{-1} (visible)	RF01	Holographic high performance filter (notch)
	100 cm^{-1} (visible)	RF02	Holographic standard filter (notch)
	200 cm^{-1} (visible and near-IR)	RF03	High specification edge filter (dielectric)
	350 cm^{-1} (UV edge, PL)	RF04	High efficiency edge filter (dielectric)
	500 cm^{-1} (deep UV edge)	RF05	High efficiency edge filter (dielectric)
	NExT filter	RF06	Raman spectra close to Rayleigh line (~5 cm^{-1})
	Kinematically mounted Rayleigh filters	RF07	Easy plug-and-play for multiple wavelength systems
	Automatic changeover notch Rayleigh filters	RF08	Motorized filters for multiple wavelength systems
Gratings	600 lines mm^{-1}	GR01	For low dispersion work
	1200 lines mm^{-1}	GR02	Normal choice for near IR excitation studies
	1800 lines mm^{-1}	GR03	Normal choice for visible excitation studies
	2400 lines mm^{-1}	GR04	Normal choice for near UV excitation studies
	3600 lines mm^{-1}	GR05	Normal choice for deep UV excitation studies
	Kinematic grating mount	GR06	Allows rapid changeover of gratings
	Automated dual grating mount	GR07	Allows rapid automated switching between two of the above gratings
Optics	Visible optimized optics	OP01	Spectrometer internal optics for visible excitation wavelengths
	UV optimized optics	OP02	Spectrometer internal optics for UV excitation wavelengths
	Near-IR optimized optics	OP03	Spectrometer internal optics for near-IR excitation wavelengths
	Kinematic optic mounts	OP04	Easy change mounts for rapidly switching between UV and visible excitation

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			Capabilities							
			Raman spectroscopy (RS)	Confocal Raman spectroscopy (CRS)	CRS + global imaging (GI)	CRS + GI + high res RS	CRS close to excitation line	UV confocal Raman spectroscopy (CRSUV)	CRSUV + photoluminescence (PL)	NIR fluorescence suppression Raman
Objectives	Visible x5, x20, x50	OB01	●	●	●	●	●	◆	●	●
	Visible x10, x100	OB02	◆	◆	◆	◆	◆	◆	◆	◆
	UV x15, x40	OB03	◆	◆	◆	◆	◆	●	●	◆
	Visible long working distance x5, x10, x20, x50	OB04	◆	◆	◆	◆	◆	◆	◆	◆
	Water immersion objective	OB05	◆	◆	◆	◆	◆	◆	◆	◆
Multi-dimensional	xyz manual stage	MD01	●	●	●	●	●	●	●	●
	xyz motorized stage	MD02	◆	◆	◆	◆	◆	◆	◆	◆
	xyz motorized stage (encoder)	MD03	◆	◆	◆	◆	◆	◆	◆	◆
	Focus track system	MD04	◆	◆	◆	◆	◆	◆	◆	◆
	Imaging filters	MD05	◆	◆	●	●	◆	◆	◆	◆
	Line focus system	MD06	◆	◆	◆	◆	◆	◆	◆	◆
	LCTF system	MD07	◆	◆	◆	◆	◆	◆	◆	◆
	SNOM	MD08	◆	◆	◆	◆	◆	◆	◆	◆
Polar	Linear polarizers	PR01	●	●	●	●	●	●	●	●
	Half-wave plates	PR02	●	●	●	●	●	●	●	●
	Depolarizers	PR03	◆	◆	◆	◆	◆	◆	◆	◆
Cal	Calibration source	CA01	◆	◆	◆	◆	◆	◆	◆	◆
	Ordinate calibration system	CA02	◆	◆	◆	◆	◆	◆	◆	◆
Microscope accessories	Hot stage	AC01	◆	◆	◆	◆	◆	◆	◆	◆
	Hot/cold stage	AC02	◆	◆	◆	◆	◆	◆	◆	◆
	Cold stage	AC03	◆	◆	◆	◆	◆	◆	◆	◆
	Electrochemical cell	AC04	◆	◆	◆	◆	◆	◆	◆	◆
	High pressure cell	AC05	◆	◆	◆	◆	◆	◆	◆	◆
	Fiber optic probe – compact	AC06	◆	◆	◆	◆	◆	○	○	◆
	Fiber optic probe – high efficiency	AC07	◆	◆	◆	◆	◆	○	○	◆
	Fiber optic probe – with video viewer	AC08	◆	◆	◆	◆	◆	○	○	◆
	Fiber optic probe – high temp/high pressure	AC09	◆	◆	◆	◆	◆	○	○	◆
	Macro-sampling set	AC10	◆	◆	◆	◆	◆	◆	◆	◆
	Macro-sampling chamber	AC11	◆	◆	◆	◆	◆	○	○	◆
Software	GRAMS/32®	SW01	●	●	●	●	●	●	●	●
	Renishaw WiRE™	SW02	●	●	●	●	●	●	●	●
	Renishaw custom PASS™	SW03	◆	◆	◆	◆	◆	◆	◆	◆
Libraries	Inorganics and minerals	LB01	◆	◆	◆	◆	◆	◆	◆	◆
	Explosives and drugs	LB02	◆	◆	◆	◆	◆	◆	◆	◆
	Fibers	LB03	◆	◆	◆	◆	◆	◆	◆	◆
	Polymers and contaminants	LB04	◆	◆	◆	◆	◆	◆	◆	◆

Objectives	Standard objectives
	Contact Renishaw for information on these and other special objectives
	Objective for use with UV spectrometers
	For use with hot/cold stages etc.
	For studying solutions and immersed samples
Multi-dimensional	Manual operation stage with microscope slide clip
	1 µm step size
	0.1 µm step size
	Automatically maintains focus during mapping experiments
	Standard Raman imaging option (20 cm^{-1})
	Laser power density reduction. Line scan
	Liquid crystal tuneable filter for imaging and spectrum acquisition
	Scanning near-field option for high spatial resolution
Polar	For sample orientation measurements
	Used with polarizer, gives 90° shift in polarisation direction
	Scrambles laser light to sample
Cal	Light source for Raman shift calibration
	For calibration of intensity axis
Microscope accessories	Room temperature to 1773 K (1500 °C)
	77 K to 873 K (-196 °C to 600 °C)
	4.2 K (-269.0 °C) to room temperature
	Glass electrochemical cell
	Diamond anvil cell
	12,5 mm diameter
	Larger rugged probe
	With integral video viewer for sample viewing and focusing
	For process monitoring applications
	For analyzing bulk liquid and solid samples
	For analyzing bulk liquid and solid samples, couples to instrument via fiber optics
Software	Galactic industries Windows-based software
	Standard instrument control software (requires GRAMS/32®)
	Customizable process monitoring software (requires GRAMS/32® and WiRE™)
Libraries	Minerals, gemstones, and oxides
	Explosives, drugs, and drugs precursors
	Specialized fiber library
	Rubbers, polymers, and general contaminants

Legend

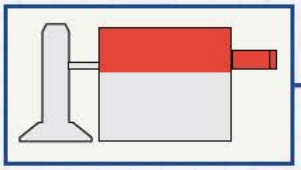
- ● included in basic configuration
- ◆ option
- ○ please contact Renishaw for further details
- choose 1 or more from box
- choose 1 only from box

These charts summarize the majority of options and upgrades available for the Renishaw RM series Raman microscopes.

We are continually developing new upgrade modules. Please contact your local Renishaw supplier for further information about any of the products you see here, or to discuss any special requirements you may have.

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Laser options



Renishaw spectrometers can be fitted with a variety of excitation lasers to suit your requirements

Laser wavelengths available

- 244 nm
- 325 nm

} UV spectroscopy

- 442 nm
- 488 nm
- 514 nm
- 532 nm
- 633 nm

} visible spectroscopy and 2-D imaging

- 785 nm
- 830 nm

} near-IR spectroscopy

See diagram below for ranges covered

Others on request



Switchable options

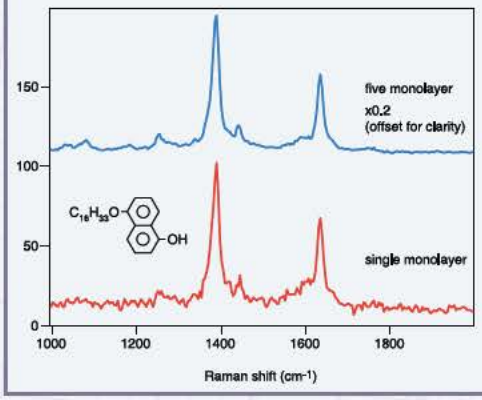
Common baseplate

Up to 3 lasers permanently mounted

No adjustment required



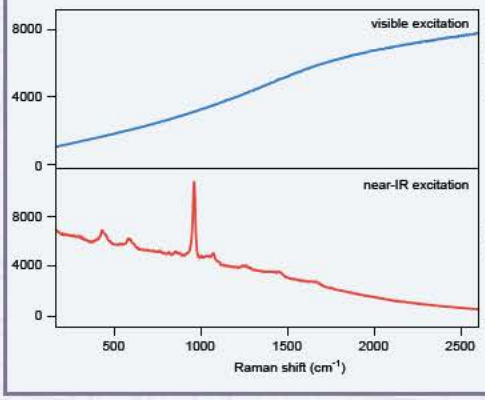
UV Raman spectroscopy



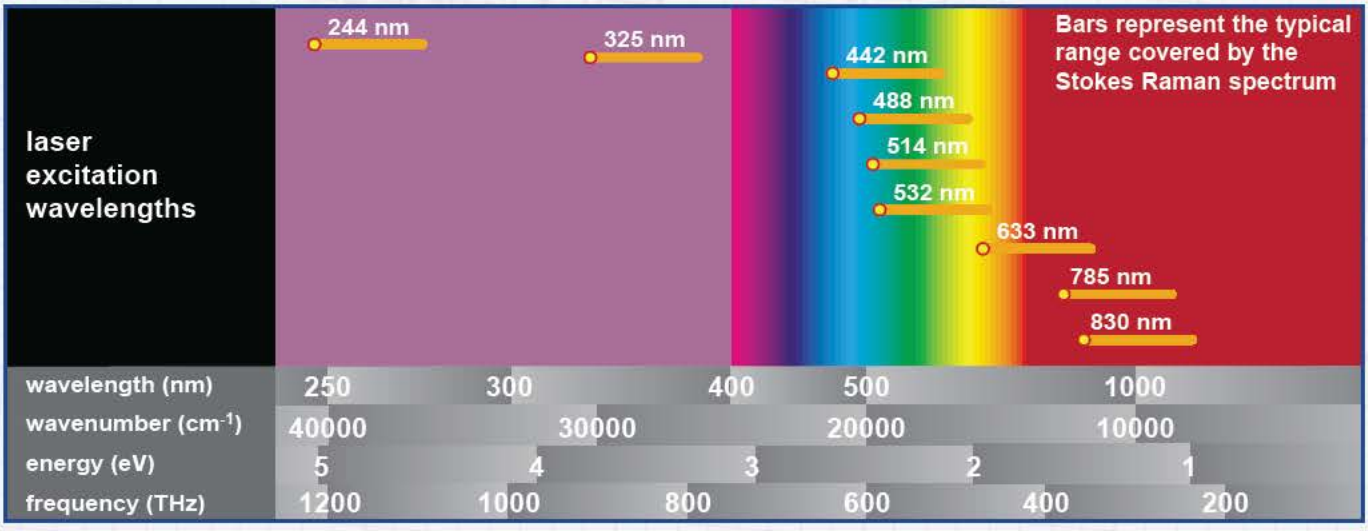
UV excitation can be used to obtain spectra from molecular monolayers.

Data courtesy of Dr. Zhou Bing, Institute of Theoretical Chemistry, Jilin University, Peoples' Republic of China.

Near-IR Raman spectroscopy



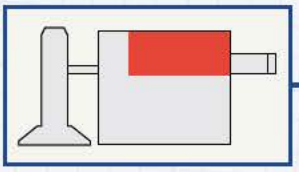
Spectra from dentine (calcified tissue from a tooth). The lower near-IR spectrum has greatly reduced luminescence and shows discernible Raman features not seen in the visible spectrum.



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Grating options

RENISHAW



Gratings available

- 600 lines/mm
- 1200 lines/mm
- 1800 lines/mm
- 2400 lines/mm
- 3600 lines/mm

Ranges covered
Extended scanning automatically provided } see below



Select gratings to optimize the resolution, spectral range and efficiency for your own applications

Manual grating change system

Magnetic
Kinematic
'One-click' changeover

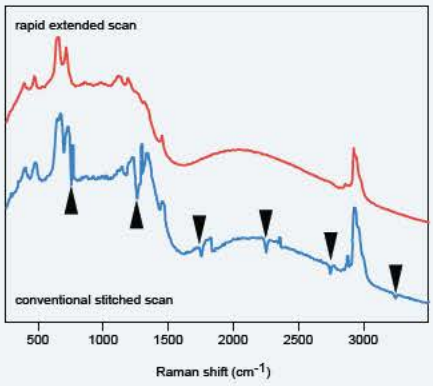


Automated grating change system

Back-to-back dual gratings
Motorized
Software controlled



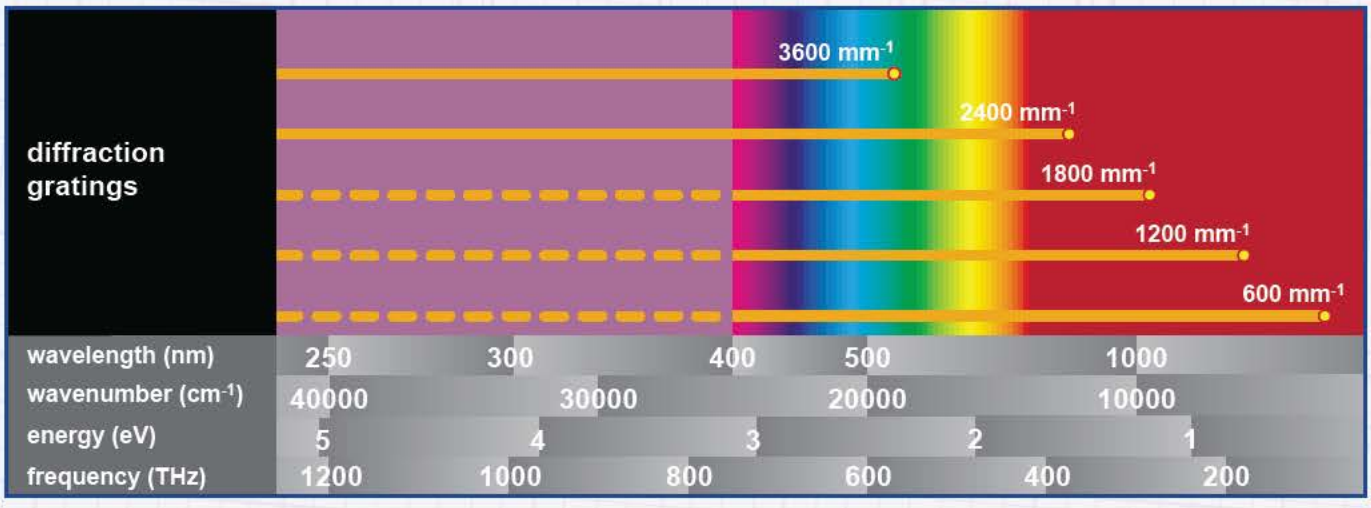
Rapid extended scanning



Spectra comparing Renishaw's continuous extended scanning method with the conventional sequential scanning method.

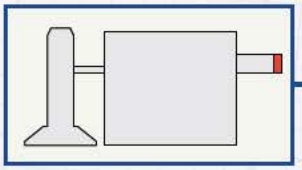
Renishaw's proprietary extended scanning method is available as standard on all Renishaw RM series Raman systems.

Broad spectral ranges can be studied using only one diffraction grating, eliminating "stitching" artifacts.



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Detector options



A variety of detectors can be fitted to Renishaw spectrometers with custom options (e.g. germanium detector for IR) available on request

RenCam CCD camera

All-in-one compact unit (105 mm x 105 mm x 135 mm)
Simple installation (no added control box)
Thermoelectric cooling to -70 °C (maintenance free)
576 x 384 pixels standard (others available)
Ultra low noise (<7 e^- $pixel^{-1}$, chip dependent)
Low dark current (down to 0.0005 e^- $pixel^{-1}$ s^{-1}, chip dependent)



Chips available with RenCam (UV/visible/near-IR)

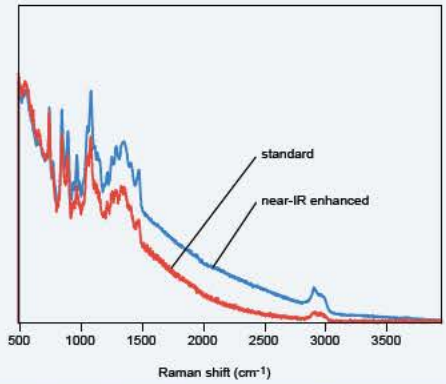
High performance chips are available to cover a wide range of customer applications

- Standard
- Deep depletion for enhanced near-IR sensitivity
- AIMO (Advanced Inverted Mode Operation)
- Deep depletion with UV enhanced coating
- AIMO with UV enhanced coating

See diagram below for detection range

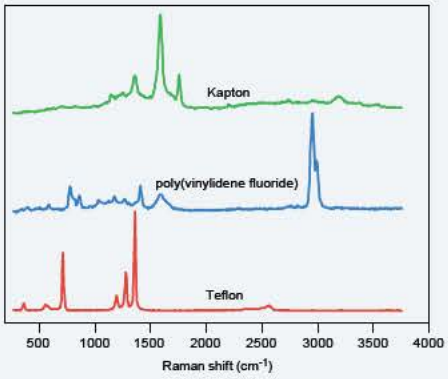


Near-IR Raman spectroscopy

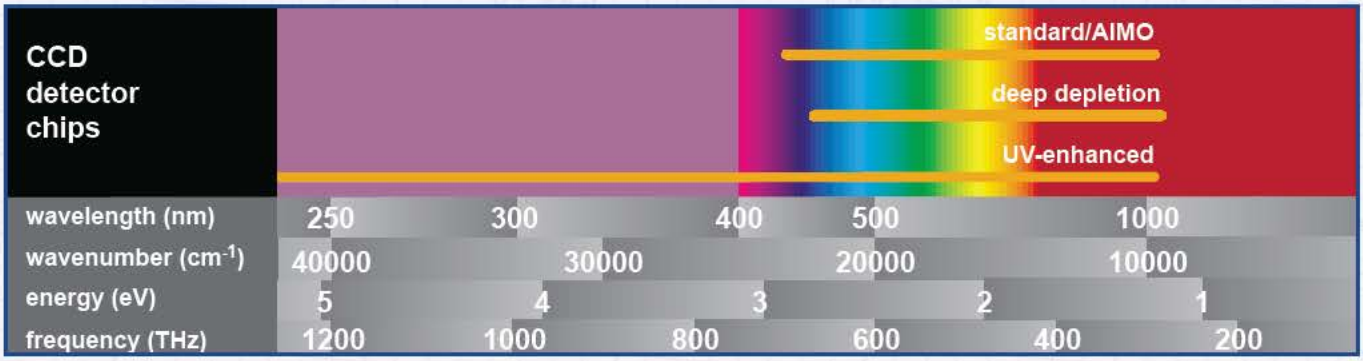


Near-IR excitation (782 nm) has been used to obtain spectra from agarose (an agar derivative). The near-IR enhanced CCD camera chip gives improved detection of high wavenumber signals.

UV Raman spectroscopy

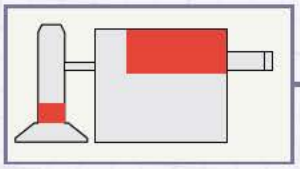


UV excitation (244 nm) is used to overcome background luminescence and observe Raman bands which are not seen using a visible excitation source.



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Lens and objective options



Renishaw offers a variety of both internal and external optics which are optimized for the laser(s) used

Spectroscopy optics, UV/visible/near-IR

Precision kinematically mounted modules

Rapid change-over, no realignment

High optical efficiency

Operating range: (229 to 1100) nm and beyond

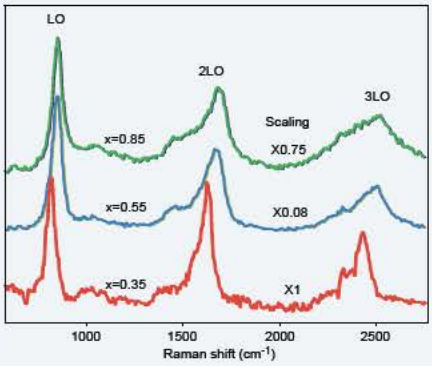


Microscope optics - many options, including:

- UV and UV-visible optimized objectives
- Standard: x5, x20, x50
- High magnification: x100
- Super-long working distance: e.g. x20, ~20 mm
- Water immersion objectives



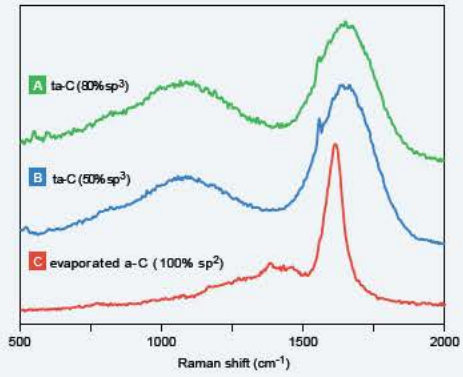
UV Raman spectroscopy



Room temperature Raman spectra for layers with varying Ga content (x) in the series $Ga_xAl_{1-x}N$, using 244 nm excitation, < 1 mW laser power and 1 µm laser spot size.

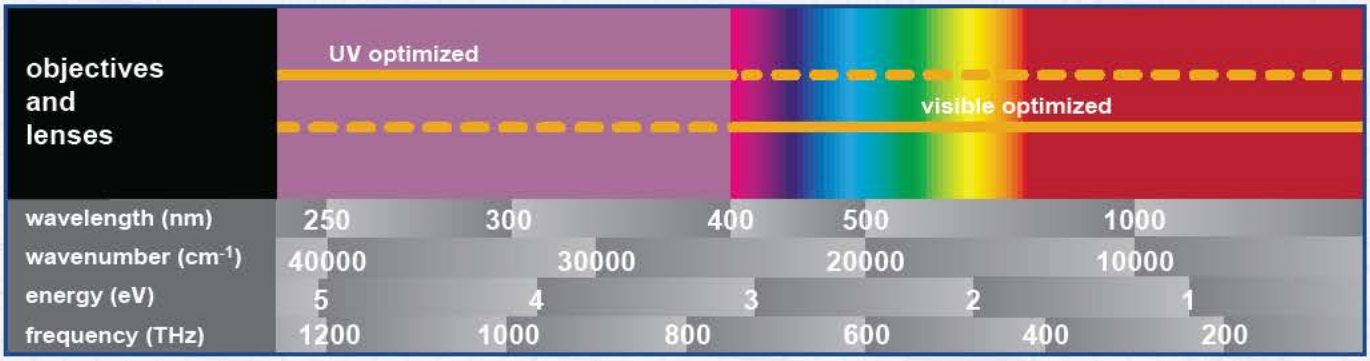
Data courtesy of M. Kuball, University of Bristol, UK, and D. Batchelder, University of Leeds, UK.

UV Raman spectroscopy



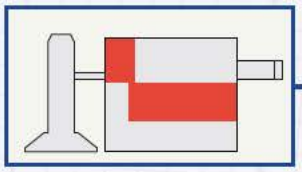
Room temperature spectra for diamond-like carbon, showing sp^2 and sp^3 bands for three carbon films of differing composition.

Data courtesy of K. Gilkes, University of East Anglia, UK.



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Filter options

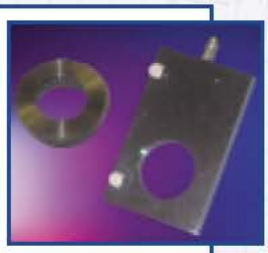


Renishaw offers a wide variety of Rayleigh line rejection filters and polarizers for all laser wavelengths

Rayleigh filters

For Raman shift measurements above:

- 50 cm^{-1} } visible lasers (notch)
- 100 cm^{-1} }
- 200 cm^{-1} visible and near-IR lasers (dielectric)
- 350 cm^{-1}, 325 nm laser } UV lasers (dielectric)
- 500 cm^{-1}, 244 nm laser }



Easy change (manual)

Filter assembly

Pre-aligned, removable baseplate

Filters changed in under one minute



Easy change (automated)

Motorized

Rapid changeover of laser wavelengths

Software controlled



Polarizers/analyzers for all laser wavelengths

- Linear polarizers
- Half-wave plates
- Depolarizers



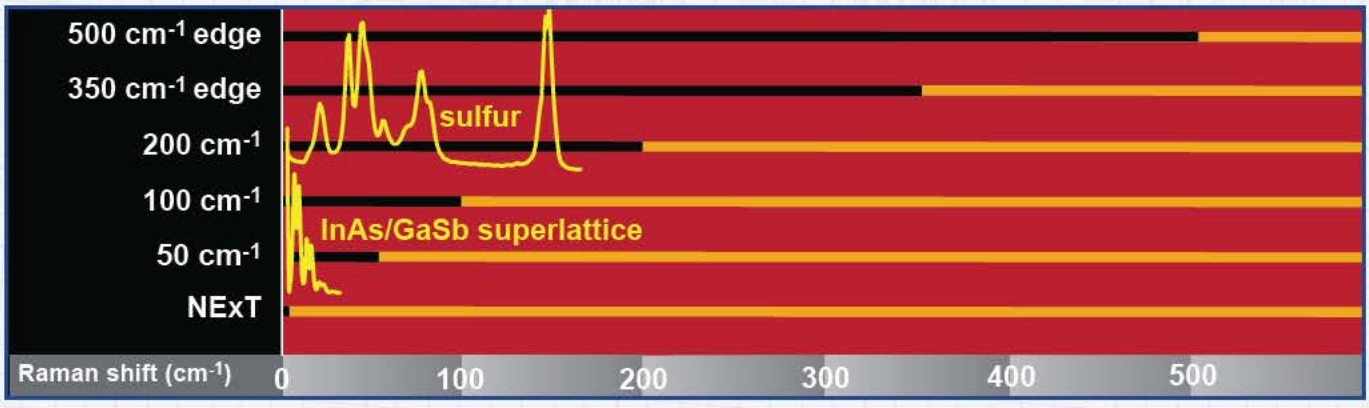
NExT filter

Near excitation line

Low wavenumber work (for Raman measurements to 5 cm^{-1})

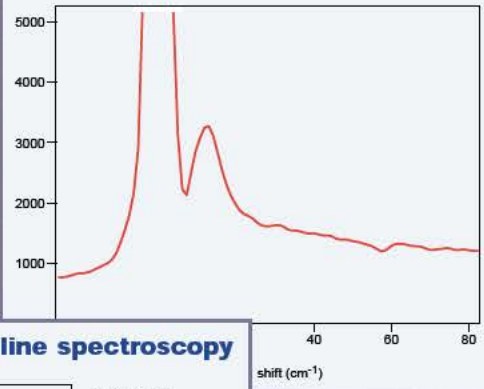
Tunable over a wide wavelength range





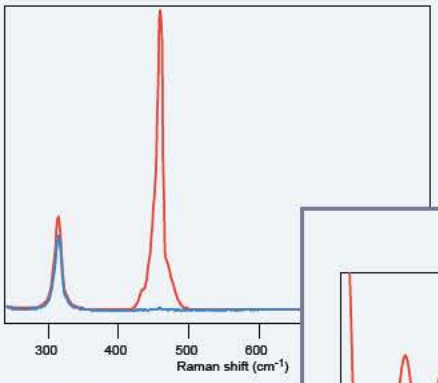
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Near-excitation line spectroscopy



NExT filter spectrum of polyethylene showing the longitudinal acoustic modes.

Polarization measurements

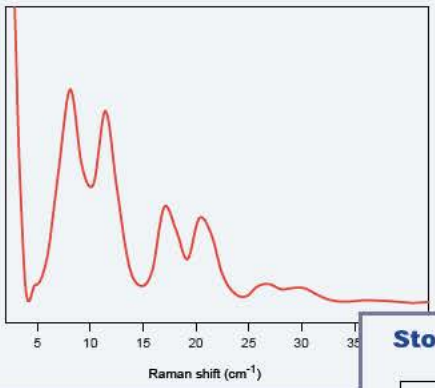


Polarization spectra of carbon tetrachloride:

red $z(x,x)\bar{z}$

blue $z(x,y)\bar{z}$

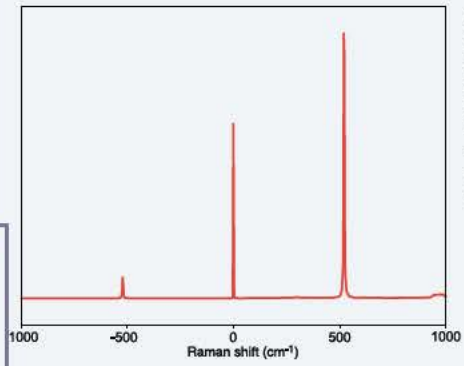
Near-excitation line spectroscopy



NExT filter spectrum of an InAs/GaAs superlattice showing the folded longitudinal acoustic modes.

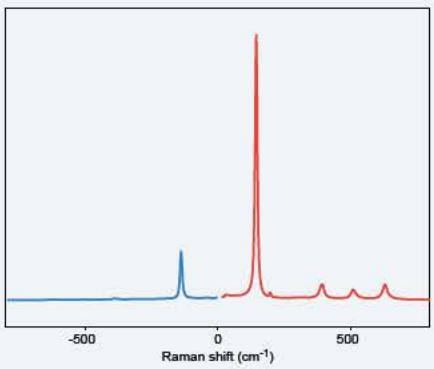
Data courtesy of P.C. Klipstein, Clarendon Laboratory, University of Oxford UK.

Stokes and anti-Stokes Raman spectroscopy



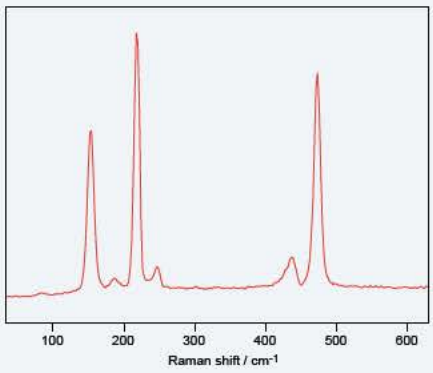
Room temperature spectrum of silicon. Using the novel Renishaw notch filter technology both Stokes and anti-Stokes Raman shifts can be observed.

UV near-excitation Raman spectroscopy



Room temperature Raman spectra of titanium dioxide using UV excitation and NExT filter to show both Stokes and anti-Stokes Raman shifts close to the excitation line.

Visible Raman spectroscopy



Sulfur spectrum taken using a 100 cm-1 holographic filter (y axis corrected for instrument response).

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Advanced forms of multi-dimensional spectroscopy are available with Renishaw spectrometers

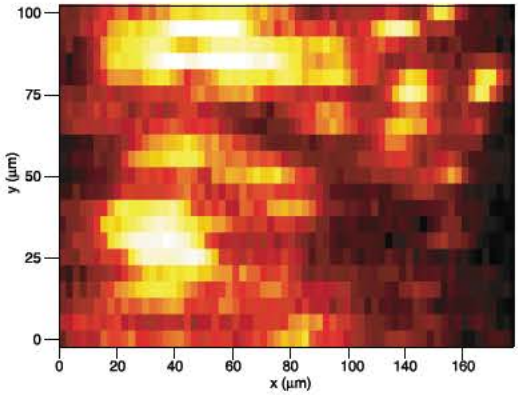
Line imaging

Individual complete spectra are collected simultaneously along an illuminated line

3 or 4 dimensions
x-position
y-position
wavenumber
intensity

- line length up to 1 mm (depending on the objective used)
- reduces power density enabling the study of easily-damaged samples
- additional mapping stage option allows areas to be mapped





Scanned line image of photoluminescence spectra from the 1.68 eV silicon defect (yellow areas) in a CVD diamond film.

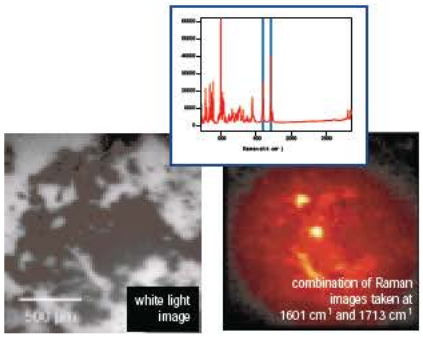
Direct global imaging

Single wavenumber images collected simultaneously over an area of the sample

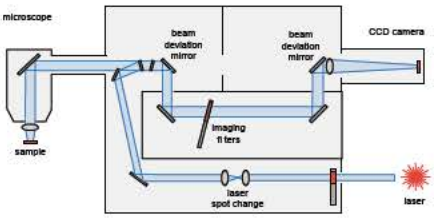
3 dimensions
x-position
y-position
intensity

- Renishaw's patented angle-tuneable-filter imaging technology
- simultaneous acquisition of Raman data from an area illuminated by the enlarged laser spot
- filters can be tuned to transmit any Raman band or other spectral feature of interest
- very rapid data acquisition in comparison with traditional techniques
- areas up to 1.5 mm diameter are imageable (objective dependant)
- liquid crystal tuneable filter also available for high spectral and spatial resolution applications





Standard microscope (white light) and Raman images of a mixture of cocaine hydrochloride and sugar. The Raman image reveals the particles of cocaine as bright regions.



Schematic diagram of the configuration of the system for global imaging.

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Point-by-point mapping

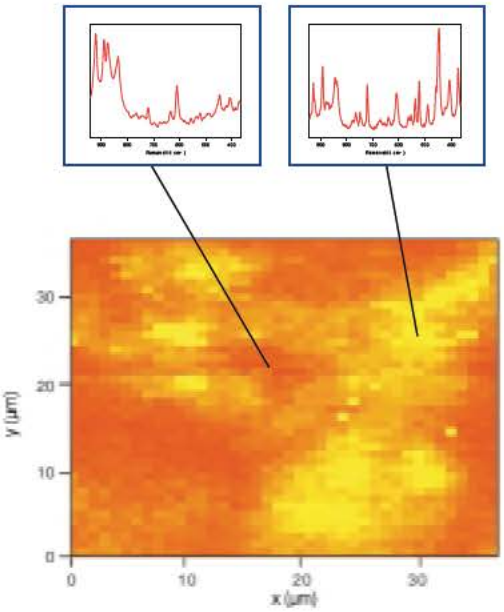
3,4, or 5 dimensions

x-position
y-position
z-position
wavenumber
intensity

Automated xyz stage control allows spectra comprising lines, areas, and volumes to be sequentially acquired 'point by point'

- maps of many features can be produced, e.g. chemical distribution, sample stress variations
- software makes production of peak intensity and other maps easy
- dimensions of mapped region limited only by stage size (typically 100 mm x 75 mm x 50 mm)
- unique focus tracking capability keeps the sample in focus during acquisition of maps of particularly rough or large samples and provides topographic data





Raman map of pharmaceutical tablet. Yellow regions contain high concentrations of active ingredient. Map consists of a plot of the intensity of one of the Raman bands of the active ingredient.

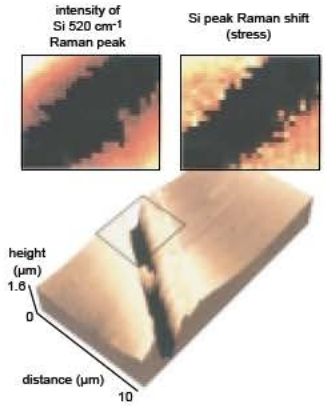
SNOM-Raman

Scanning near-field optical microscopy

SNOM-Raman uses a sub-wavelength aperture to deliver laser light to a sub-microscopic region of a sample

- sub-micrometer spatial resolution
- complementary atomic force data to give surface topography

Developed in conjunction with University of Leeds, UK.



Raman (top) and shear force (bottom) images from a scratch on a silicon wafer, showing residual stresses and deformed silicon.

Figure courtesy of D.A.M. Smith, D.N. Batchelder, S. Webster, University of Leeds, UK.

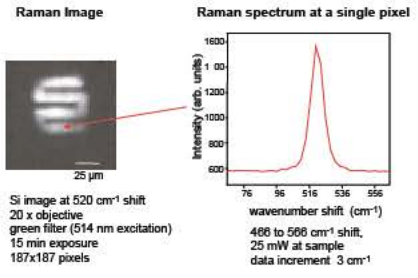
LCTF-Raman

Liquid crystal tuneable filter

Combined Raman spectroscopy and digital imaging

- no moving parts
- high speed spectral scanning
- broad spectral range
- high optical quality

Developed in conjunction with Spectral Dimensions Inc. of Olney, MD, USA.

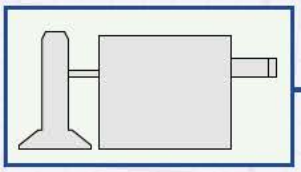


Raman image of a test sample (left), and a spectrum taken from one point (right).

Figure courtesy of E.N. Lewis, P. Colarusso, and I. Levin at the National Institutes of Health in Bethesda, Maryland, USA.

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Software and spectral library upgrades



Computers

As computers and operating systems are rapidly changing, Renishaw continually evaluates the latest developments in PC technology. Computers supplied by Renishaw are extensively tested prior to delivery to ensure full compatibility with instrument hardware and software, giving trouble-free use in all applications.

Software

- WiRE™ (Windows-based Raman Environment), Windows 95™, standard
- Focus track (focus maintenance)
- xyz mapping stage support
- Video viewer support
- Temperature cell support
- Auto-calibration and calibration transfer
- Custom PASS™ software (Process Application Spectroscopy Suite) for automation and interface to sample handling, compatible with Renishaw process units

Compatible with GRAMS/32® spectroscopy software

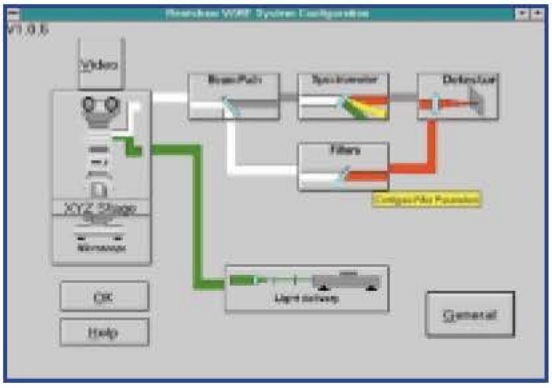
Spectral libraries

- Inorganics and minerals
- Explosives and drugs
- Fibers
- Polymers and contaminants

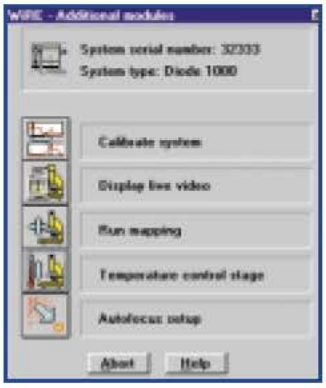


Software options

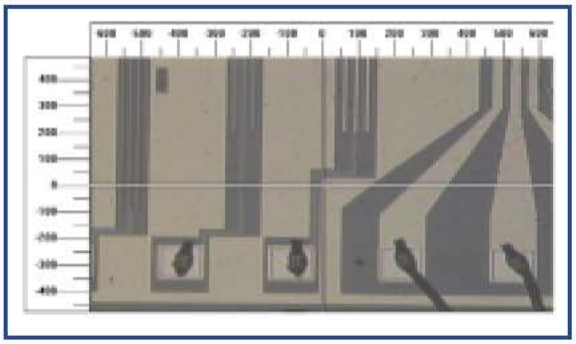
Fully integrated software and hardware for complete experimental control



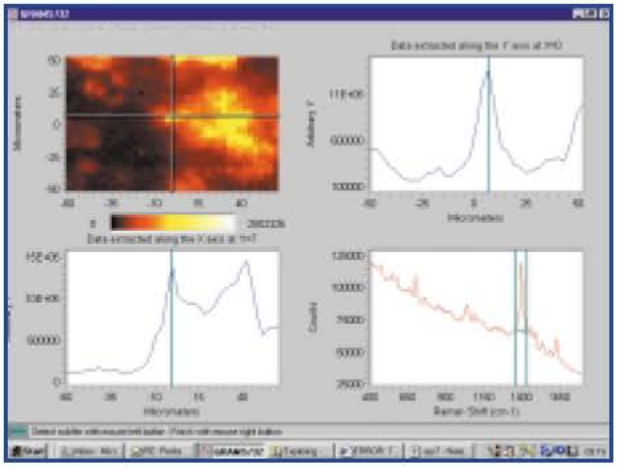
Instrument components accessible at the click of a button



Control instrument functions and experiments



Capture and integrate images for presentations and reports using the video viewer

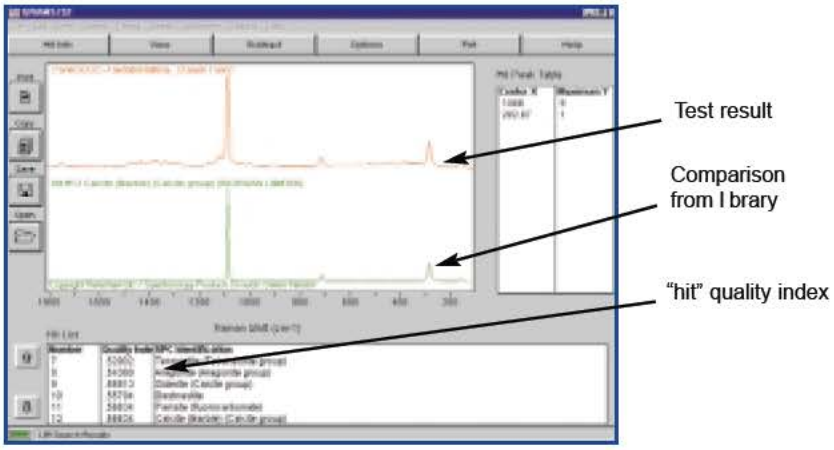


Integrated software for multiple display viewing

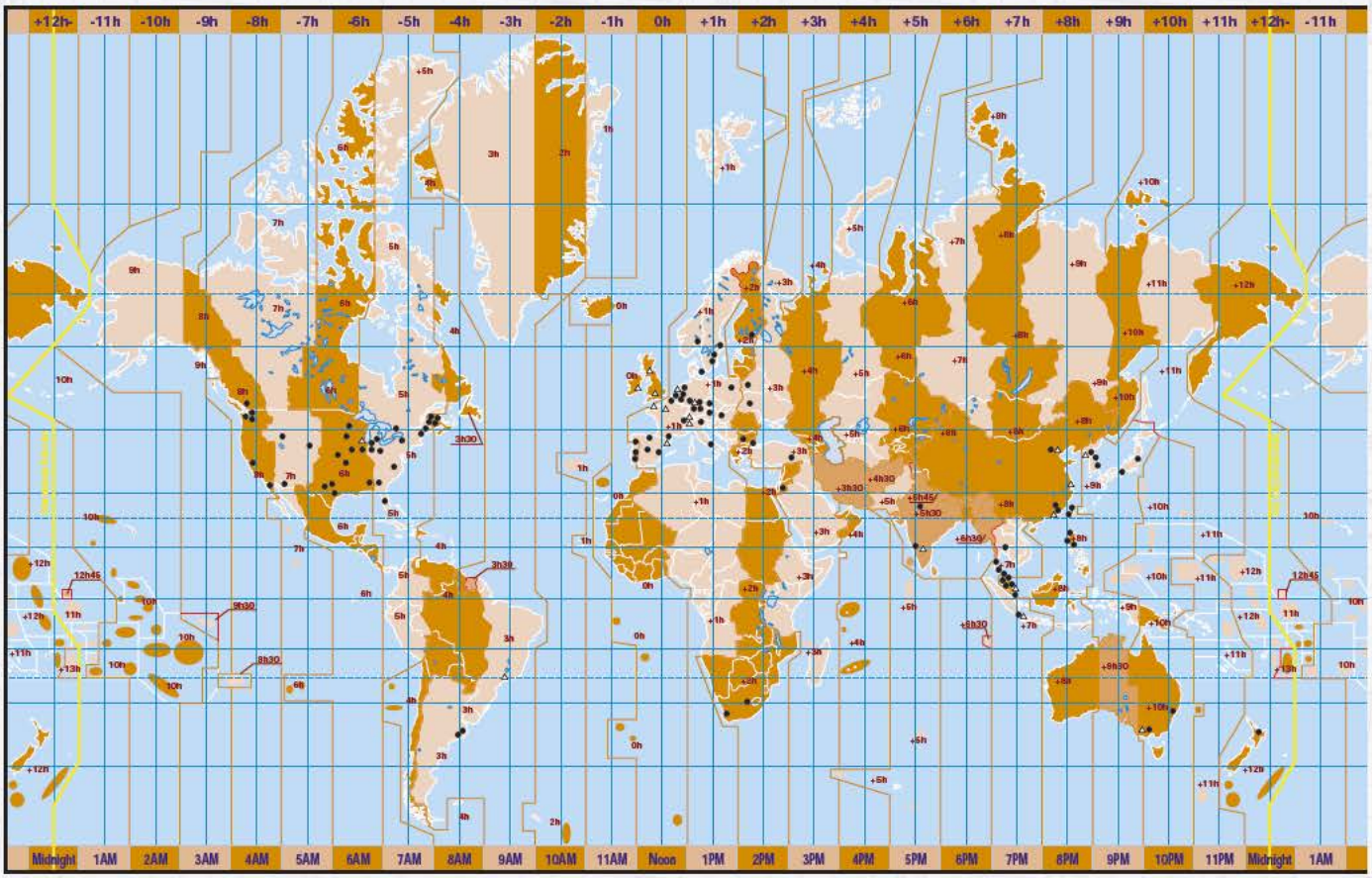
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Spectral libraries

One or more libraries can be searched simultaneously to match specified sample peaks or the entire spectrum



Installation, servicing and support



△ Subsidiaries ● Agents and distributors

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