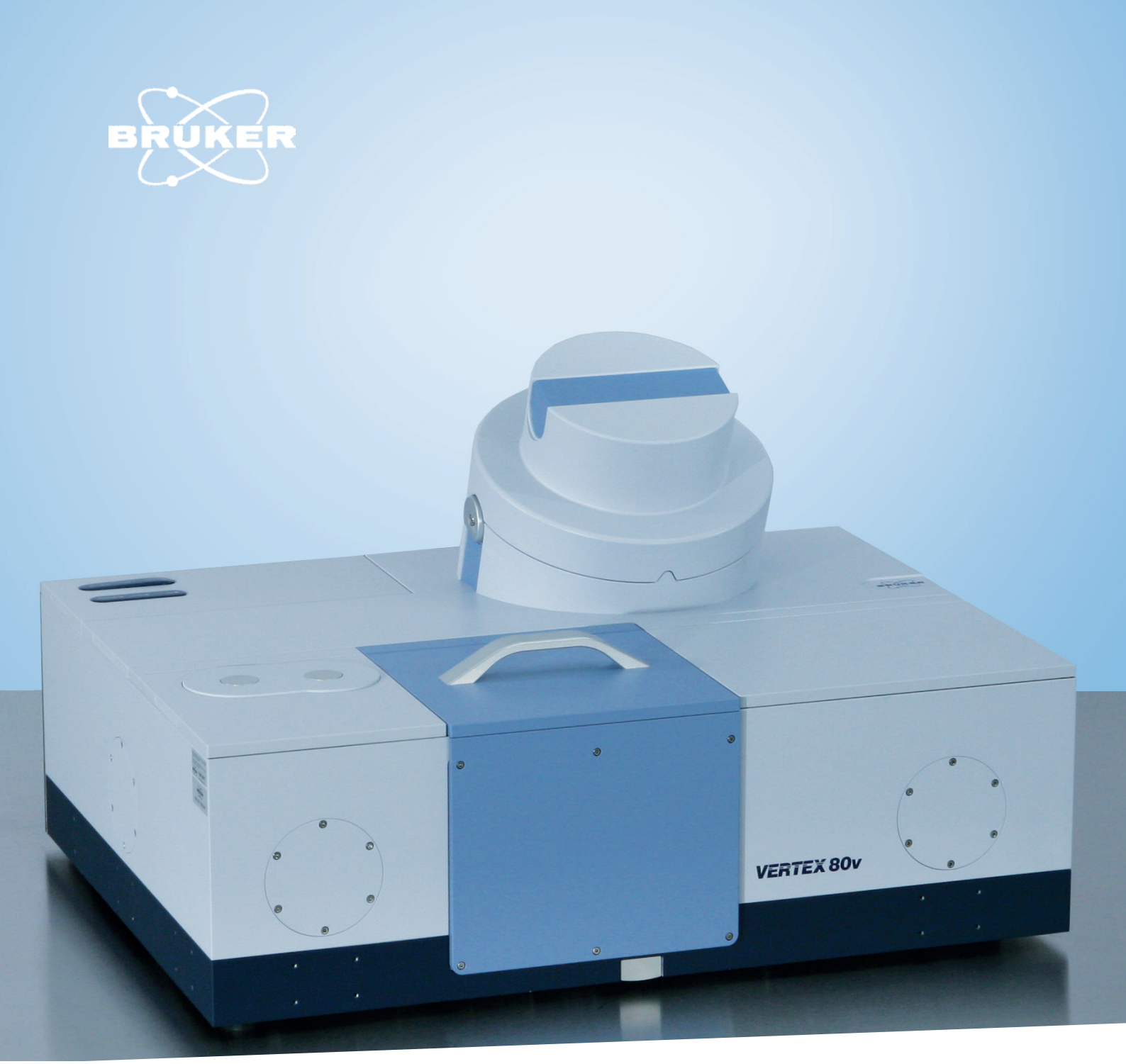
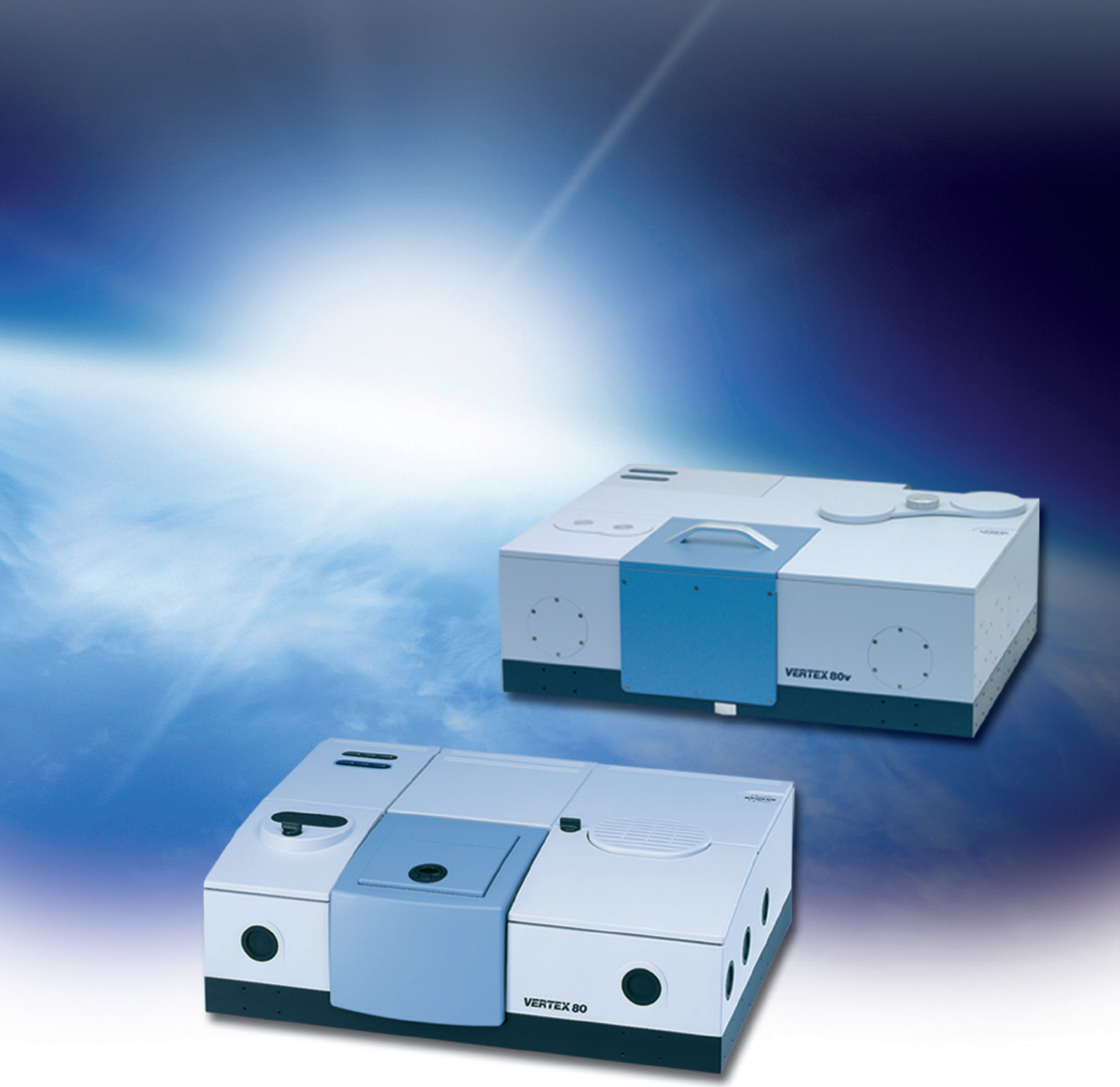


ADVANCED RESEARCH FT-IR SPECTROMETERS

VERTEX Series

Upgrade to a Higher Peak

Innovation with Integrity



The VERTEX Series is the culmination of everything Bruker has pioneered and developed over more than 40 years. Built on a fully upgradeable optics platform that is designed with the utmost flexibility in mind, VERTEX FT-IR spectrometers share a wide range of advanced features.

System Design

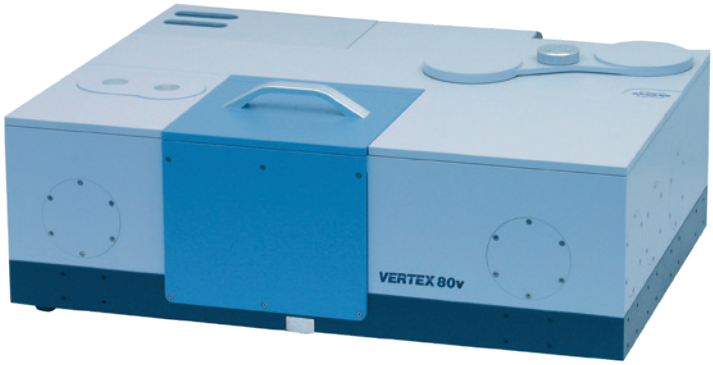
The VERTEX 80 and 80v are designed for the most demanding research applications, and utilize the UltraScan™ interferometer that is designed for high resolution, rapid scanning, and superior performance over a very wide spectral range. The vacuum version VERTEX 80v provides the ultimate rejection of interference from the laboratory environment.

BRAIN: BRuker Artificial Intelligence Network

BRAIN is a collection of intelligent functions; including the recognition of sampling accessories and optical components, and automatic set up and verification of measurement parameters. Spectrometer electronics and mechanical components are constantly monitored to assure they are functioning correctly. The electronically coded sources, detectors, and beamsplitters are recognized by the instrument, and the experimental parameters are immediately reconfigured by Bruker Optics' Automatic Component Recognition (ACR) system. In addition, if two conflicting components are installed, the system will recognize this and suggest possible solutions to the user. These features provide ease of use for the VERTEX Series even for demanding, complex research applications.

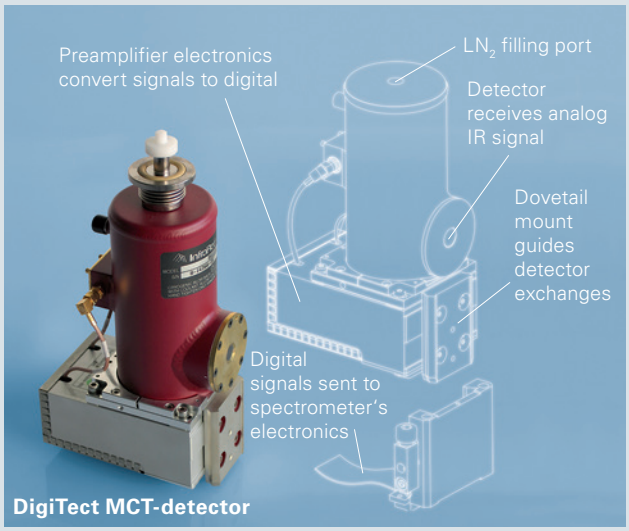
Superior Features

- Highest resolution and resolving power
- Peak signal-to-noise performance
- Fastest scanning speed
- Evacuable, purgeable or sealed and desiccated optics bench for lowest atmospheric interferences
- Largest number of beam ports, software selectable
- Easy beamsplitter exchange without interferometer alignment for widest spectral range extension to the near IR, visible/UV and far IR/THz
- Recognition of all sampling accessories and optical components
- Step/Slow-Scan time resolved and modulation options
- Widest range of extensions to meet all current and future needs



VERTEX 80v vacuum optics bench.

Fully Digital Data Acquisition



The VERTEX Series is a fully digital FT-IR spectrometer providing the highest flexibility and the highest instrument performance. The data acquisition is based on delta-sigma ADC's with true 24-bit dynamic range that are integrated into the detector preamplifier electronics. Bruker's patented advanced DigiTect technology prevents external signal disturbance and guarantees the highest signal-to-noise ratio.

- True 24-bit dynamic range
- No gain-switching artifacts
- Parallel dual-channel data aquisition
- Integrated detector electronics
- No noise spikes in the IR spectrum
- Compact electronics design

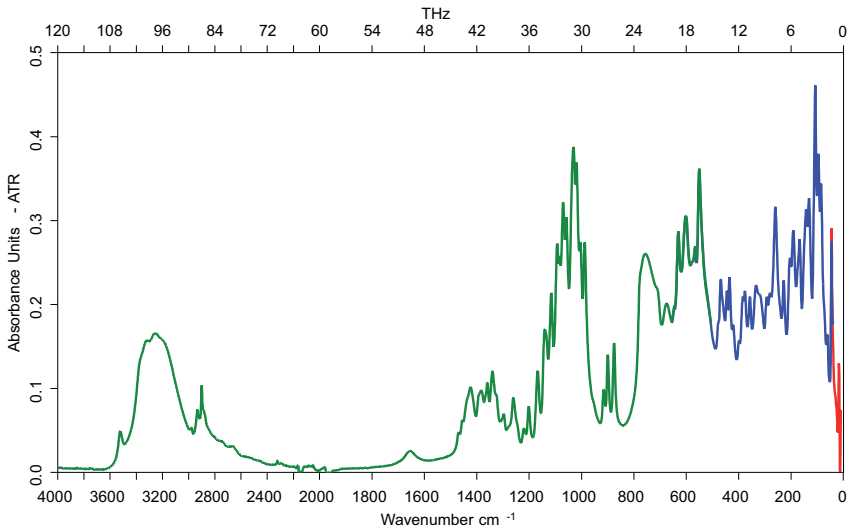
Wide Spectral Range

Spectral Range Extension

The VERTEX 80 and the VERTEX 80v can optionally be equipped with optical components to cover the spectral range from 10 cm^{-1} (5 cm^{-1} for the VERTEX 80v) in the very far IR, or terahertz region, through the mid IR, near IR, visible and ultraviolet spectral ranges all the way to 50,000 cm^{-1}. With its pre-aligned optical components and the actively aligned UltraScan™ interferometer, spectral range change is easily accomplished. Automated switching in the full spectral range is provided by the four position automatized beamsplitter exchange unit BMS-c which works even under vacuum condition. The new unit is field upgradable on already installed VERTEX 80v spectrometers. In connection with an optional external detector chamber in total up to five detectors can be permanently mounted and remotely selected. All of these detectors are usable to acquire data of samples placed inside the standard sample compartment. The different detectors are operated either at room temperature or liquid N_2 and liquid He temperatures.

Electronically coded beamsplitters can be manually or optional automatically exchanged by the user. The spectral range change is recognized when the component is inserted.

Match of spectral ranges



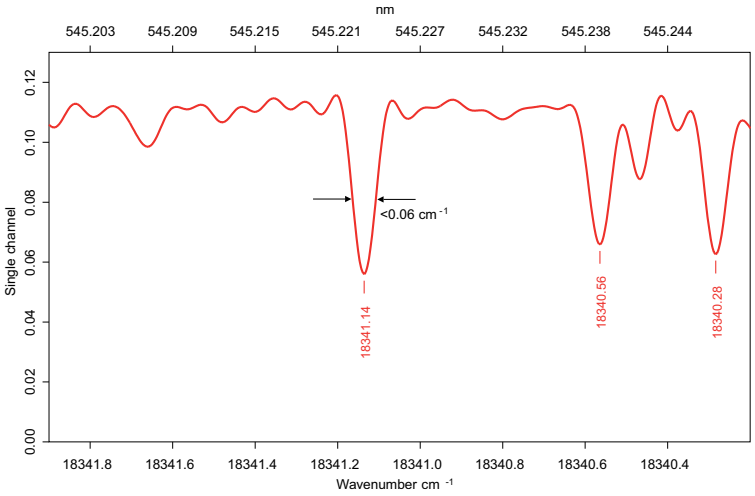
Using the Platinum Diamond Micro-ATR unit (A225/Q) the pharmaceutical filler material lactose monohydrate was measured in the mid and far IR spectral ranges showing a perfect match in the overlapping ranges at 600 cm^{-1} and below 100 cm^{-1}.

Highest Resolution

Highest Spectral Resolution

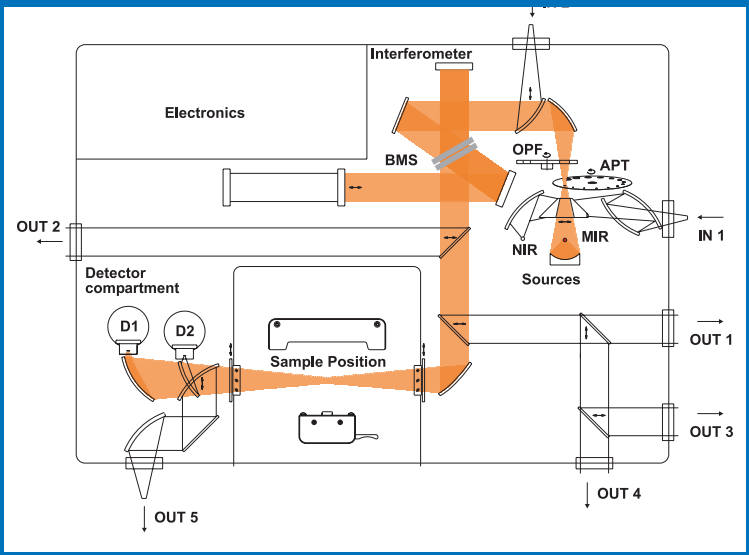
The VERTEX 80 standard configuration provides apodized spectral resolution of better than 0.2 cm^{-1}. For advanced high resolution application an optical PEAK resolution of better than 0.06 cm^{-1} is available. Such a high resolution is achieved even in the short wavelength visible spectral range, providing a resolving power of $\nu/\Delta\nu$ (band position divided by the band width at half height) of better than 300,000:1. Other manufacturers measure the resolution in the mid-IR around 2,000 cm^{-1}. A far more stringent test of a spectrometer is to measure the resolution at short wavelength, because it requires a much higher resolving power and optics precision.

VERTEX 80 optics bench in the standard configuration.



Resolving power of the VERTEX 80
High resolution measurement showing electronic band transitions of iodine vapor in the visible spectral range, with a typical absorption band width at half height of less than 0.06 cm^{-1}. Demonstrated resolving power, $\nu/\Delta\nu$, is better than 300,000:1 which is unmatched by any commercial bench-top FT-IR spectrometer.

VERTEX 80 beam path



UltraScan™ Interferometer

The VERTEX 80 and the VERTEX 80v vacuum FT-IR spectrometers are based on the actively aligned UltraScan™ interferometer, which provides PEAK spectral resolution. The infinite life linear air bearing, TrueAlignment of the scanning interferometer arm and PEAK quality optics guarantee the ultimate sensitivity and stability.

The innovative TrueAlignment technology does not produce the artifacts, such as ghost peaks and additional noise, that can occur with the dynamic alignment systems used in other spectrometers.

VERTEX 80v Vacuum Optics Bench

Why Vacuum Optics?

The most common method of reducing the effects of atmospheric contaminants is to purge the optics bench as can be done for the VERTEX 80 FT-IR spectrometer. However, there are certain cases, in which it is difficult to obtain adequate results with a purged instrument. Residual moisture absorptions by room air can lead to significant noise in infrared spectroscopy. The vibrational modes of water vapor and carbon dioxide exhibit rotational splitting, giving a very large number of sharp and intense lines. Software procedures can not completely remove them because their shape and intensities are temperature and resolution dependent and the possible uncompensated residuals may mask weak but important spectral features. Only a vacuum spectrometer can completely remove these lines, thus permitting the highest quality spectra to be recorded by making use of the achievable high sensitivity and stability.

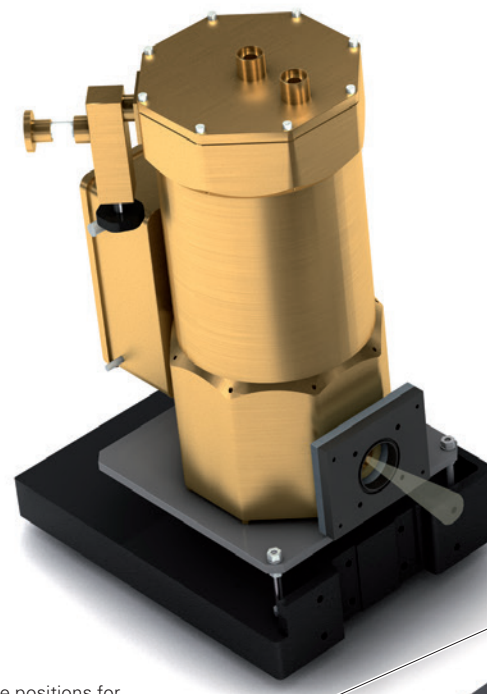
Vacuum Advantages

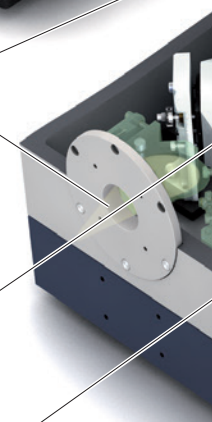
- Weak spectral features are not masked by moisture absorptions
- High spectral resolution features do not interfere with CO_2 and H_2O absorption lines
- Cast aluminium housing of the optics bench provides highest stability
- No problems caused by dry air purge supply fluctuations

The VERTEX 80v vacuum spectrometer provides unique options for the separation of the sample compartment from the additional parts of the optics bench. The sample compartment ports are either permanently equipped with IR windows, or adjustable telescopic windows can be used in order to minimize the room air path length or it is even possible to fit automatic sample compartment shutters. These shutters are especially useful since they allow venting and re-evacuating the sample compartment for sample exchange and leave the optics beam path free of any window absorptions which increases the signal to noise ratio of the measured spectra.

VERTEX Vacuum Features

- Rapid evacuation by high speed, dry vacuum pump
- Four position automatic beamsplitter exchange option for the VERTEX 80v vacuum optics bench.
- Automatic sample compartment shutter option for quick sample exchange
- Permanently mounted windows or adjustable telescope windows for permanently purged sample compartment
- EMC compatible O-ring sealing





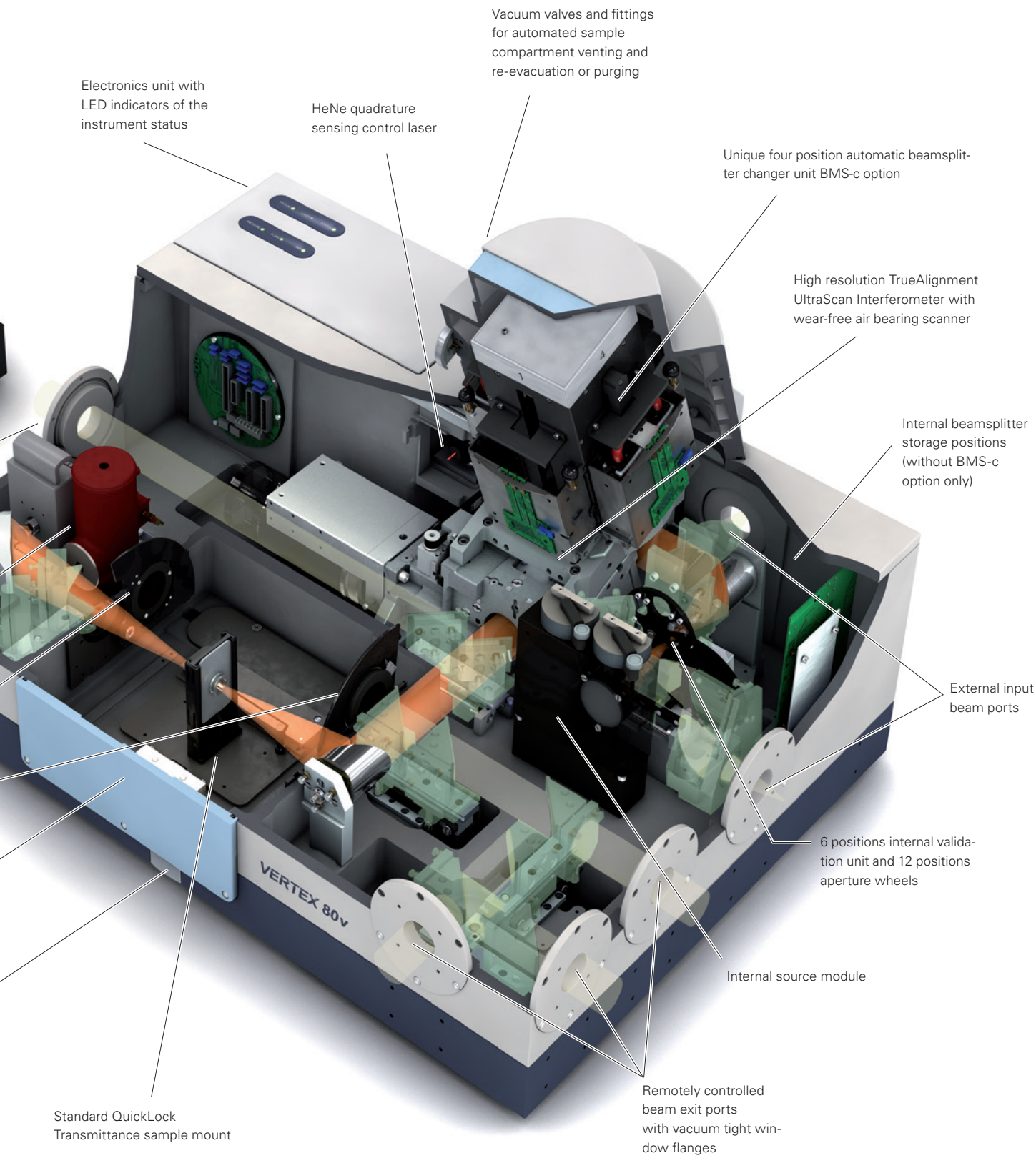
Possible positions for externally vacuum tight adapted detectors such as liquid He cooled bolometers for the far IR/THz spectral ranges

Detector compartment with selectable DigiTect positions for room temperature and LN_2 cooled detectors

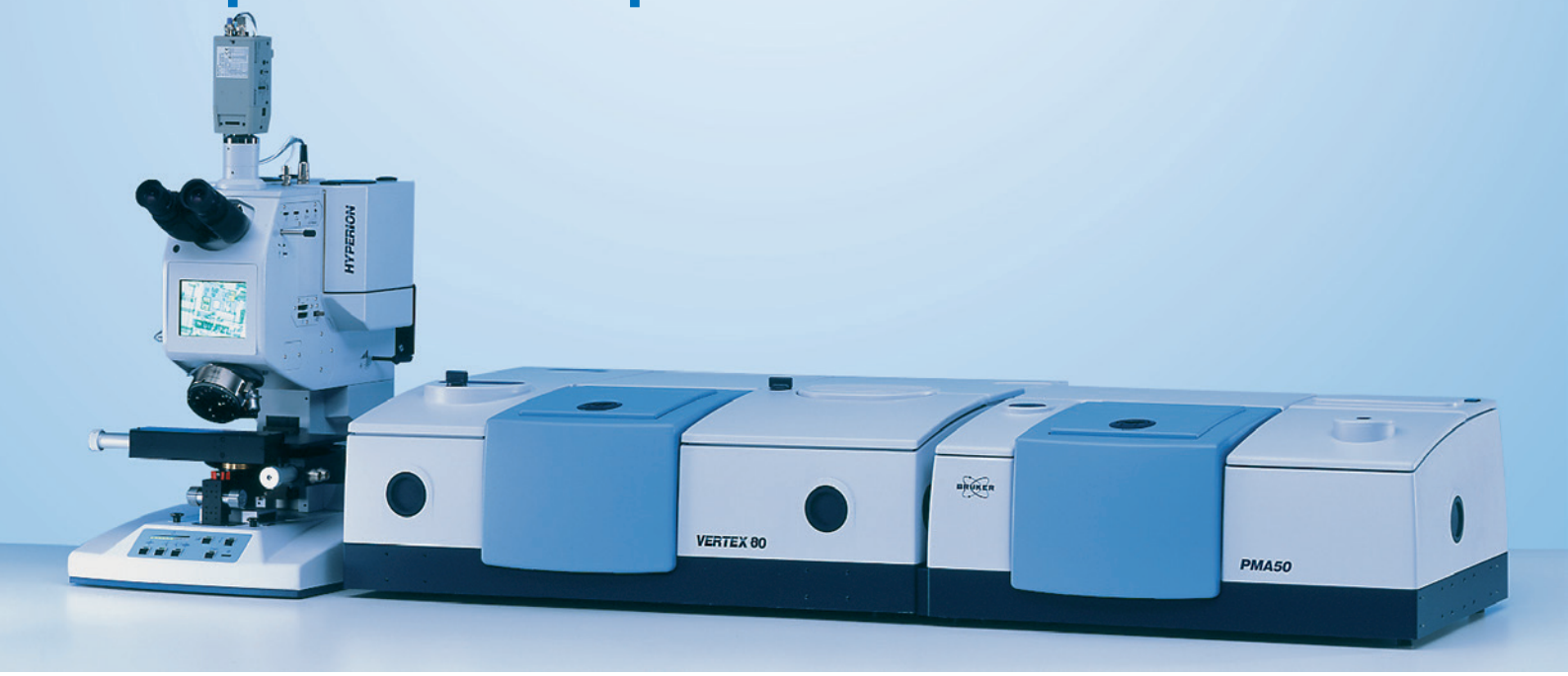
Optional automatic sample compartment shutter

Removable and vacuum tight sample compartment front side flange

External QuickLock accessory release button for easy exchange of internal measurement accessories


Vacuum valves and fittings for automated sample compartment venting and re-evacuation or purging
Electronics unit with LED indicators of the instrument status
HeNe quadrature sensing control laser
Unique four position automatic beamsplitter changer unit BMS-c option
High resolution TrueAlignment UltraScan Interferometer with wear-free air bearing scanner
Internal beamsplitter storage positions (without BMS-c option only)
External input beam ports
6 positions internal validation unit and 12 positions aperture wheels
Internal source module
Remotely controlled beam exit ports with vacuum tight window flanges
Standard QuickLock Transmittance sample mount
VERTEX 80v

Expand Your Capabilities



The HYPERION II provides the most advanced FT-IR microscopy capabilities, utilizing state of the art optics for optimal sample visualization.

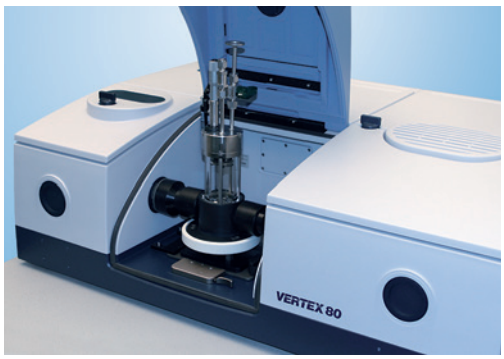
The PMA 50 is ideal for polarization modulation infrared reflection absorption spectroscopy (PM-IRRAS) and vibrational circular dichroism (VCD) spectroscopy.

Upgradability

The VERTEX optics and beam path are designed for highest flexibility and upgradability. Spectral range extensions to FIR/THz, NIR or UV/VIS, additional optical components for highest spectral performance, internal accessories or external modules for new applications, or other high-end functionalities such as rapid scan, step/slow scan and automatic BMS changer (available for VERTEX 80v) are easy and cost-efficient to achieve.

Internal Accessories

The VERTEX has a large sample compartment to accommodate virtually any FT-IR sampling accessory from any vendor. Sampling accessories are mounted and pre-aligned on Bruker's QuickLock baseplate for fast, easy and reproducible exchange. Immediately after the sampling accessory is inserted, it is automatically recognized by the IntelliSense coding. Existing commercial and custom made accessories can be retro-fit to the Automatic Accessory Recognition (AAR) system, including the firmware.
Vacuum tight sample compartment adaptations for various measurement accessories are made available in order to acquire environment isolated pure spectra. Examples are cryogenic liquid or closed cycle refrigerator (CCR) cooled cryostats or multipath gas cells for operation at room and variable temperatures.



The large QuickLock sample compartment accommodates any type of short path or long path gas cell (e.g. White type) or dedicated sample accessories for e.g. reflectance measurements at variable angle of incidence. The angle of incidence at the below shown A513/Q can be adjusted manually or stepper motor driven.

External Accessories

The VERTEX series offers an extensive line of sampling accessories for the internal sample compartment for transmission, ATR, specular, diffuse reflectance and other types of measurements. The VERTEX series is also ideal for applications that need to be carried out using accessories that can only be mounted externally, e.g. for space reasons or to keep the internal compartment free for more routine measurements.

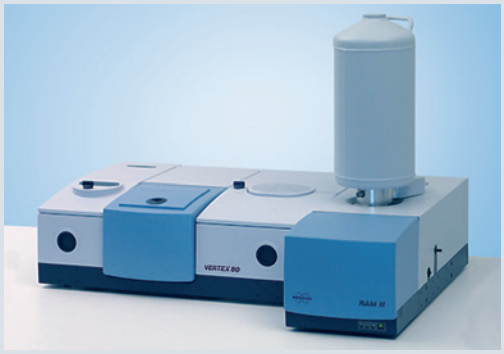
There are virtually no limitations with respect to flexibility. Five beam exit ports on the right, front and left side and two beam input ports on the right and rear side of the optics bench are available. This allows simultaneous connection of, for example, a synchrotron light source using the rear side input port, the PMA 50 polarization modulation accessory at the right side exit port, a fiber optics coupling at the right front port, a bolometer detector at the left front port and the HYPERION FT-IR microscope at the left side exit port.

The possibility of combining internal and multiple external accessories makes the VERTEX Series an exceptionally powerful system that can handle almost any analytical problem that can be solved by FT-IR analysis.

Available External Accessories

- HYPERION II FT-IR Microscope
- HYPERION II FT-IR Imaging System
- RAM II FT-Raman Module and the
- RamanScope III FT-Raman Microscope
- PL II Photoluminescence Module
- HTS-XT High Throughput Screening eXTension
- TGA-coupling
- PMA 50 Polarization Modulation
- Accessory for VCD and PM-IRRAS
- External sample compartment, evacuable or purgeable
- Vacuum PL/PT/PR measurement unit
- 4 position detector chamber
- Fiber optic coupling unit with MIR- or NIR-fiber probes for solids and liquids
- External vacuum tight UHV-chamber adaptation
- Large Integrating sphere
- Auto sampler devices
- External sampling platform for simultaneous ATR and transmittance measurements
- verTera THz Extension for VERTEX 80v

RAM II FT-Raman Module



The RAM II dual-channel FT-Raman module combines fast and easy sample handling with maximum suppression of interfering fluorescence obtained by using a 1064nm laser for excitation. Bruker's proprietary ultra high sensitivity intrinsic Ge detector with 5 days hold time of refrigerant, superior collection optics, and the 24-bit dynamic range electronics provide unsurpassed sensitivity and long-term stability. The RAM II's large sample compartment can accommodate an extensive range of prealigned sampling accessories. The system can also be coupled to the RamanScope III FT-Raman microscope for fluorescence free Raman analysis of small samples.

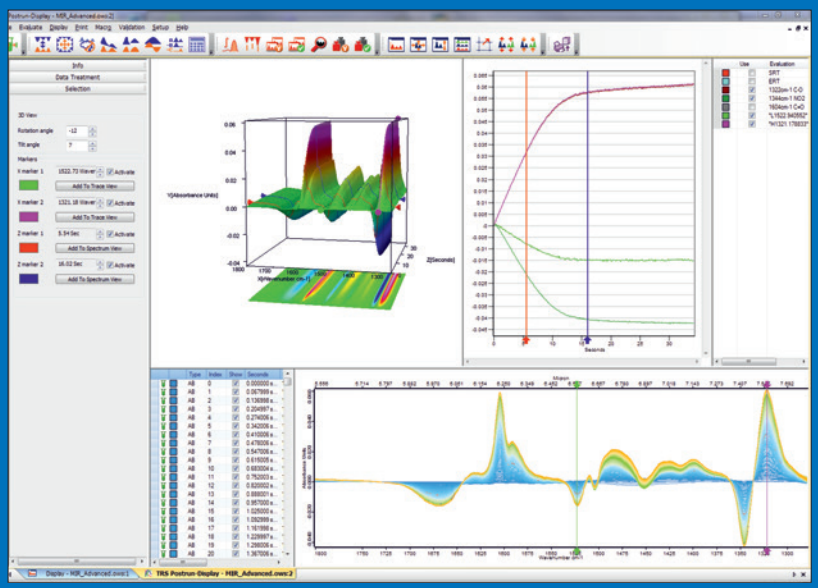
HYPERION FT-IR Microscope

Featuring full automation, infrared chemical imaging, crystal-clear sample viewing and a wide variety of IR and visible objectives, the HYPERION series provides everything needed to conduct the most demanding micro-analysis easily and efficiently. The HYPERION uses a Focal Plane Array (FPA) detector and proprietary detector optics for hyperspectral imaging, resulting in unmatched speed, sensitivity, and spatial resolution down to the diffraction limit.

Data Acquisition and Analysis

OPUS Software

The integrated OPUS spectroscopy software provides unsurpassed flexibility. As an example, the OPUS/3D package shown on the right provides processing and viewing of the results obtained with time resolved or mapping packages such as OPUS/CHROM, REACTION, MAP, FPA and VIDEO. It supports 2D (traces) and 3D (stacked and contour) representations of the data together with video images. OPUS/3D includes a variety of useful post-processing options. All manipulations and evaluation functions offered in the OPUS software can be applied to 3D files in the same way they are applied to a single spectrum.



The parallel two-channel data acquisition design of the VERTEX series makes demanding applications like advanced modulation and time resolved spectroscopy in the Rapid- and Step-Scan mode easier and more powerful than ever before and provides outstanding signal-to-noise ratios.

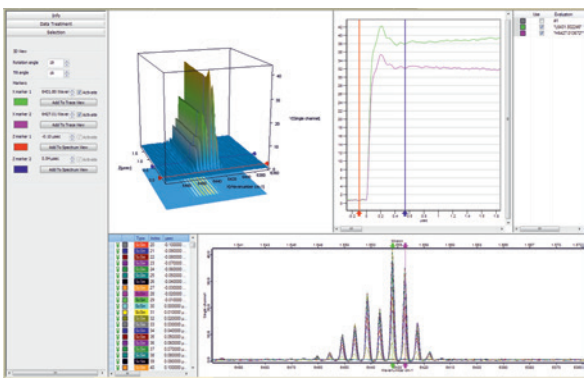
Step-Scan

As an example, the kinetics of the switch-on behavior of an IR-laser LED was measured at 10ns temporal and 2 cm^{-1} spectral resolution, using the VERTEX 80 equipped with a liquid N_2 cooled very fast DC-coupled photovoltaic (pv) MCT detector in the step-scan data acquisition mode. The figure on the right shows the 3D representation of the result under OPUS 7.

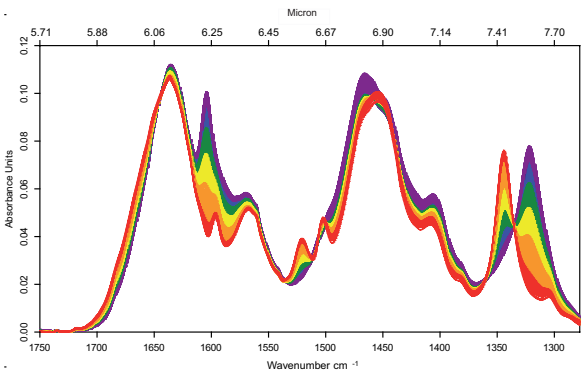
Rapid-Scan

The benchmark for the highest Rapid-Scan speed has been set! More than 110 spectra/sec can be acquired with the VERTEX 80 Series instruments using a liquid N_2 cooled MCT detector, an optical scanner velocity of 20 cm/sec and 16 cm^{-1} spectral resolution. The spectra on the right monitor an enzyme catalysis reaction with 68 msec temporal resolution and 4 cm^{-1} spectral resolution. Further post-measurement software can improve the temporal resolution down to 17 msec (see application note AN74).

Step Scan



Rapid Scan



Applications

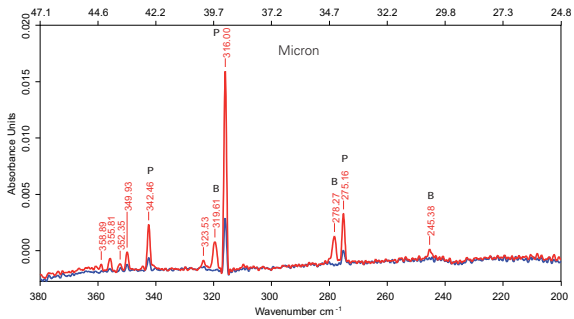
Excellence in all FT-IR Studies

The VERTEX series is the best range of FT-IR spectrometers available for demanding applications and measurements that require exceptional signal-to-noise ratios, such as the study of chiral molecules using vibrational circular dichroism (VCD), the measurement of monolayers or sub-monolayers using infrared reflection absorption spectroscopy (IRRAS), and the measurement of impurities in semiconductors. Cryostat systems and adaptations to ultra high vacuum chambers are also available for these types of studies.

Semiconductor Impurity Determination

Shallow impurity concentrations in silicon such as boron (B) and phosphorous (P) can be determined below 10K in the transmittance mode. Outstanding sensitivity in the range of low ppta (parts per tera atoms) is typically achieved, which corresponds to a concentration of ~10^{11} atoms/cm^3. The spectra on the right show the boron and phosphorus absorption band series in the far IR with (red curve) and without (blue curve) illumination of a 3.5 mm thick single crystal silicon sample. The spectra were measured using a liquid He cooled bolometer detector at 0.5 cm^{-1} spectral resolution.

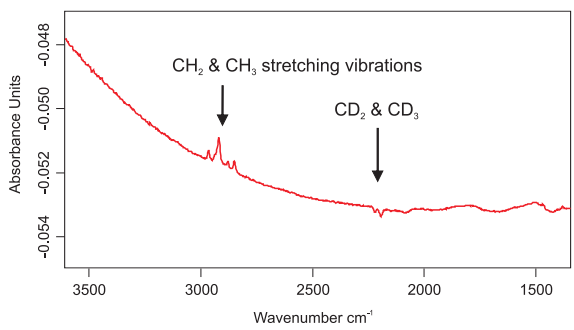
Shallow impurities in Silicon



Thin Layer Analysis

The example on the right shows the grazing angle reflectance spectrum of a C18 thiol self assembled monolayer (SAM) on gold, measured under vacuum condition. The background used for the measurement was a deuterated version of the same monolayer, and the inverted C-D stretching bands are clearly visible in the spectrum. The baseline curvature is due to differences in the quality of the gold substrate between the two samples.

C18-Thiol SAM



Specifications

		VERTEX 80	VERTEX 80v
Performance	Spectral Range	Mid-IR, NIR, Far-IR/THz, Visible/UV 10 cm^{-1} to 50,000 cm^{-1} (200 nm)	Mid-IR, NIR, Far-IR/THz, Visible/UV 5 cm^{-1} to 50,000 cm^{-1} (200 nm)
	Spectral Resolution	Better than 0.2 cm^{-1} (apodized), optional better than 0.06 cm^{-1}	Better than 0.2 cm^{-1} (apodized), optional better than 0.06 cm^{-1}
Optics Bench	Optics Housing	Standard sealed and purgeable	Standard vacuum or purgeable, includes dry vacuum pump
	Input Ports	Up to 2	Up to 2
	Output Ports	Up to 5	Up to 5
	Sample Compartment	Purgeable	Vacuum or Purgeable
	Accessory Recognition	Standard	Standard
	Component Recognition	Standard	Standard
Optional Components & Electronics	Detectors internal	Up to two 24 bit dual-channel ADC DigiTect™	Up to two 24 bit dual-channel ADC DigiTect™
	Detectors external	Four, multiplexed up to 16	Four, multiplexed up to 16
	Interferometer	UltraScan™	UltraScan™
	Sources	Internal air cooled MIR, optional Tungsten NIR and external water cooled MIR, Tungsten, Hg-Arc and air cooled Deuterium	Internal MIR, optional Tungsten NIR and external water cooled MIR, Tungsten, Hg-Arc and air cooled Deuterium
	Dual Channel Electronics	Standard	Standard
	Interface	Ethernet	Ethernet
	Bolometer	1 optional	2 optional
	Internal Validation Unit and Aperture Wheel	Standard	Standard
Dedicated Techniques	Rapid Scan	>110 spectra/sec at 16 cm^{-1} spectral resolution	>110 spectra/sec at 16 cm^{-1} spectral resolution
	Slow Scan & Step Scan	10 Hz (0.00063 cm/sec), Phase modulation and internal demodulation, Temporal resolution 6 µsec/2.5 nsec	10 Hz (0.00063 cm/sec), Phase modulation and internal demodulation, Temporal resolution 6 µsec/2.5 nsec
External Accessories	HYPERION Series FT-IR Microscopy and Imaging System, RAM II FT-Raman and PL II Photo-Luminescence Modules, PMA 50 Polarization Modulation Compartment, HTS-XT High Throughput Module and TGA-IR Coupling		
Software	Integrated OPUS operation and evalution software, fully validated, IQ/OQ/PQ test standards, 21 CFR Part 11 compliant		

Laser class 1 product (VERTEX 80)
Laser class 2 product (VERTEX 80v)

Bruker Optics is continually improving its products and reserves the right to change specifications without notice.
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