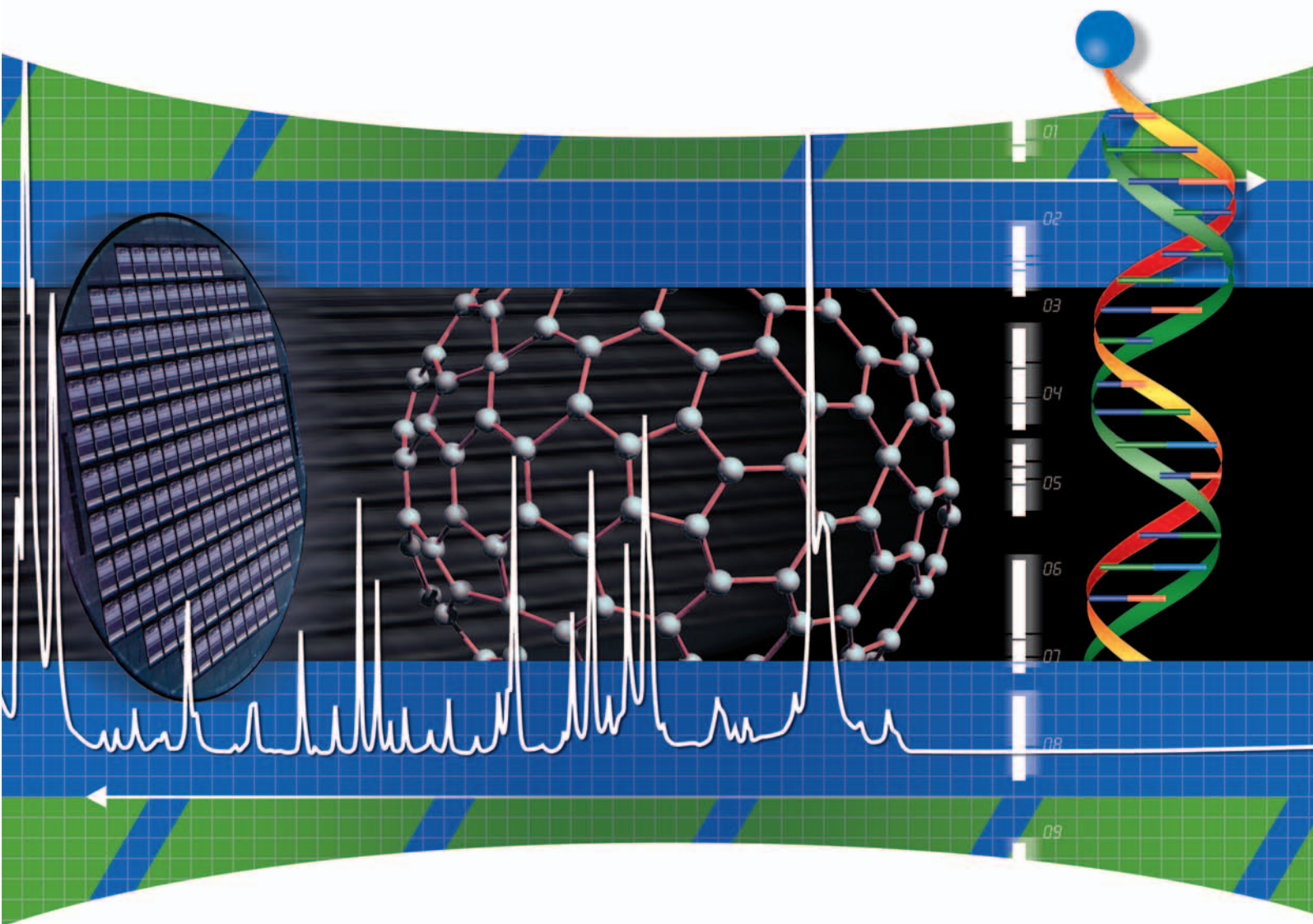


T64000 and U1000



Summary

Introduction
to Research Raman

T64000 Technology

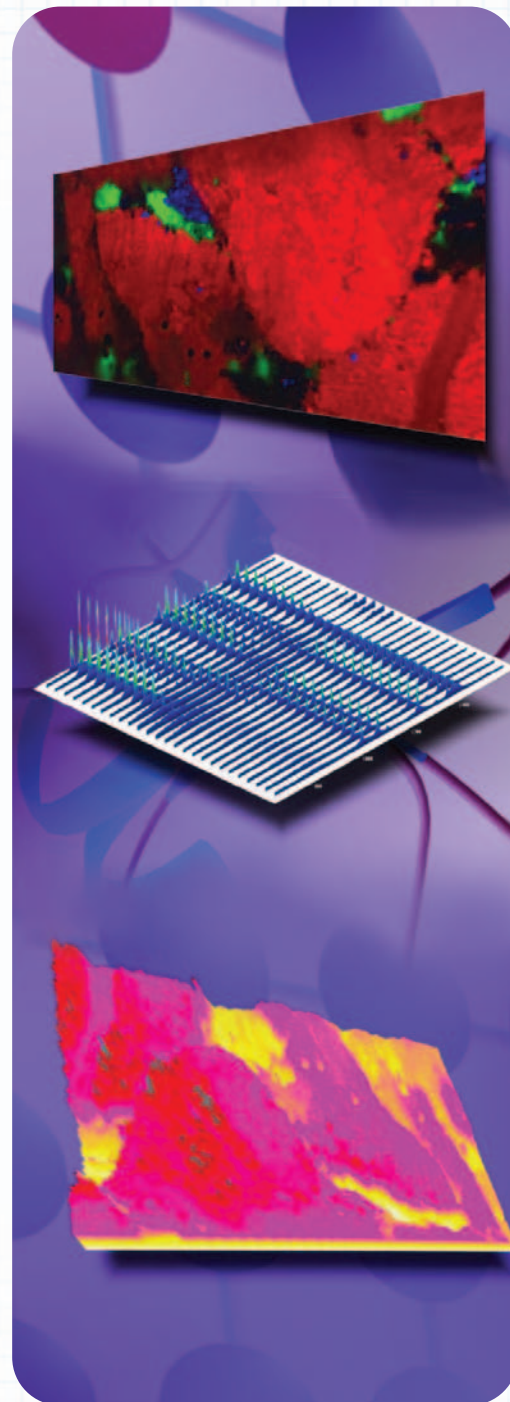
U1000 Technology

Applications
of Research Raman

High resolution, Low frequency, UV – NIR Raman,
Resonance Raman, Raman mapping

Microscopes
& Macro Sampling

Software, Detectors
& Accessories



HORIBA Jobin Yvon is the world leader in Raman spectroscopy, manufacturing the broadest range of Raman spectroscopic systems, ranging from analytical to process monitoring to high end research instruments.

The company has been providing state-of-the-art Raman systems for over forty years and now comprises of the combined expertise of the Jobin Yvon, Dilor, and SPEX teams.

Raman spectroscopy has become an increasingly important spectroscopic technique. Small benchtop instruments have been developed for use in routine and analytical measurements. However, more and more demanding applications in areas such as solid state physics, semiconductors and materials research are limited by the restrictions of the small benchtop instrument.

The T64000 and U1000 high-end research systems offer unequalled performance and flexibility, providing high spectral resolution, extensive tune-ability and improved stray light rejection. New developments in control electronics, optics and software go to provide the highest performance Raman systems available.

U1000



T64000

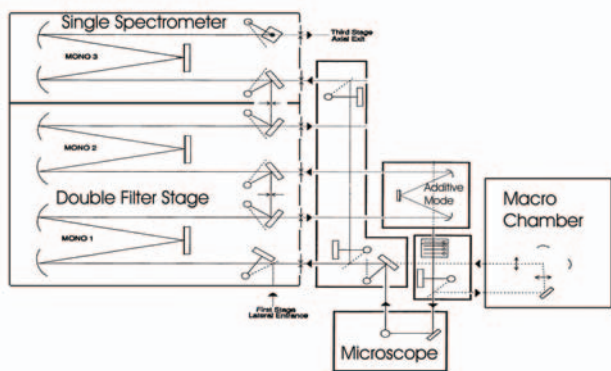


T64000

Three different modes of operation for the highest level of performance and versatility.

The HORIBA Jobin Yvon Raman division utilises state-of-the-art design technology such as CAD, grating simulation and optics software to enable the T64000 to offer the very highest performance, flexibility and sampling capabilities.

Each completed system undergoes rigorous and complete QC testing prior to delivery, and is installed by trained engineers.



Double subtractive/Single :

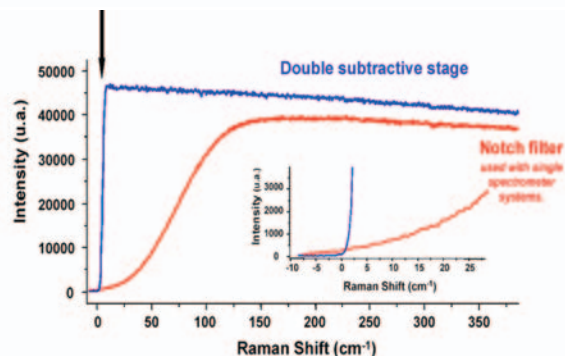
for the measurement of low frequency bands (typically down to 2 to 5 cm^{-1}) over a broad wavelength range.

Triple additive :

3 x 640mm focal length for ultra high spectral resolution ($< 0.15 \text{ cm}^{-1}$)

Single spectrograph :

for the highest optical throughput on weak scattering samples, fluorescence and PL measurements.



Far superior laser rejection of the T64000

One of the key features of the T64000 is its very high level of laser (stray light) rejection. Above the performance is shown relative to the laser rejection found with a standard single notch filter arrangement

T64000 - Total Performance and Flexibility

The T64000 can accommodate the most demanding of applications with a unique level of functionality and performance :

Following the established high performance Raman systems of the Jobin Yvon, Dilor, and SPEX brands, the new T64000 series II triple spectrometer system is a versatile, high performance, research grade system.

- Three stage monochromator with optics, aperture and coupling optimised for performance and stability.
- Multiple motorised switching mirrors for ease of operation
- Multiple entrance and exit ports
- Directly coupled microscope options (and macro chamber if required) rigidly coupled to the spectrometer
- A large choice of options and components to enable full customisation of the system eg. gratings, detectors and sampling optics enabling operation from the UV to the NIR

Latest Technology

It combines the latest software and electronics control, with newer and optimised sampling facilities, such as the confocal FSM (Free Space Microscope). The latest generation in optics and gratings including the patented PACH grating technology enables system performance to be pushed still further. The system is particularly suited to measurements where low frequency modes, high resolution, or true spectral tune-ability are required. It provides performance in these areas which is not accessible to the small benchtop instrument.

Ultimate Flexibility

The T64000 series II is designed to provide a versatile platform for Raman analysis. It has a TRUE integrated triple spectrometer design for unprecedented optical stability and performance. The mechanical coupling is rigid and stable, the optical coupling is efficient and throughput is maximised throughout. The spectral performances in terms of laser rejection and spectral resolution are further enhanced as the 1st and 2nd stage gratings are specifically mounted on the same drive axis eliminating any de-coupling of the grating movement found with simplified individual grating drives.

System technical specification :

Focal length : 640 mm (single stage) 3 x 640 mm (triple additive)	Step size : 0.00066 nm (with 1800 gr/mm gratings)
Low frequency : < 100 cm ⁻¹ (single stage) typically 2 – 5 cm ⁻¹ (double filter stage)	Reproducibility : better than 1 pixel
Stray light rejection : 10 ⁻¹⁴ at 20 cm ⁻¹ (514 nm laser)	Gratings : 100 to 3600 gr/mm (covering UV-NIR)

Single Spectrometer dispersion nm/mm (cm⁻¹/mm)

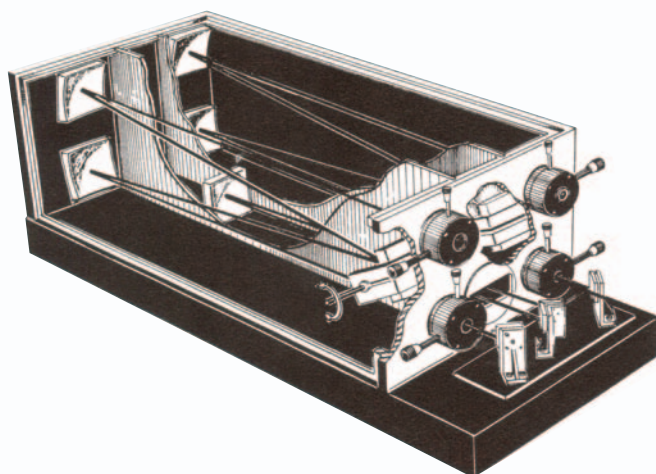
Triple additive dispersion nm/mm (cm⁻¹/mm)

Grating	at 300 nm	at 500 nm	at 800 nm	at 300 nm	at 500 nm	at 800 nm
300	5.11 (567.3)	5.07 (202.7)	5.0 (78.2)	1.70 (189.1)	1.69 (67.6)	1.67 (26.1)
600	2.52 (280.5)	2.48 (99.1)	2.39 (37.3)	0.84 (93.5)	0.83 (33.1)	0.80 (12.4)
1200	1.23 (136.2)	1.16 (46.4)	1.02 (15.9)	0.41 (45.4)	0.39 (15.5)	0.34 (5.3)
1800	0.78 (87.2)	0.70 (27.8)	0.48 (7.46)	0.26 (29.1)	0.23 (9.3)	0.16 (2.5)
2400	0.56 (62.1)	0.44 (17.7)	0.04 (0.56)	0.19 (20.7)	0.148 (5.9)	0.01 (0.19)
3600	0.318 (35.36)	0.107 (4.26)	-	0.106 (11.79)	0.036 (1.42)	-

U1000 – High resolution, high laser rejection

Specialist applications

The new U1000 double Raman spectrometer has a long 2 x 1 metre focal length with a high precision drive mechanism. The rugged aluminium chassis is stable and robust, the optics are efficient and highly developed. The instrument technology is ideally suited to very high spectral resolution (CCD and PMT detection) and to very high stray light rejection (single channel PMT detection) applications.

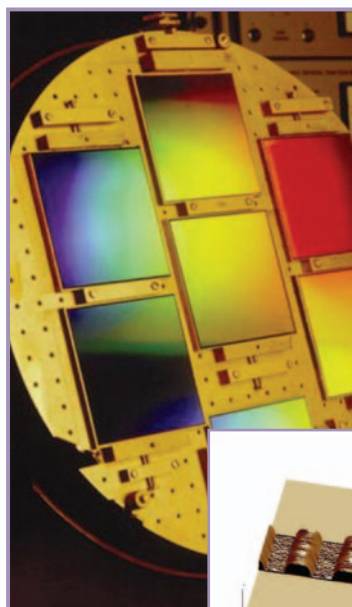


The stability and high resolution of the U1000 makes the system ideal for very high spectral resolution Raman and PL measurements

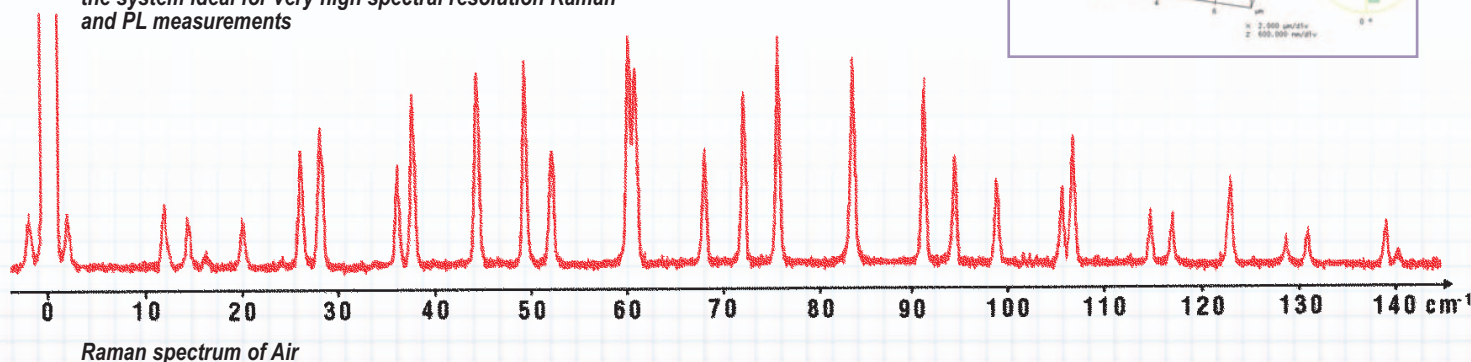
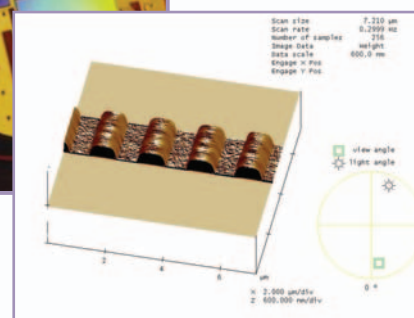
Latest Technology

As with the T64000, the instrument utilises HORIBA Jobin Yvon's expertise in grating design which combines the latest manufacturing and characterisation techniques to produce holographic and ion etched gratings that enable unequalled levels of spectral purity and efficiency to be obtained.

New software and electronics offer modern control facilities for the instrument with the same improved and optimised sampling facilities (such as the confocal microscope attachment). The U1000 system can be configured for a broad range of Micro Raman and PL measurements. Where low frequency modes are required, the U1000 provides access to the lowest frequency spectroscopic features using high sensitivity PMT detectors.

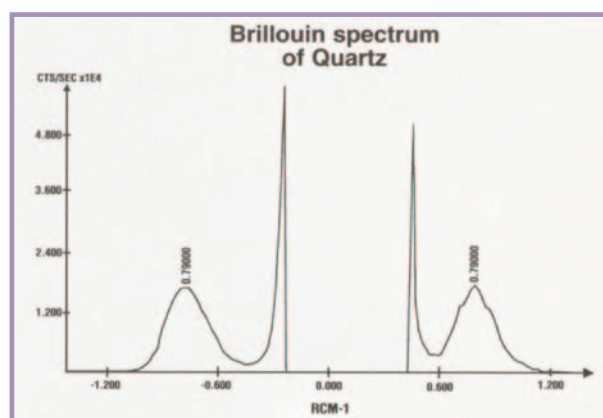
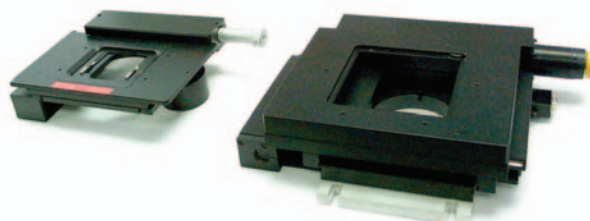


Grating production for the U1000 and T64000, optimises performance for efficiency and spectral purity



U1000 Double Monochromator

The U1000 with micro PL arrangement can be used with large wafer mapping stages and low temperature cryostats for high resolution semiconductor analysis measurements. Spectral information at such high resolution would be difficult to achieve with the small focal lengths typical of simple benchtop instruments.



With the double monochromator performance, the Stokes and anti-Stokes measurements can be obtained close to the laser line. Brillouin spectra (such as quartz above) would be impossible on a standard single spectrometer system.

System technical specification :

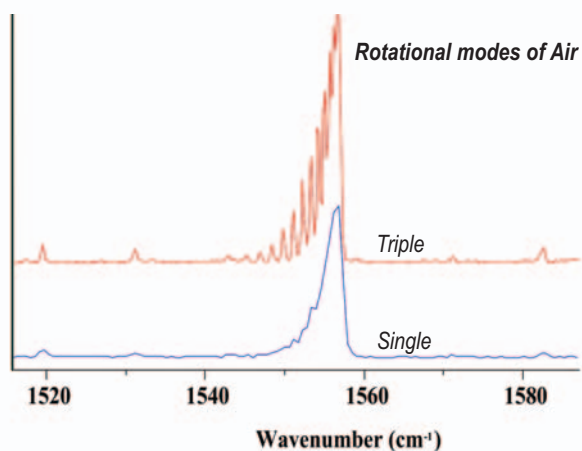
Scanning mechanism : High precision Sine Bar	Step size : 0.006 nm (with 1800 gr/mm gratings)
Focal length : 2 x 1 metre (double additive)	Reproducibility : better than 1 pixel (CCD) 0.1A (single channel PMT)
Low frequency : typically 2 – 5 cm^{-1} (with PMT) Stray Light rejection : 10^{-14} at 20 cm^{-1} of the Rayleigh line	Gratings : 100 to 3600 gr/mm (covering UV-NIR) 110 mm x 110 mm gratings

U1000 Dispersion nm/mm (cm^{-1}/mm)

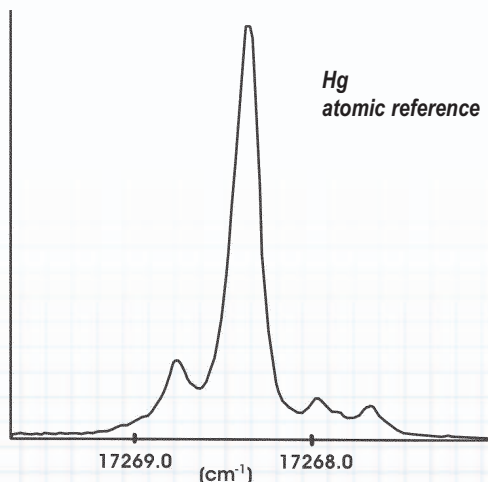
Grating	at 300 nm	at 500 nm	at 800 nm
300	1.650 (183.36)	1.641 (65.66)	1.625 (25.40)
600	0.818 (90.92)	0.81 (32.26)	0.783 (12.23)
1200	0.400 (44.40)	0.381 (15.25)	0.340 (5.32)
1800	0.258 (28.63)	0.232 (9.29)	0.168 (2.62)
2400	0.185 (20.54)	0.151 (6.04)	0.03 (0.47)
3600	0.108 (30.80)	0.044 (1.77)	-

High and Ultra high resolution : U1000 and T64000

The standard, yet comparatively long 640 mm focal length spectrometer mode of the T64000 gives a good level of spectral resolution that is ideal for investigating general effects on bonding environments, such as phase. The "fingerprint" Raman spectrum is then a powerful tool for identifying chemical composition and molecular structure.



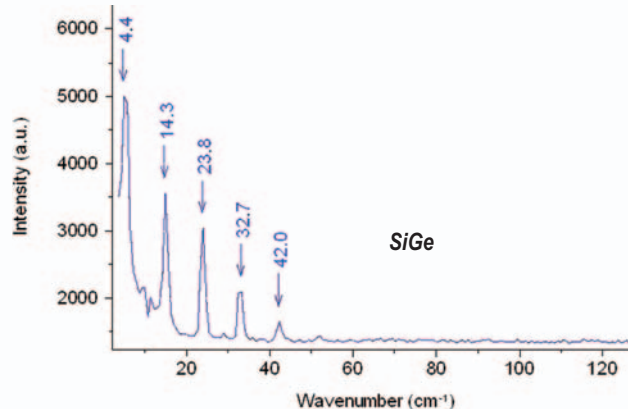
With the use of the ultra-high resolution triple additive configuration of the T64000 or the U1000 double monochromator, it is possible to study the position of Raman bands to an unparalleled degree of precision and accuracy. This is of particular importance for the measurements of intrinsic stress in materials such as GaN, SiC and in diamonds and in High Pressure Temperature measurements in earth science where stress induced shifts in the order of 0.1 cm⁻¹ are often found.



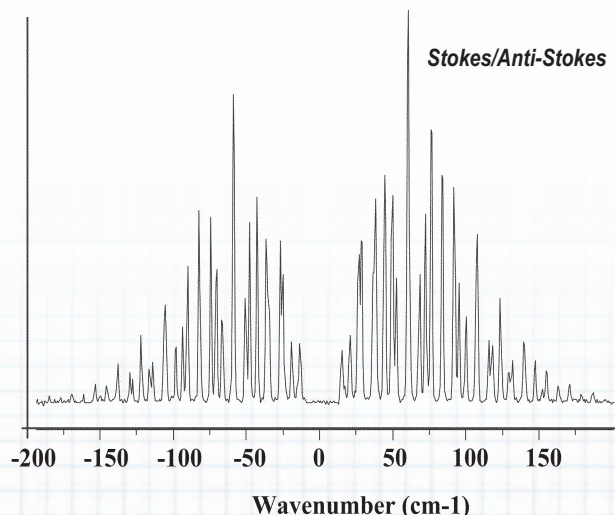
High stray light rejection : U1000 and T64000

(T64000 double subtractive filter stage)

Holographic notch filter technology provides a very good solution to laser rejection for visible wavelengths in many applications. However, there are acknowledged limitations to the use of these filters for work with tuneable sources and for work close to the laser line. Even with specially developed low frequency accessories, with many difficult samples it is still often impossible to obtain reliable data at 10, 20 or 30 cm⁻¹ on smaller Raman systems.

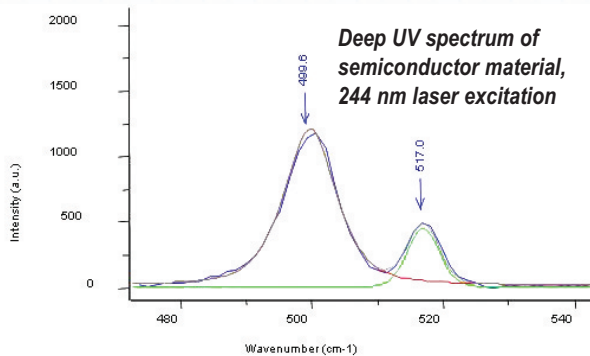


In using the U1000 or double subtractive configuration of the T64000, it is possible to obtain spectral information very close to the laser line. The above illustrates a spectrum of a proprietary SiGe material in which it is possible to observe spectral bands down as low as 4 cm⁻¹. The double spectrometer modes are ideal for studying such detail as LA modes in polymer systems, folded acoustic modes in semiconductors, crystal lattice modes, bonding effects in ceramics and so forth.



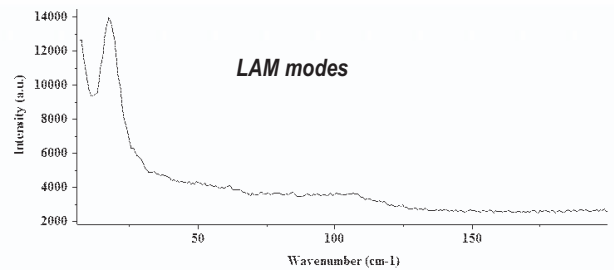
UV Raman

Samples such as semiconductors, proteins, coatings and diamond can benefit from the use of deep UV excitation. The filter stage of the T64000 enables low frequency modes to be observed even in the deep UV.



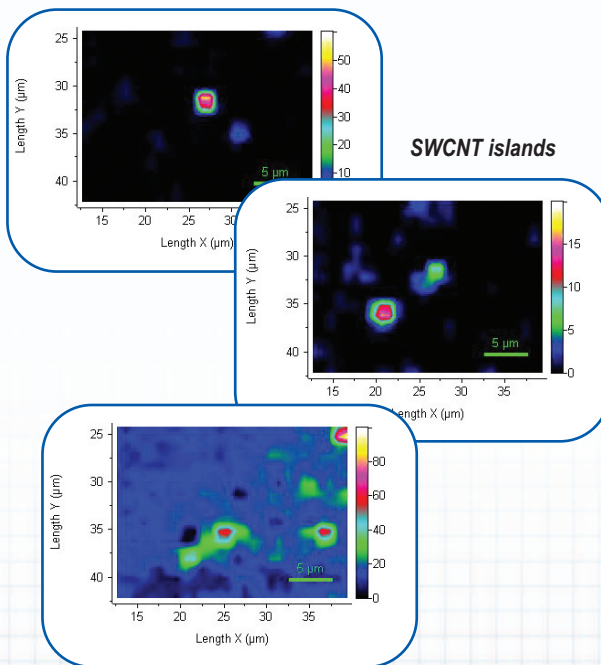
Polymer Matrices

Polymer samples can be fully explored with the Research Raman systems. Combined Raman and FTIR micro-analysis provides information on composition and component distribution, whilst the low frequency operation can determine LAM and low frequency modes characterising polymer structure in greater detail.



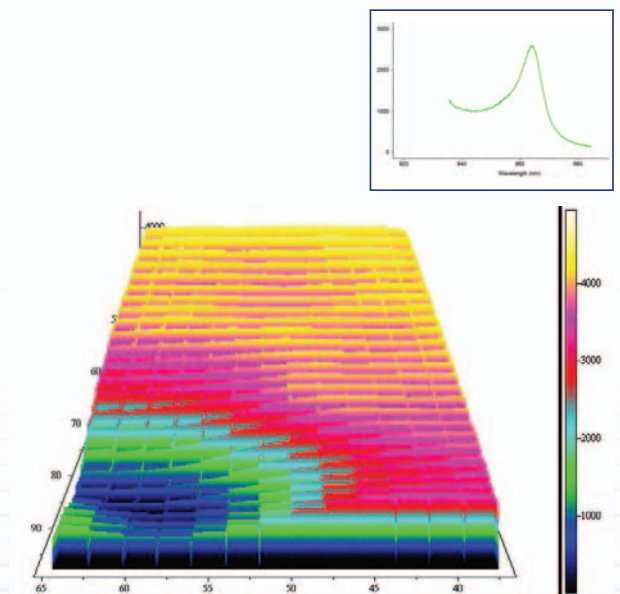
Resonance Raman

Samples such as carbon nanotubes, SERS, haem centres and bio-molecules can benefit from using tuneable sources and filters to match resonance conditions. Combined with confocal Raman mapping structural variations and distribution maps can be generated on samples such as SWCNT (single-walled carbon nanotube) islands.



Raman and PL Mapping

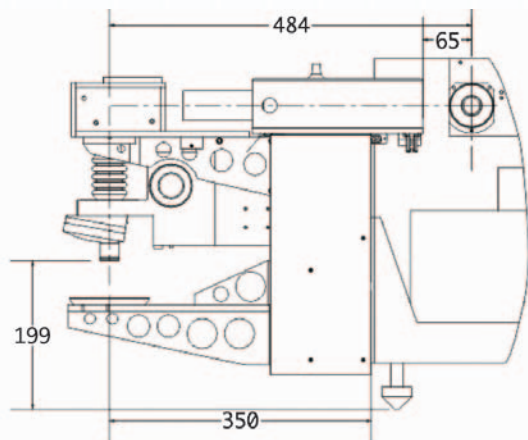
Use of the confocal microscope options can provide detailed 'chemical' images of samples. PL maps of semiconductor materials at high resolution, component localisation and distribution, stress/strain and other such microscopy measurements can be undertaken. The use of the NIR array and PIN diode detectors can even provide full spatially resolved PL information in the 800 nm to 2000 nm spectral range.



Microscopes & Macro Sampling

Confocal Microscopy : (Single mode and Triple mode microscopy)

Since the first commercialisation of the Raman microscope by Jobin Yvon in the early 1970's, the use of spatially resolved Raman analysis has continued to expand. The high spatial resolution of the new range of confocal microscope options for the T64000 and U1000 provide the highest spatial discrimination. They are capable of studying micron scale phases within geological samples, semiconductor micro-structures, even at high spectral resolution or under extreme High Pressure Temperature (HPT) conditions (where the FSM microscope is utilised).



FSM Open Frame Microscope

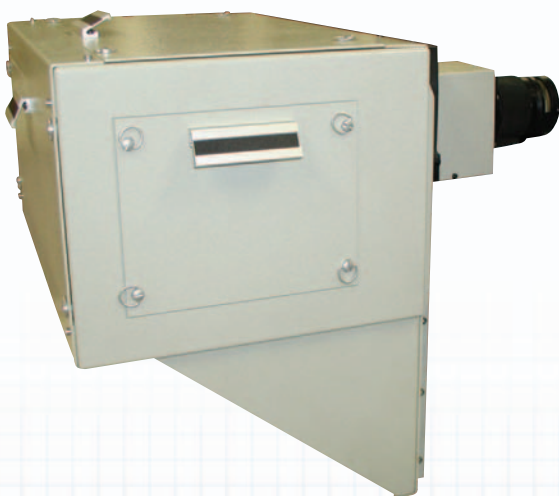
Line Scan

The unique patented Line-Scan system available on the microscope systems of the T64000 and U1000 offers the advantage of fast Raman Line-mapping. The laser is scanned across the sample at high speed by precise scanning mirrors. The effect is to produce a uniform line illumination across the sample which can be used to produce spatially resolved information across the line or an averaged spectral result ideal for less homogeneous sample types.

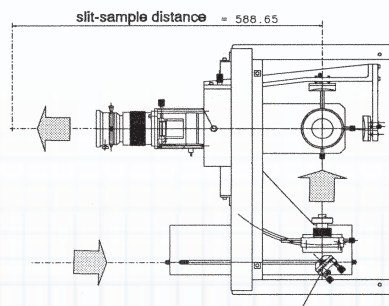
INV and UV options

The Inverted (INV) confocal microscope attachment offers access to biological samples and certain screening applications, whilst the UV microscope is adapted to provide high throughput efficiency and confocal performance without compromise in the deep UV.

Versatile Macro Chamber

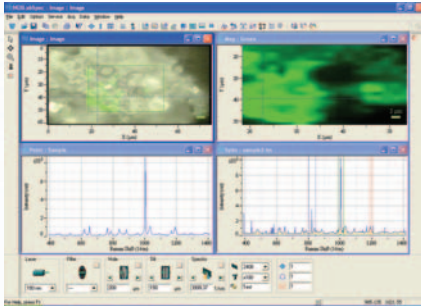


The macro chamber option offers yet further flexibility for samples where Raman microscopy is not suitable, such as samples in the bulk or where larger sampling volumes are required. This sampling device can be used in the UV-NIR regions, with interchangeable collection optics covering adjustable collection from 90° to 180° geometries. Various sample holders and mounts for bulk cryostats (such as side window He cryostats) are available.



Software

Available for Windows, 98, 2000, XP, NT

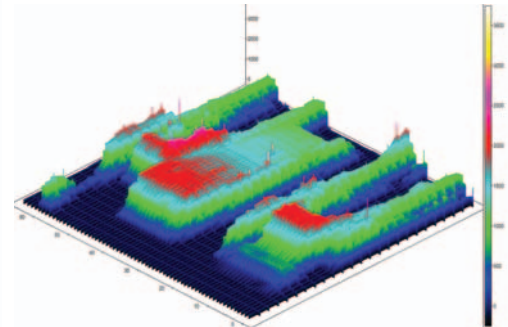


The LabSPEC NGS Spectral Software has been designed and written in-house specifically for Raman and luminescence measurements.

This highly sophisticated open architecture Kernel based software offers an efficient and easy-to-use tool for both the research and analytical operator. Icon driven screens control the different instrument functions and data acquisition. Specialised analysis and procedures within the Windows format can be incorporated.

It does not rely upon third party software, and can hence be customised for specific requirements and is not restricted in its scope of data acquisition or manipulation.

The LabSPEC NGS software also introduces the new CREST Scanning (Continuous Rapid Extended Scanning Technology) and automated acquisition control for the T64000 and U1000. The CREST scanning acquisition enables Raman spectra to be acquired over large spectral ranges seamlessly and free from any spectral artefacts that may be produced where simplified scanning operation is utilised. Fully automated Raman mapping, autofocus and image generation capabilities are provided with the confocal microscope accessory, offering as never before an ultra high performance and automated data acquisition.



Detectors



Specialised CCD detector options are supplied for use on the research Raman systems from HORIBA Jobin Yvon. Back thinned, deep depletion, open electrode, air and LN2 cooled CCD versions are all available.

Further detection options are available, including the InGaAs array detectors which can then provide access to the important NIR PL region and analysis at 1.1, 1.3 and 1.5 μm . Extended NIR detection systems can push still further into the Mid-IR range for new materials characterisation.

Intensified CCD and fast SPAD or PMT detection can be added to the system to enable single channel and time resolved capabilities to be explored fully.

Accessories

A broad range of accessories are available to expand the Research Raman instruments including :

- Microscope options
- Motorised Mapping stages
- Macro Chamber
- CCD detectors (LN2 or Air cooled)
- Secondary detection options (IR array, PMT etc...)
- Heating /cooling stages
- Remote sampling probes
- LWD and UV objectives
- UV, visible and NIR laser sources



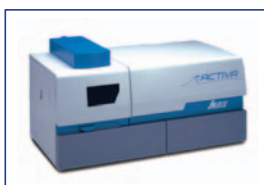
FLUORESCENCE



OPTICAL SPECTROSCOPY



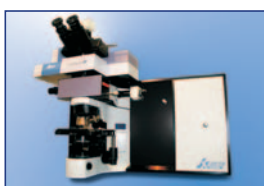
ATOMIC EMISSION SPECTROGRAPHY/ ELEMENTAL ANALYSIS



DETECTORS



RAMAN ANALYSIS



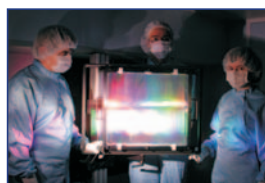
OEM SPECTROMETERS AND GRATINGS



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PARTICLE SIZE ANALYSERS



ELLIPSOMETRY



FORENSICS



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