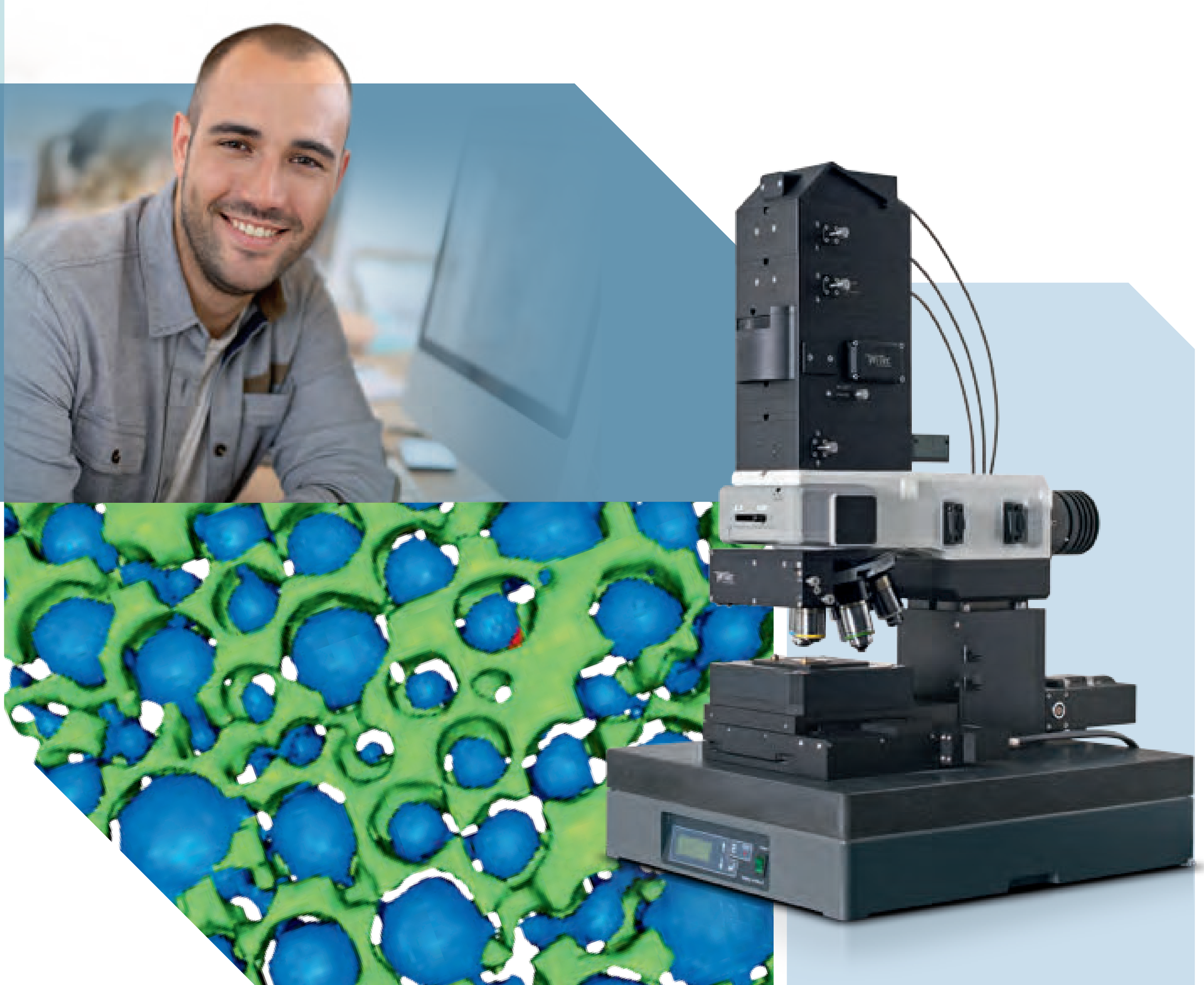
WITec alpha300 Series

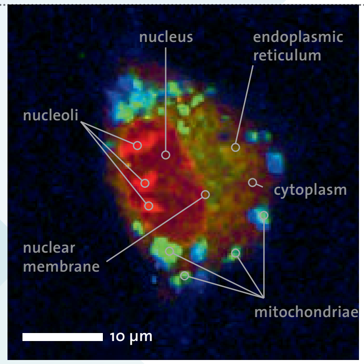
Raman · AFM · SNOM

High-Resolution Optical and Scanning Probe Microscopy Systems

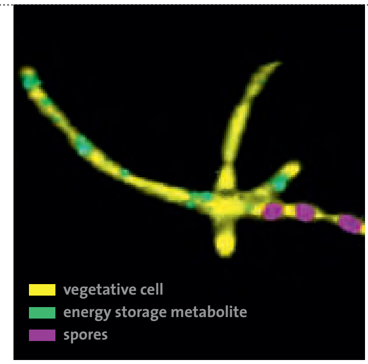


www.witec.de

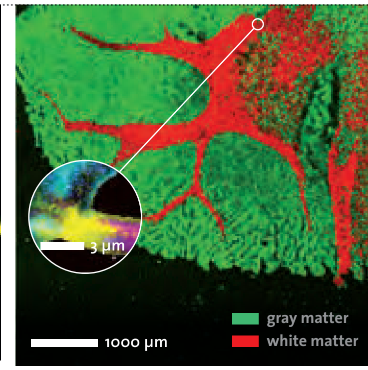
Life Science



Raman image of a living cell

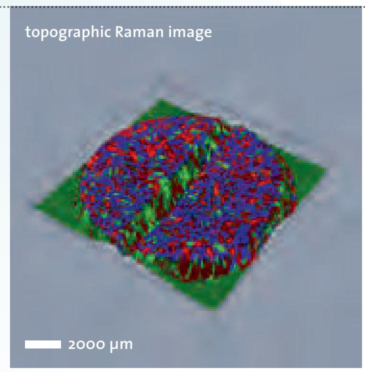


Raman image of Bacillus cereus

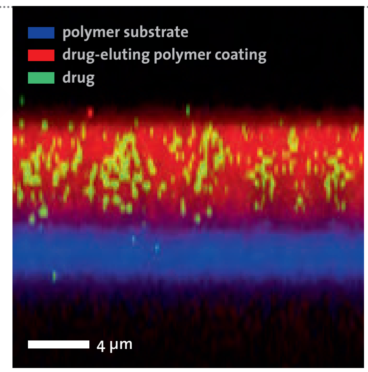


Large-area Raman image of the gray and white brain matter of a hamster brain along with a high-resolution zoom-in image at the border between gray and white brain matter

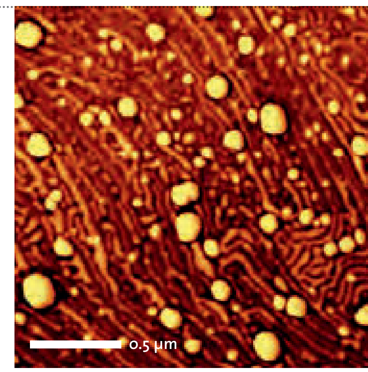
Pharmaceutics, Cosmetics and Food Science



TrueSurface Microscopy® applied to a pharmaceutical tablet

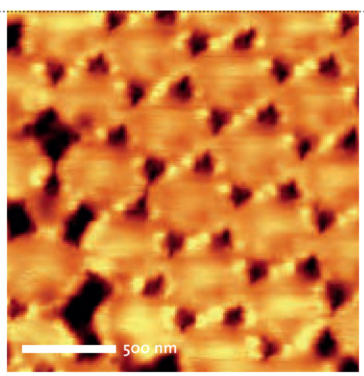


Confocal Raman depth-scan image of a drug-eluting stent

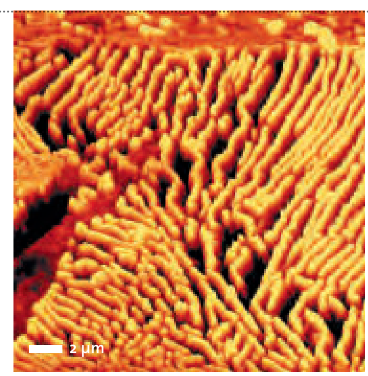


High-resolution AFM phase image of a drug-eluting stent surface showing the polymer substrate structure with the embedded drug particle

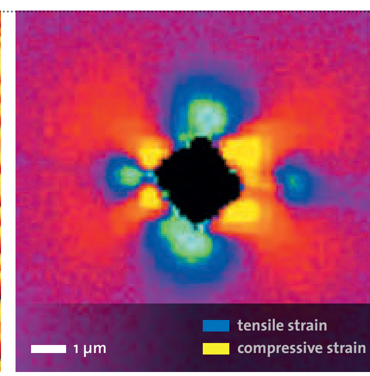
Materials Science



High-resolution SNOM image of a latex projection pattern

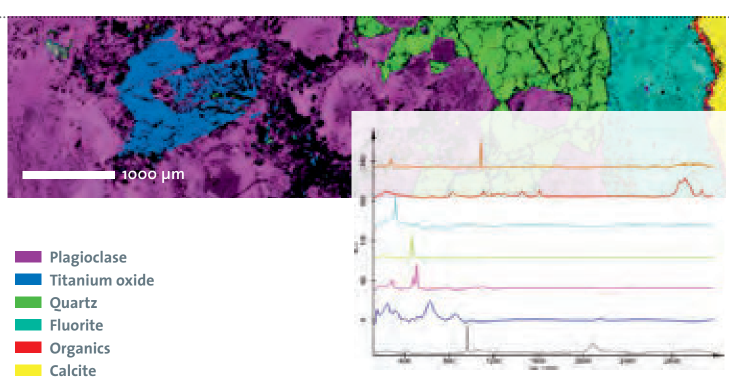


AFM topography image of a steel surface

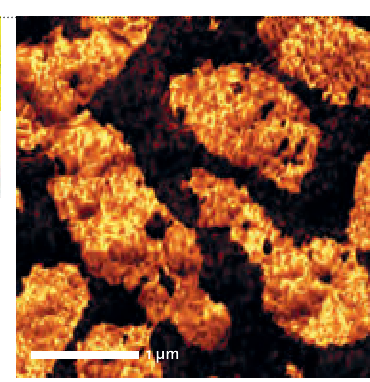


Material stress in silicon imaged via peak-shift analysis

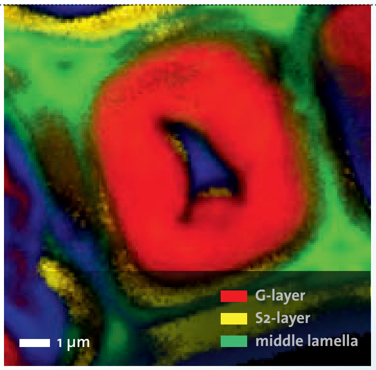
Geoscience



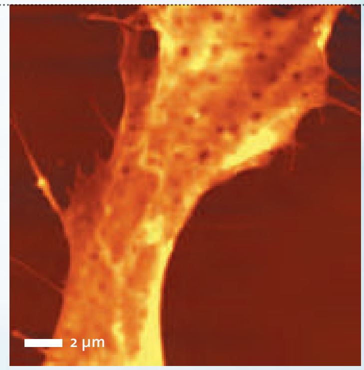
Large-area Raman image of a polished rock section with corresponding spectra



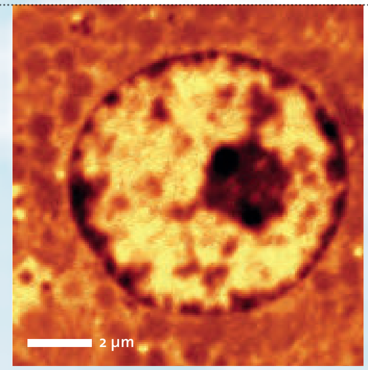
AFM image (Pulsed Force Mode) of fossilized bacteria



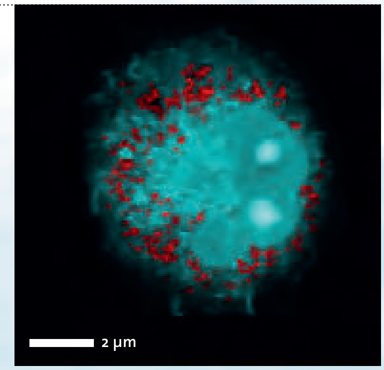
Raman image of a wood cell



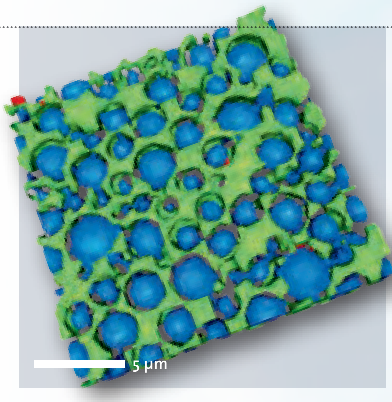
AFM image of a cell surface



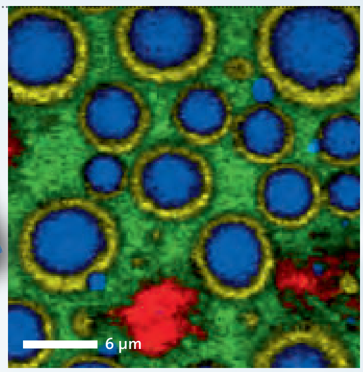
SNOM image of the nucleus of a rat hepatocyte



Raman image of a macrophage cell incubated with oleic acid

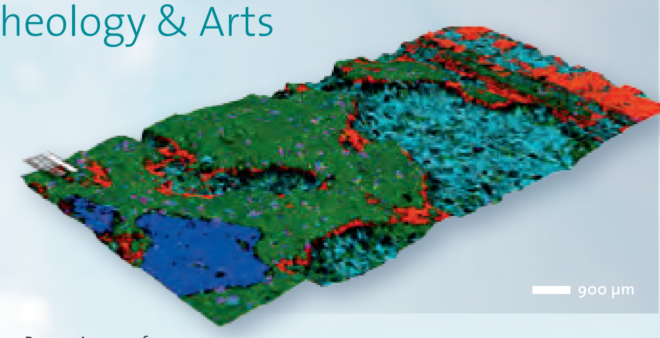


3D Raman volume image of a pharmaceutical emulsion (25 x 25 x 20 µm³, 2,000,000 Raman spectra)

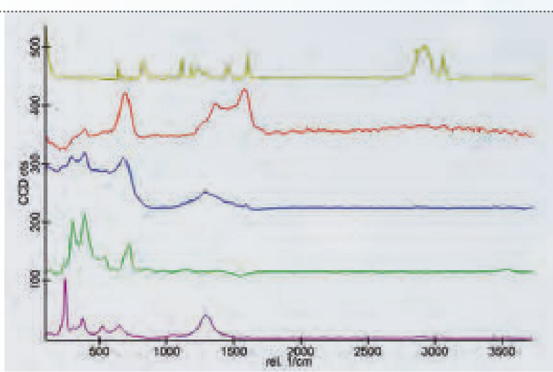


Emulsion used in food production (Red + green: fatty matrix, blue: aqueous phase, yellow: emulsifier PGPR)

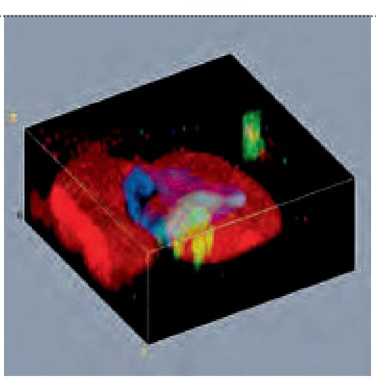
Archeology & Arts



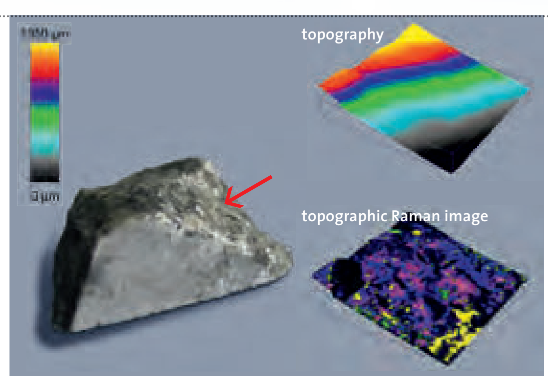
TrueSurface Raman image of an ancient wall painting



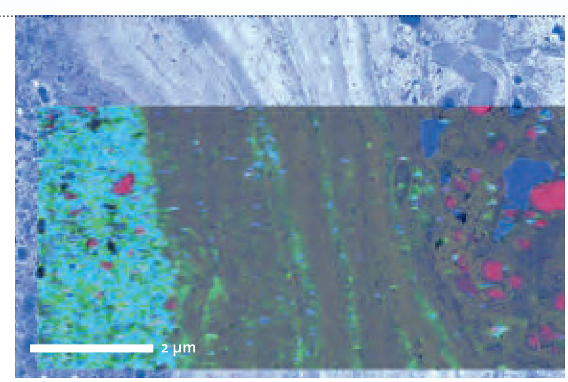
Phases of various iron oxides and corresponding spectra *(samples courtesy of Akzo Nobel)*



3D Raman image of a fluid inclusion in garnet

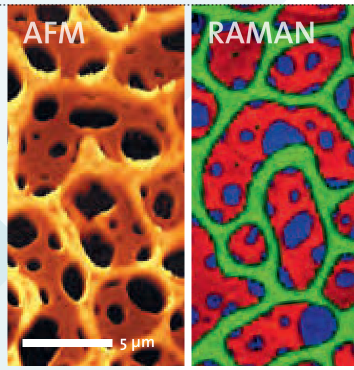


TrueSurface Microscopy® measurement performed on a rough and inclined rock sample

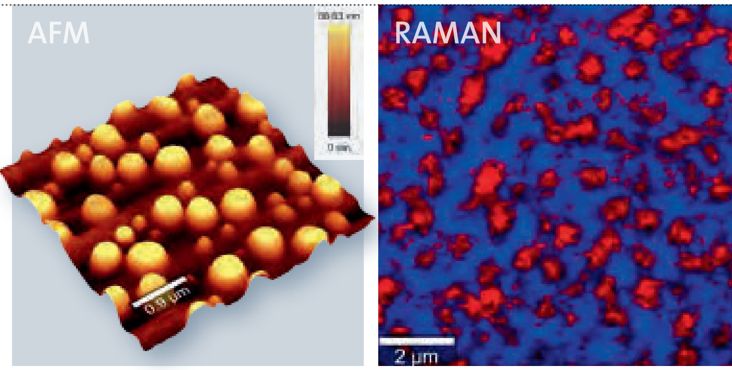


White light video and Raman overlay of microcrystalline rock phases

Polymer Science

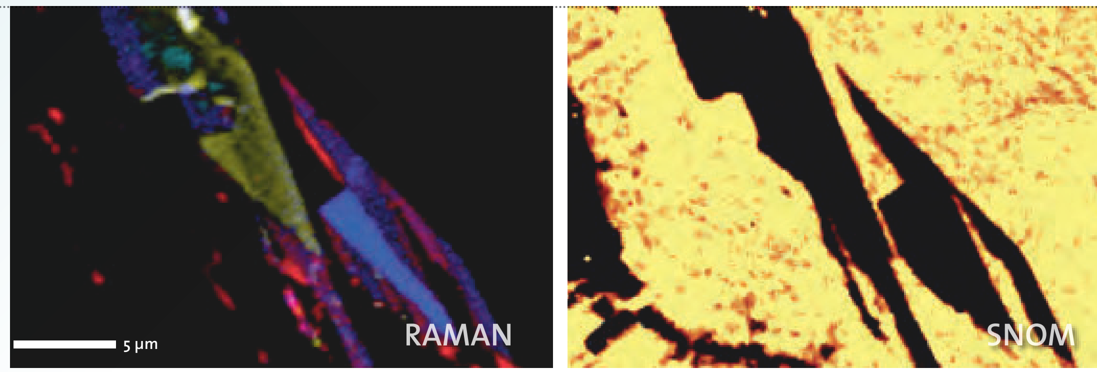


Confocal Raman and AFM topography image of a polymer blend on glass



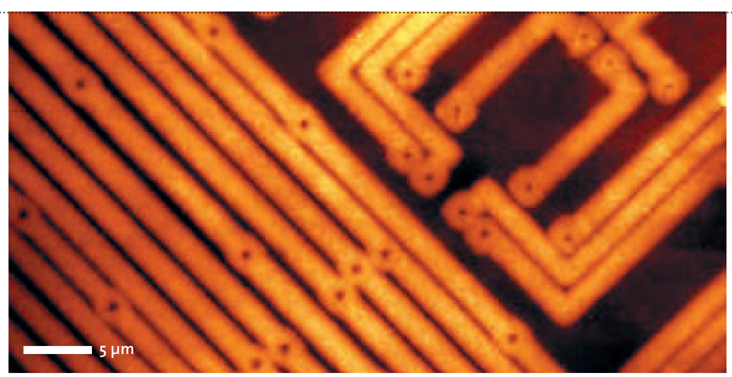
AFM image of a polymer blend (left) and corresponding Raman image (right)

Carbon Materials

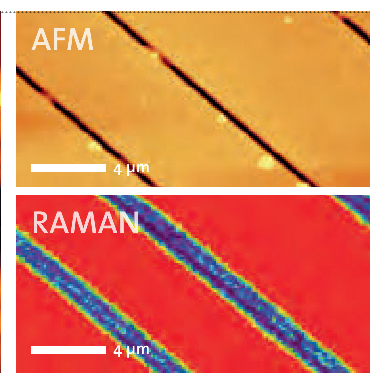


Imaging of a graphene sample with Raman and SNOM (sub-diffraction limit imaging)

Photovoltaics & Semiconductors

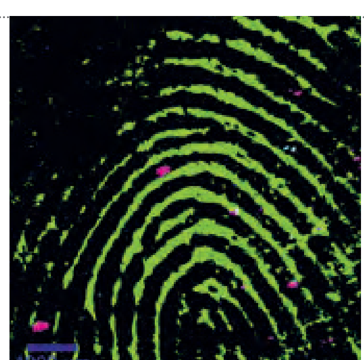


AFM image of an integrated circuit

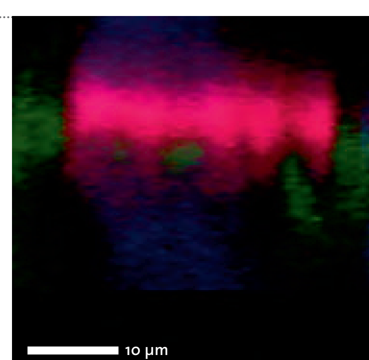


Raman and AFM images of the same sample area on a wafer

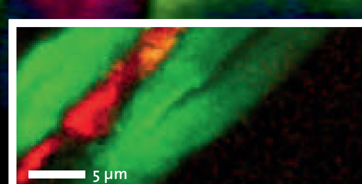
Forensics



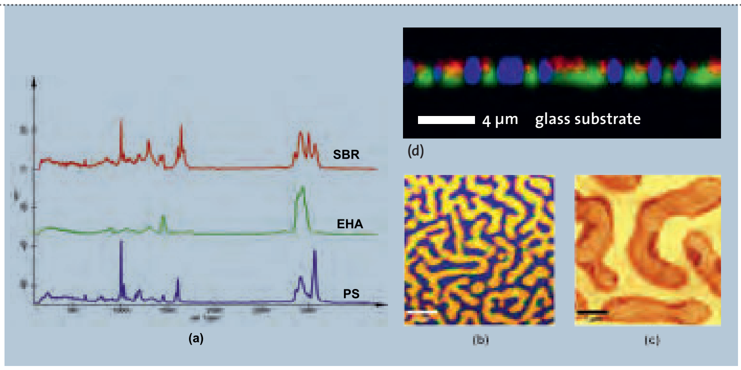
Raman image of a fingerprint with explosive material residues



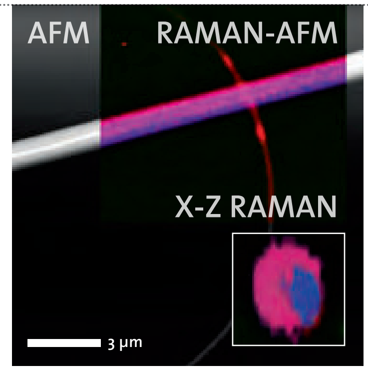
Order of ballpoint pen writing on paper determined by a depth profile (green: pen I, red: pen II, blue: fluorescence)



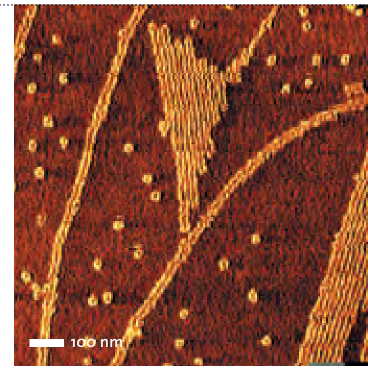
Raman image of a textile fiber



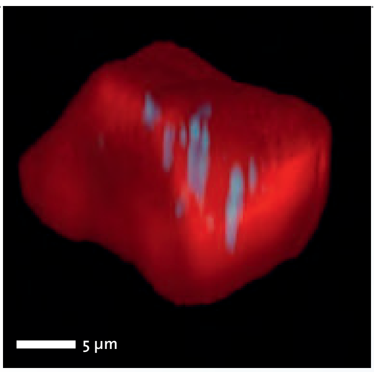
Three-component polymer blend (SBR, EHA, PS), Raman images [xy (b) and xz (d) scans] along with spectra (a) and high-resolution AFM phase image (c)



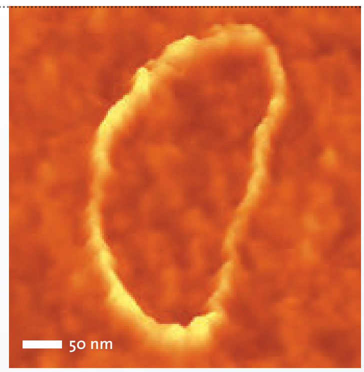
Two component fiber: Raman-AFM overlay and Raman x-z cross section



AFM-phase image of long chain polymer molecules

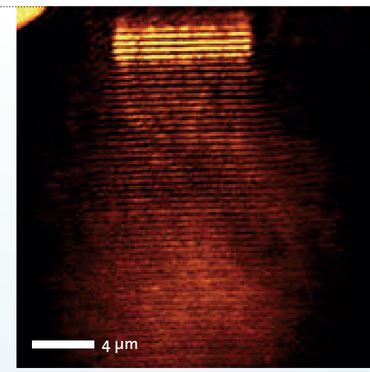


3D Raman image of a diamond inclusion (red) in quartz (black) with impurities (blue)

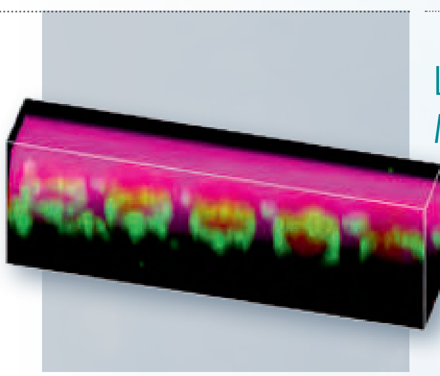


AFM image of a carbon nanotube on a silicon substrate

Nanophotonics

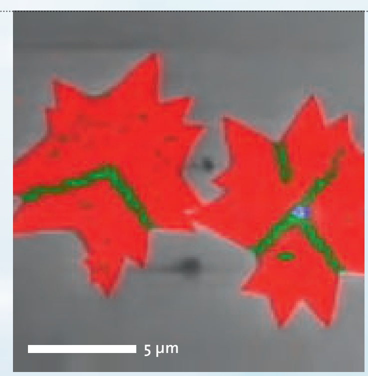


SNOM image of a surface plasmon-polariton wave launched on a nanostructured metal grid

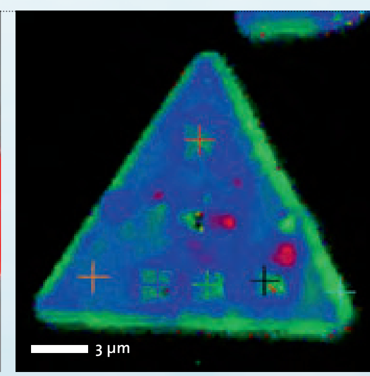


3D confocal Raman image of a GaN layer

Low-dimensional Materials

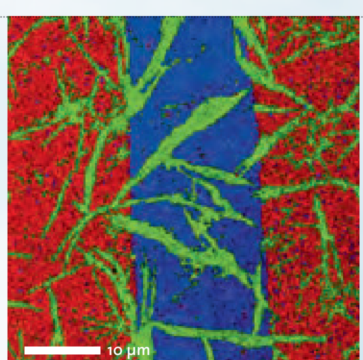


Correlative Raman-SEM image of MoS_2

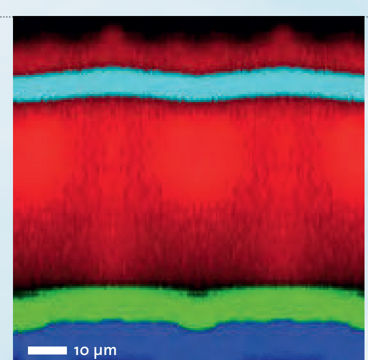


Photoluminescence image of WS_2

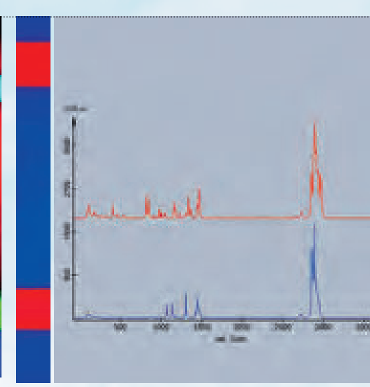
Coatings & Thin Films



Ultrafast Raman image of a 7.1 nm PMMA film (red) on glass (blue) with a 4.2 nm alkane contamination layer (green) on top



Raman image (depth profile) of the inner multi-layer coating of a beverage container



xz-Raman image of thin layers of PE (blue) and PP (red) showing a virtually lossless depth analysis

alpha300 Series
The Instruments

Fiber-based Beam Delivery – Facts and Benefits

WITec's modular design relies on efficient beam delivery via optical fiber. Long-term investments in research and development have yielded an exceptional understanding of fiber-coupling mechanisms, enabling benefits unattainable with more conventional methods.

- Virtually lossless energy transmission
- Fibers provide a guaranteed diffraction-limited point light source for the highest confocality and spatial resolution
- Pre-configured and pre-aligned fiber-coupling units guarantee long-term stability and user-friendliness without the need for further adjustment
- Polarization direction of the light is maintained for the most intricate polarization-dependent measurements
- Lasers and spectrometers can be mounted far away from the microscope, allowing flexible and compact system footprints that can alleviate thermal or vibrational disturbances

Microscope Design & Components

01 OUTPUT COUPLER

primary spectrometer

02 OUTPUT COUPLER

additional spectrometers

03 LASER INPUT COUPLERS

Single & triple wavelength modules combinable and stackable for more wavelengths

04 VIDEO-CAMERA COUPLER

able to house different camera models

05 KÖHLER WHITE-LIGHT ILLUMINATION

with adjustable LED intensity

06 AFM BEAM-DEFLECTION UNIT

for cantilever-based topography and near-field optical measurements

07 MICROSCOPE TURRET

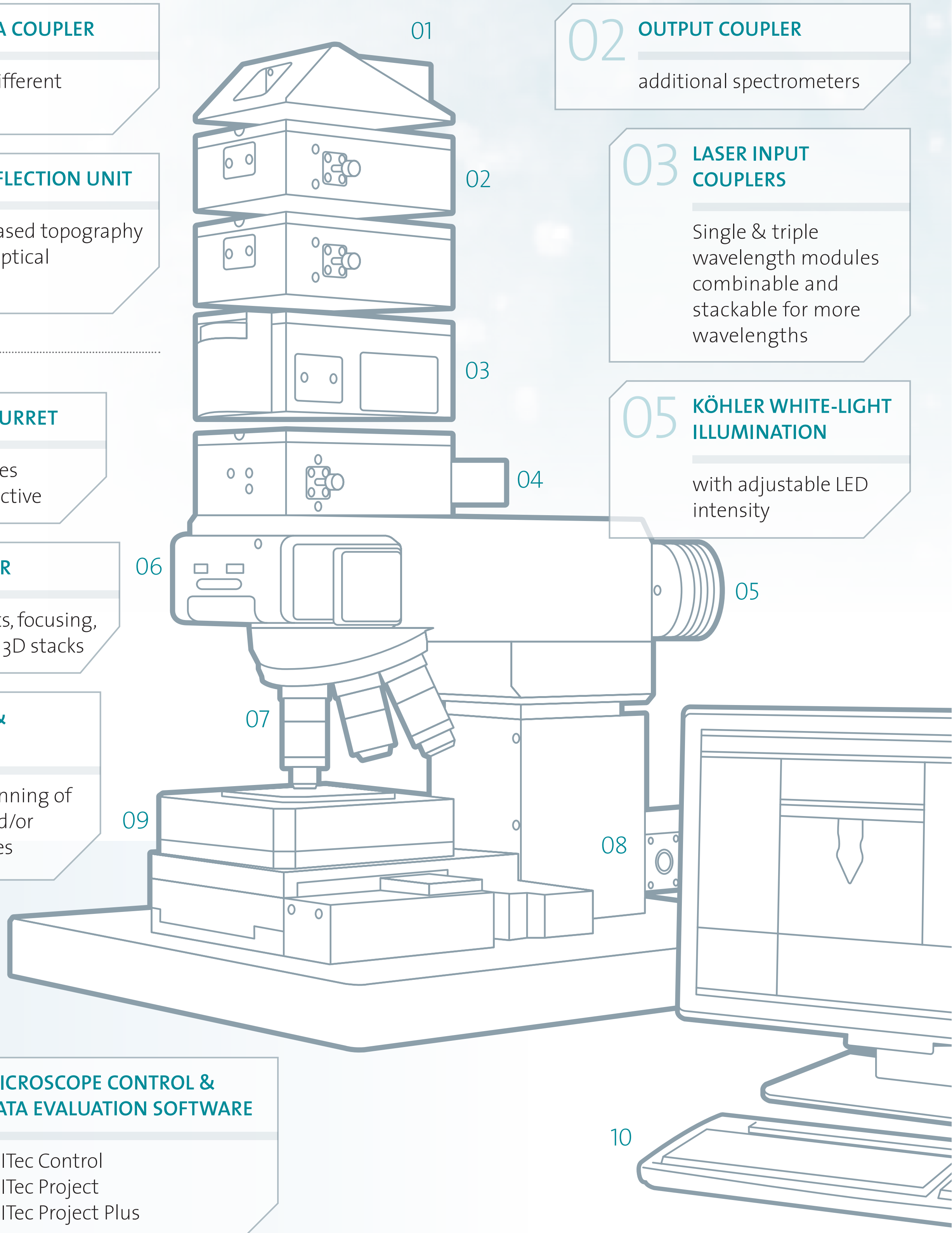
up to 6 objectives
WITec SPM objective

08 STEPPER MOTOR

for z-movements, focusing, depth profiling, 3D stacks

09 POSITIONING & SCAN STAGES

cooperative scanning of piezo-driven and/or motorized stages

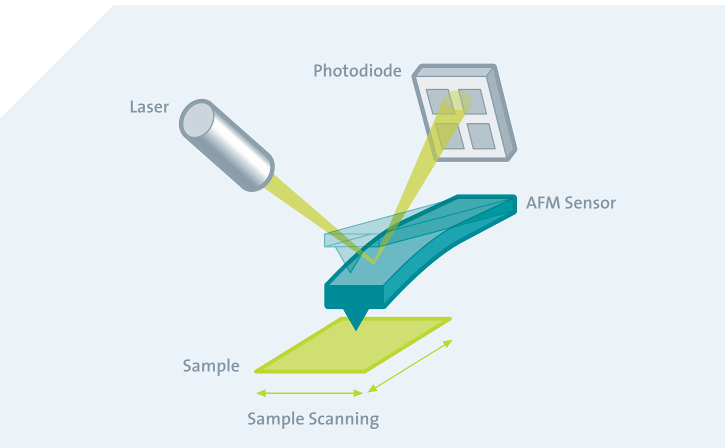


10 MICROSCOPE CONTROL & DATA EVALUATION SOFTWARE

WITec Control
WITec Project
WITec Project Plus

Techniques

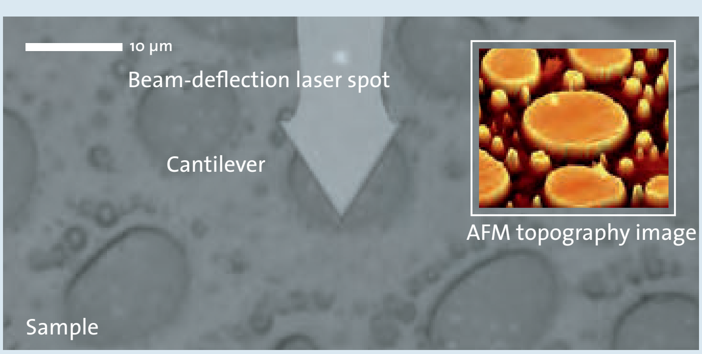
Atomic Force Microscopy (AFM) – Nanoscale Surface Characterization



Atomic Force Microscopy traces the topography of samples with extremely high resolution by recording the interaction forces between the surface and a sharp tip mounted on a cantilever.

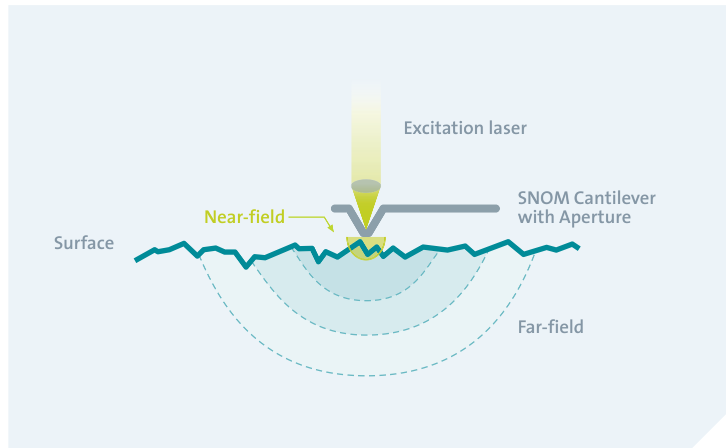
The sample is scanned under the tip using a piezo-driven scanning stage and the topography is displayed as an image. Atomic Force Microscopy provides spatial information parallel and perpendicular to the surface with resolution in the nanometer range.

In addition to high-resolution topographic information, local material properties such as adhesion and stiffness can be investigated by analyzing the tip-sample interaction forces with WITec DPFM technology.



Simultaneous sample and cantilever survey from above through the WITec AFM objective.

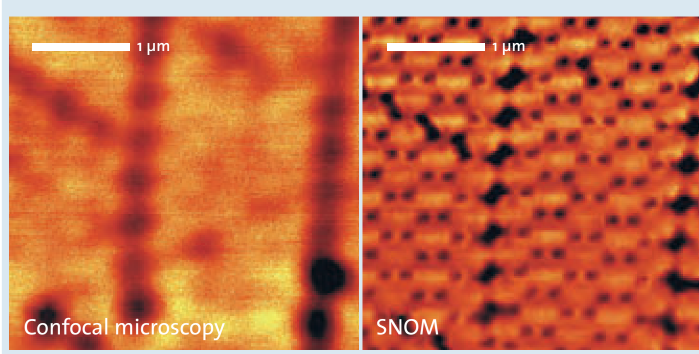
Scanning Near-field Optical Microscopy (SNOM) – Optical Imaging Beyond the Diffraction Limit



In Scanning Near-field Optical Microscopy, the excitation laser light is focused through an aperture with a diameter smaller than the excitation wavelength, resulting in an evanescent field (or near-field) on the far side of the aperture.

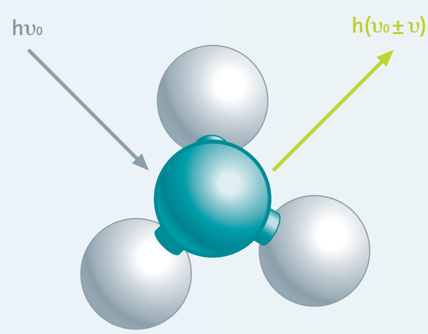
When the sample is scanned at a small distance below the cantilever tip the optical resolution is limited only by the diameter of the aperture. The transmitted or emitted light is then detected point by point and line by line in order to generate an optical image.

The aperture itself is located at the apex of a hollow pyramid on the micro-fabricated WITec SNOM cantilever. The optical resolution attainable is in the range of 60 – 100 nm.



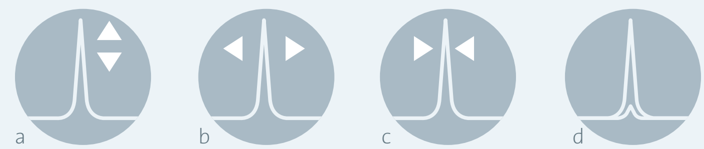
Comparison of optical resolution between confocal microscopy (left) and scanning near-field optical microscopy (right) on a latex projection pattern.

Confocal Raman Microscopy – 3D Chemical Imaging



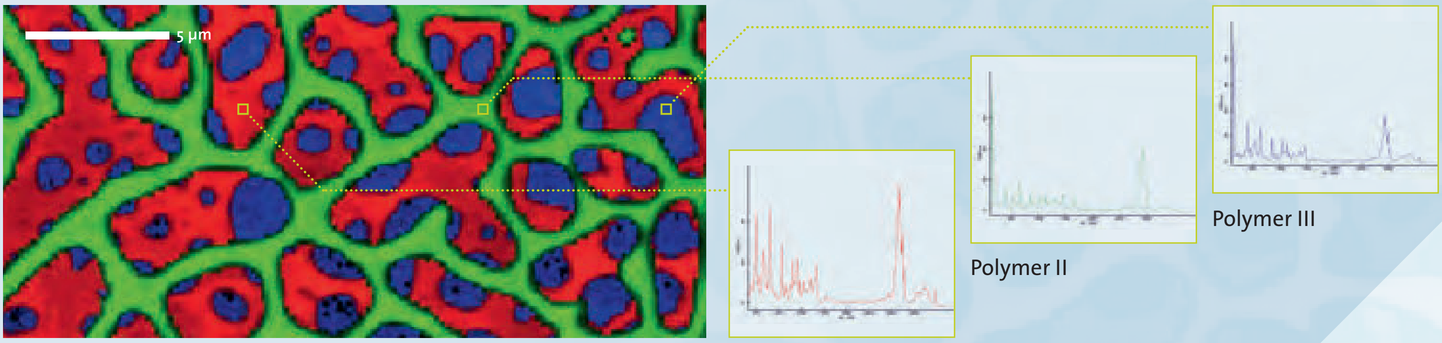
Additional sample information from the Raman spectrum:

a. Peak intensity: Quantity/amount of a specific compound
b. Peak shift: Identification of stress and strain states
c. Peak width: Degree of crystallinity
d. Polarization state: Crystal symmetry and orientation



A Raman spectrum shows the energy shift of the excitation light (laser) as a result of inelastic scattering by the molecules in a sample. The incident light excites or annihilates vibratinal states of the chemical bonds within the molecules. Different chemical species consist of different atoms and bonds, so each molecule can be easily identified by its unique Raman spectrum. This enables high resolution microscopy with chemical characterization.

In Raman imaging the Raman spectra are collected nondestructively with a high-throughput confocal microscope/spectrometer combination. A high-sensitivity CCD camera connected to a powerful computer and software system is used to detect the Raman signal.



Raman image of a polymer blend along with corresponding spectra.

alpha300 R
Raman Instruments

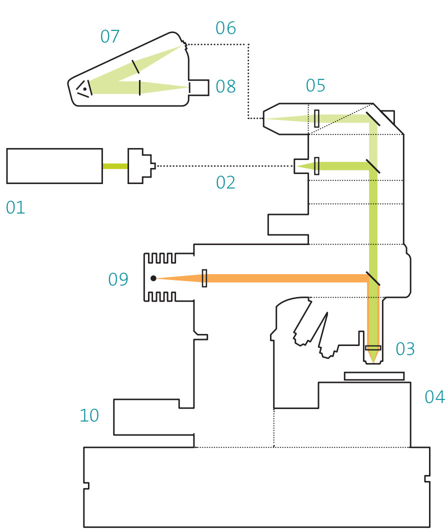
WITec's innovative spirit has kept the alpha300 series at the forefront of the Raman imaging market since it initially revolutionized the field and established FAST RAMAN IMAGING® as a standard technique. Ongoing development of the first truly confocal Raman imaging system continues to enable the setting of benchmarks in sensitivity, speed and 3D imaging as well as spectral quality, spatial resolution, ease-of-use and compatibility with other measurement techniques.

FAST RAMAN IMAGING®

FAST RAMAN IMAGING® is a standard built-in feature included with every motorized or piezo-driven sample-scanning WITec Raman system. Acquisition times for a single Raman spectrum can be as low as 125 ms (Back-illuminated CCD) or 38 ms (Front-illuminated CCD). The ULTRAFAST RAMAN IMAGING® option with EMCCD technology offers integration times down to 0.76 ms/spectrum.

Key Features:

- Confocal micro-Raman spectroscopy
- Single-point spectra acquisition
- Single-point depth profiling
- Time series
- Raman spectral imaging (FAST & ULTRAFAST RAMAN IMAGING®) with motorized or piezo-driven scanning stage
- Image stacks (with motorized or piezo-driven scanning stage)
- 3D imaging and depth profiling
- Auto-focus (confocal microscopy/confocal Raman imaging)
- Automated movement of the motorized positioning stage to user-defined coordinates on the sample



01 Excitation laser
02 Optical fiber
03 Objectives
04 Scanning stage and/or motorized positioning stage
05 Filter set
06 Photonic fiber
07 Lens-based UHTS Raman spectrometer series
08 CCD detector
09 Koehler white-light illumination
10 Z-stage for focusing

alpha300 *access*

The alpha300 *access* is a high-quality confocal micro-Raman system that provides a new point of entry to WITec's leading-edge throughput and sensitivity for sub-micrometer chemical analysis.

Key Features:

- *access* to class-leading capability within challenging budget and procurement environments
- *access* to high-performance spectral Raman mapping
- *access* to exceptional spectral quality provided by the WITec UHTS Raman spectrometer series
- *access* to high-quality and ultra-precise optical microscopy components
- *access* to WITec Raman and imaging know-how
- *access* to the future of Raman spectroscopy through upgradeability

Raman Lab Arrangement

Raman Microscopy & 3D Raman Imaging

The outstanding sensitivity of WITec's optical systems reduces acquisition times for single Raman spectra down to well below 1 ms and enables ULTRAFAST RAMAN IMAGING® and time-resolved micro-Raman spectroscopy with unprecedented resolution. Detecting signals from weak Raman scatterers or extremely low material concentrations or volumes with the lowest excitation energy levels is the unrivaled advantage of WITec systems. All Raman spectra are collected and processed by the WITec software suites, which also provide for post-processing and in-depth analysis of spectral data.

Resolution in Confocal Raman Imaging

WITec confocal Raman microscopes achieve a lateral resolution limited only by the physical law of diffraction (λ/2 of the excitation wavelength, ~ 200 nm lateral resolution for VIS). The confocality of the optical design is furthermore characterized by an excellent depth resolution and facilitates the generation of 3D Raman images and depth profiles.

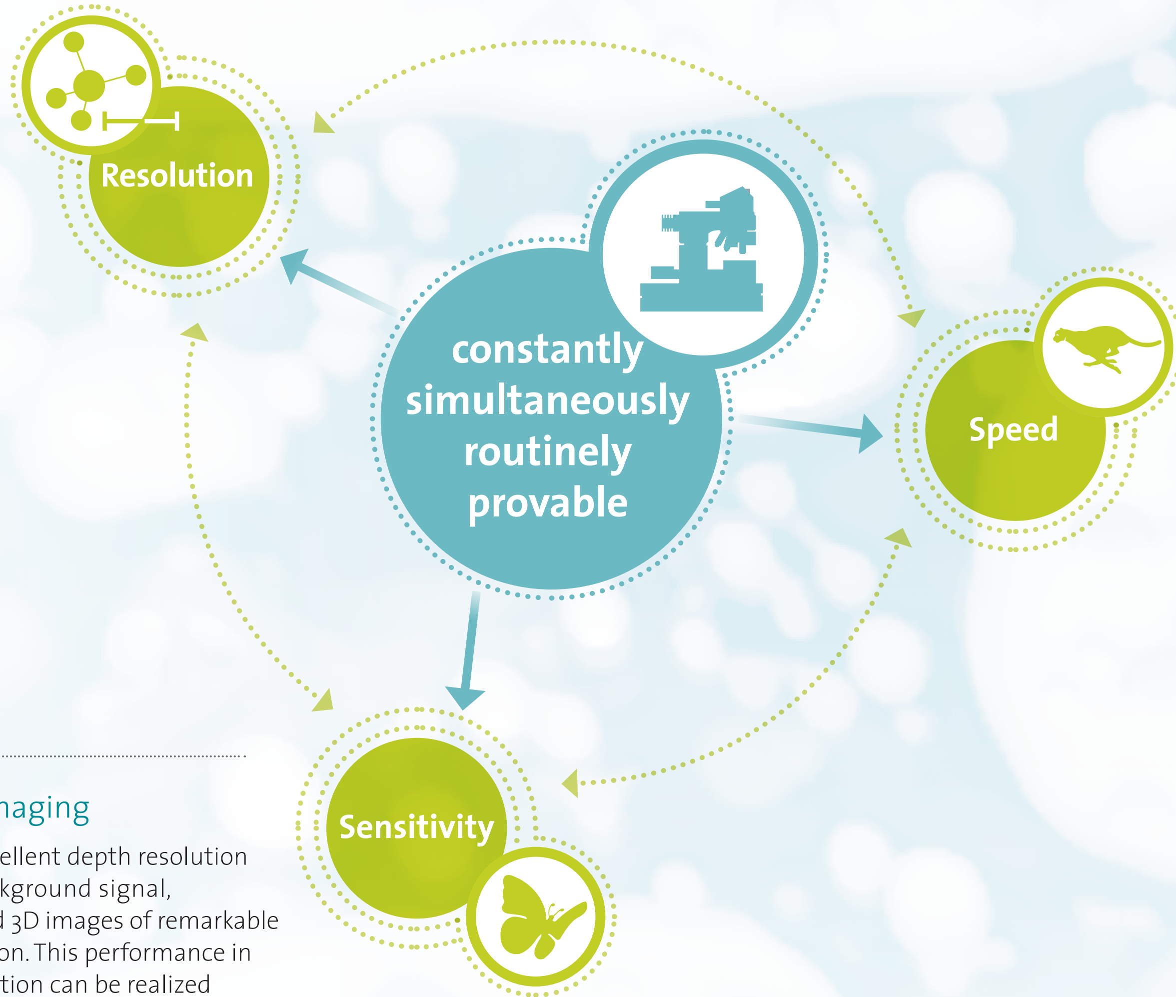
WITec UHTS Series: Ultra-High Throughput Spectrometers for Raman Microscopy

WITec Raman microscopes and imaging systems combine an extremely sensitive confocal microscope with an ultrahigh-throughput spectroscopy system (UHTS) for unprecedented capability in chemical characterization. The lens-based, wavelength-optimized spectrometers of the UHTS series allow more than 70% transmission for high speed and high resolution Raman imaging. All UHTS spectrometers feature an optical fiber port and an automated triple-grating turret. Customers can choose from among a variety of gratings to match individual requirements in terms of spectral range and resolution. For detection, several different types of CCD camera with quantum efficiencies exceeding 90% can be selected.

Benefits:

- ULTRA-HIGH throughput
- ULTRA-FAST acquisition times
- ULTRA-SHARP and symmetric peak shape
- ULTRA-CONFIGURABLE: several focal lengths and gratings available

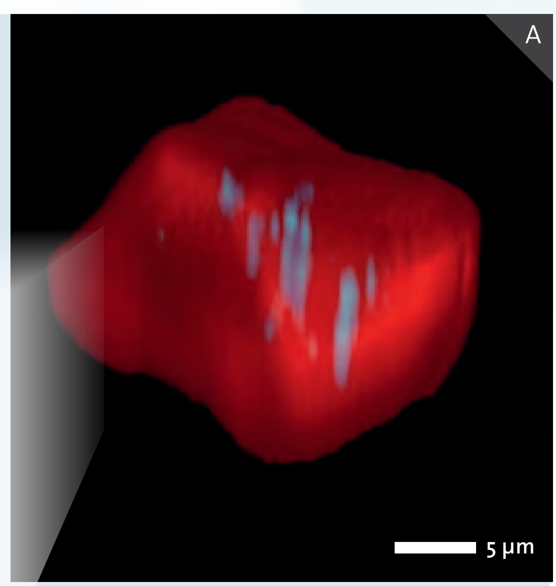
For further details on the spectroscopic capabilities of the UHTS series please refer to the "WITec Raman Spectroscopy Solutions" brochure.

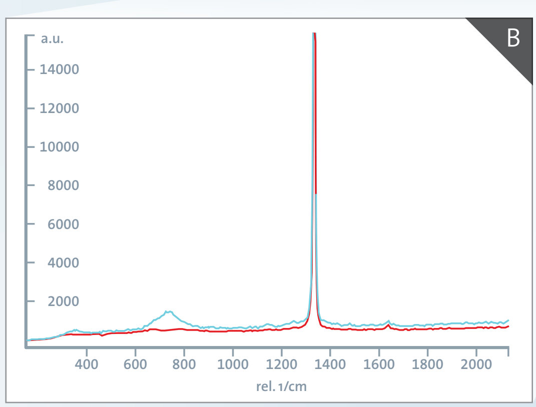


Powerful 3D Raman Imaging

The alpha300 R, with its excellent depth resolution and a strongly reduced background signal, generates depth profiles and 3D images of remarkable spectral and spatial resolution. This performance in speed, sensitivity and resolution can be realized simultaneously and without compromise.

Diffraction-limited 3D Analysis: Diamond Inclusion in Quartz with Impurities





(**A**) Raman image of a diamond inclusion in quartz. The quartz matrix has been omitted from the 3D image for better visualization of the diamond (red) and the impurities (blue).

(**B**) Raman spectra of diamond and impurities. The colors of the spectra correspond to those in the image.

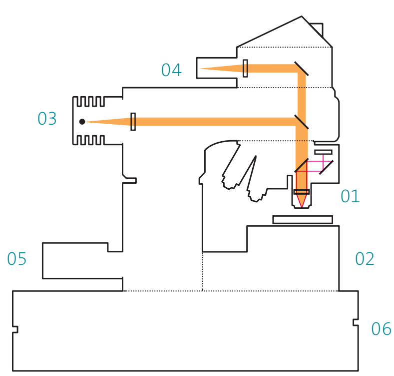
alpha300 A

Atomic Force Microscopy

The WITec Atomic Force Microscope integrated with a research-grade optical microscope provides superior optical access, easy cantilever alignment and high-resolution sample survey.

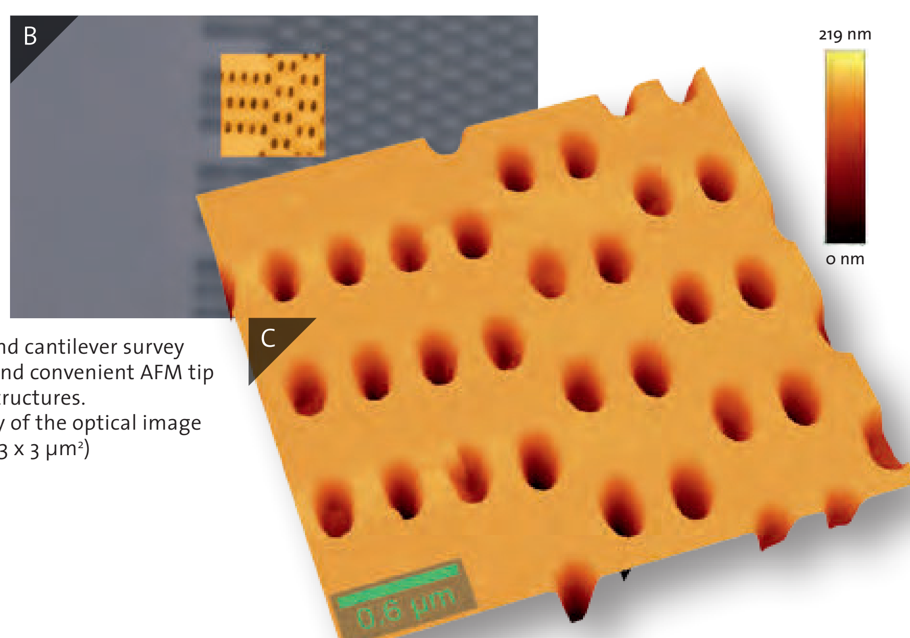
Using optical pre-inspection by means of various illumination and detection techniques (e.g. bright field, dark field, polarization, fluorescence, etc.), the user can easily determine the area of interest for the AFM measurement. By simply rotating the microscope turret, the user can switch between conventional microscopy and AFM modes quickly and easily.

The WITec AFM objective provides a direct view of both sample and cantilever for straightforward and precise cantilever tip positioning. The alpha300 A system includes an extremely linear and precise capacitive-feedback controlled scan-stage featuring TrueScan™ for exceptional accuracy over the entire scan range.



01 Objectives
02 Piezo-driven scanning stage
03 Koehler white-light illumination
04 Color video camera
05 Z-stage for focusing
06 Active vibration isolation table

Simultaneous Cantilever and Sample View for Easy Determination of the Measurement Position



The WITec AFM objective allows simultaneous sample and cantilever survey from above with high resolution. It facilitates accurate and convenient AFM tip alignment and positioning for even very small sample structures.
(**A**) Simultaneous cantilever and sample view. (**B**) Overlay of the optical image with the AFM image (AFM image: AC mode, Scan range: 3 x 3 µm²)
(**C**) 3D representation of the AFM image from B.

AFM Modes

Contact Mode:
The sample is scanned in direct contact with the AFM tip. The surface topography is recorded through deflection of the cantilever.

AC (Tapping™) Mode:
Also called intermittent mode. The cantilever oscillates at its resonance frequency and is not in constant contact with the sample. Thus the technique is particulary well suited for delicate samples. When the tip comes close to the surface, sample-tip interactions cause forces to act on the cantilever which alter the oscillation.

Lift Mode™
Lift Mode can be applied in combination with Contact or AC Mode. First, the sample is scanned in an imaging mode such as contact mode to trace the surface. Then Lift Mode™ is used to scan the sample again with a certain z-offset following the previously recorded topography. Lift Mode can be also combined with other AFM modes.

Digital Pulsed Force Mode (DPFM)
(See information below)

Magnetic Force Microscopy (MFM)
Non-contact mode for measuring the magnetic field above a sample.

Electrostatic Force Microscopy (EFM)
Non-contact mode for examining the electrostatic forces.

Phase Imaging
Recording and imaging of the phase shift signal in intermittent-contact mode (Tapping Mode™).

Nano-Manipulation/Lithography

Kelvin Probe Microscopy
Surface potential measurement

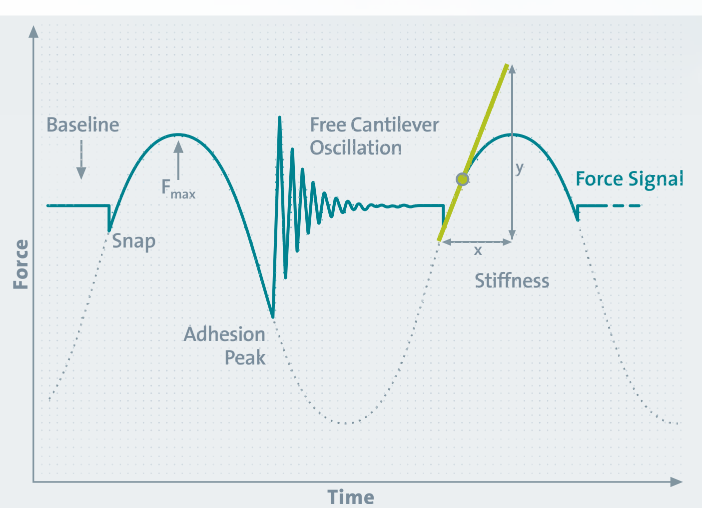
Lateral Force Microscopy (LFM)
Contact mode imaging that reveals the surface friction characteristics.

Chemical Force Microscopy (CFM)
Contact or intermittent mode for measuring chemical forces such as Van-der-Waals forces.

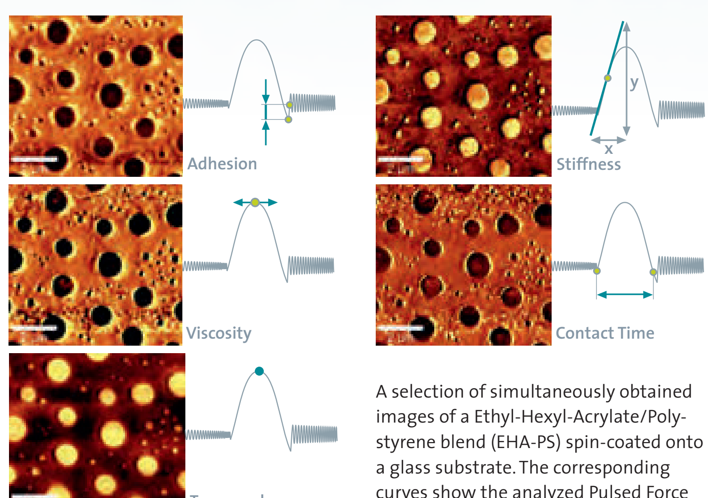
others optional

Digital Pulsed Force Mode (DPFM)
Pulsed Force Mode (PFM) is a non-resonant, intermittent contact mode for Atomic Force Microscopy that allows the characterization of material properties such as adhesion, stiffness, viscosity, energy dissipation, contact-time and long range forces along with the sample topography. Additionally, lateral forces are virtually eliminated. Therefore high-resolution mapping of delicate samples in air and fluids is easily attainable while maintaining a scanning speed comparable to contact-mode AFM. The normal forces on the sample (introduced by the AFM tip) are controlled by the feedback loop. The PFM electronics introduce a sinusoidal modulation to the z-piezo of the AFM with an amplitude of 10-500 nm at a user-selectable frequency of between 100 Hz and 2 kHz: far below the resonance frequency of the cantilever. A complete force-distance cycle is carried out at this rate, resulting in the force signal as shown in the figure below.

Imaging of Surface Properties



Pulsed Force Mode (PFM)



Digital Pulsed Force Mode (DPFM)

A selection of simultaneously obtained images of a Ethyl-Hexyl-Acrylate/Poly-styrene blend (EHA-PS) spin-coated onto a glass substrate. The corresponding curves show the analyzed Pulsed Force Mode properties. Dark areas correspond to low values. Scan range: 10 x 10 µm².

alpha300 S
Scanning Near-field Optical Microscopy

Resolution in classical optical microscopy is limited by diffraction due to the wave nature of light. Therefore a resolution below approximately λ/2 of the excitation wavelength is usually not possible. Scanning Near-field Optical Microscopy (SNOM) can overcome this diffraction limit and generate images with an optical resolution of typically between 60 and 100 nm. In addition, the technique requires only minimal , if any, sample preparation.

With the WITec SNOM objective and cantilever SNOM sensors, imaging beyond the diffraction limit is accomplished quickly and effortlessly. While acquiring the SNOM image, the AFM topography is recorded simultaneously. This benefit results from the use of cantilever sensors with tip interaction control based on the well-established beam-deflection principle for regulating tip-sample distance.

Typical applications include nanotechnology research and in particular the highly relevant fields of nano-photonics and nano-optics. In life science and materials research, SNOM permits optical detection of the most miniscule surface structures of transparent as well as opaque samples. Using fluorescence techniques, even single-molecule detection can be easily achieved.

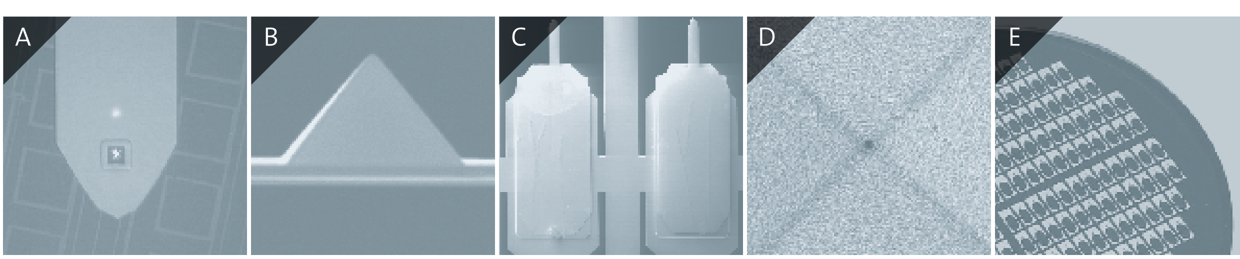
Super-resolution Microscopy

With the alpha300 S, super-resolution microscopy can be achieved at the surface of a diverse range of samples with either reflection or transmission geometry. SNOM, as compared to other optical super-resolution techniques (e. g. STED or STORM), is not limited by the availability of fluorescence dyes or specialized laser excitation sources. The operation of the system is straightforward as various automated measurement procedures such as a high-speed automatic cantilever approach and adjustment can be controlled through the intuitive software.

SNOM mode can be accessed instantly through a special objective that holds and positions the SNOM cantilever. All standard optical modes such as transmission, reflection or fluorescence are available as well as all standard AFM modes.

To detect the scattered light, either a single-photon counting photomultiplier or a single-photon counting avalanche photodiode detector can be used, both guarded by a high-speed overload protection system. The WITec UHTS series of spectrometers is also fully compatible.

Cantilever SNOM Sensors



The alpha300 S uses unique, patented, high-quality micro-fabricated SNOM sensors, consisting of a silicon cantilever with a hollow aluminum pyramid as a tip. The SNOM aperture is at the apex of the pyramid. The laser light used for optical imaging is focused into the backside of the hollow tip and then onto the sample. Due to the wide opening angle of the hollow pyramid, the transmission coefficient is much higher than that of fiber probes with the same aperture diameter. An established and proven method of mass-production enables tips with apertures of varying size to be specified according to customers' individual requirements. Cantilever SNOM sensors are, unlike fiber tips, very robust and flexible in the z-direction and allow the beam deflection technique to precisely control the tip-sample distance. All of these innovative characteristics make the handling of probes during near-field microscopy very user-friendly for the most reliable optical imaging available beyond the diffraction limit.

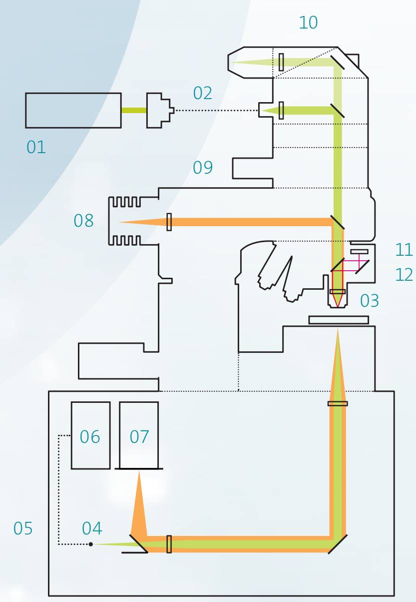
(A) Video camera top view of SNOM sensor and sample

(B) Side view of cantilever pyramid

(C) SEM image of SNOM sensors

(D) SEM image of aperture at the pyramid apex

(E) SNOM cantilever wafer



01 Laser
02 Optical fiber
03 Cantilever SNOM sensor
04 Flip mirror
05 Optical fiber
06 Detector
07 Highly sensitive video camera
08 White light LED for Köhler illumination
09 Color video camera
10 Connector for signal pick-up in bottom-up illumination
11 Fiber connector for beam deflection laser
12 Segmented photodiode

Key Features

- Spatial resolution beyond the diffraction limit (ca. 60 nm laterally)
- Unique patented SNOM sensor technique
- Ease-of-use in air and liquids
- Various atomic force and light microscopy modes included
- Non-destructive, label-free imaging technique providing super-resolution with minimal, if any, sample preparation
- Upgradeable with confocal Raman imaging for correlative microscopy and near-field Raman imaging
- Three techniques always integrated in one instrument: Confocal Microscopy, AFM & SNOM

Modularity and Combinations
The Concept

The modular and flexible design of the WITec alpha300 microscope series guarantees easy and cost-effective upgrade and extension possibilities along with access to correlative microscopy. By combining different techniques, a more comprehensive understanding of samples can be attained. Thus not only chemical information, but also structural and topographic information can be acquired at the same time and from the same sample area using only one instrument.

WITec's modular product line incorporates nearly all scanning probe and optical microscopy techniques to fulfill your individual requirements. Each WITec microscope model can always be equipped with the functionality of another variation of the alpha300 family either as a built-in feature or as a later upgrade. The WITec hardware and software environment is used for all new features or upgrades, ensuring the best possible compatibility and ease of use.

Switching Microscopy Modes by Rotating the Objective Turret.

01

Scanning Probe Microscopy (SPM) Mode for AFM or SNOM:
The SPM cantilever is held at the end of the objective's arm. The cantilever can be aligned with an integrated highly-precise inertial drive.

02

Optical modes: Rotating the turret provides access to the optical modes, allowing high-resolution confocal optical and chemical imaging to be seamlessly linked with AFM or SNOM measurements without touching or transferring the sample.

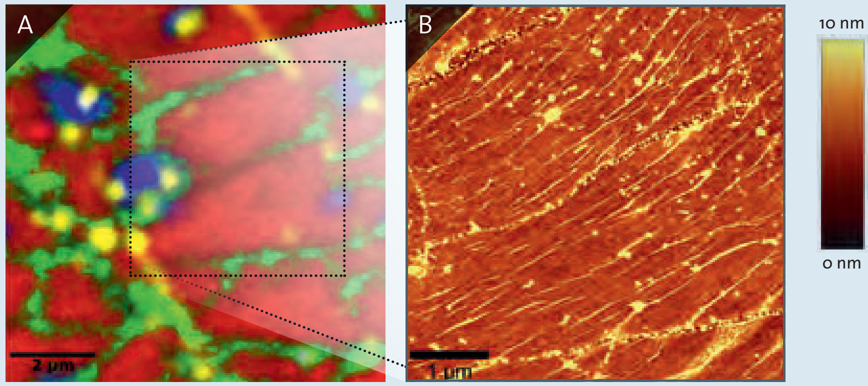
Raman-AFM

By combining the materials analysis capability of confocal Raman imaging with the ultra-high topographic and lateral resolution of an AFM, the chemical properties of the sample can be easily correlated with the surface structure.

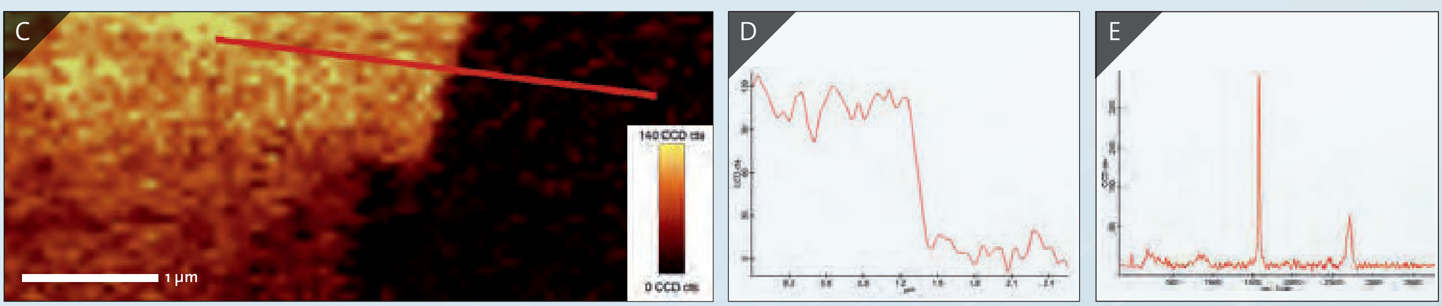
The well-established alpha300 RA was the first integrated Raman-AFM system on the market and continues to set the benchmark for combined instrument configurations.

The alpha300 RA incorporates the features of the alpha300 R Raman microscopy system for chemical imaging along with the alpha300 A Atomic Force Microscope for a more comprehensive understanding of samples.

For TERS-options, please see page 20.



Combined Raman-AFM investigation of defects of a CVD graphene layer.
(**A**) 10 x 10 µm² color-coded Raman image. The different colors indicate layers and wrinkles in the graphene film.
(**B**) 5 x 5 µm² AFM topography image of the same sample area.



(**C**) Near-field Raman image of the G-Band intensity of graphene. (**D**) The graph shows the G-band intensity along the red line and reveals the measurable signal variations between the small sample and the substrate. (**E**) Corresponding Raman spectrum obtained by the Raman-SNOM measurement.

Raman-SNOM

The alpha300 RS incorporates Raman characterization and imaging in combination with Scanning Near-field Optical Microscopy for optical imaging with resolution beyond the diffraction limit. It combines all features of the alpha300 S and alpha300 R.

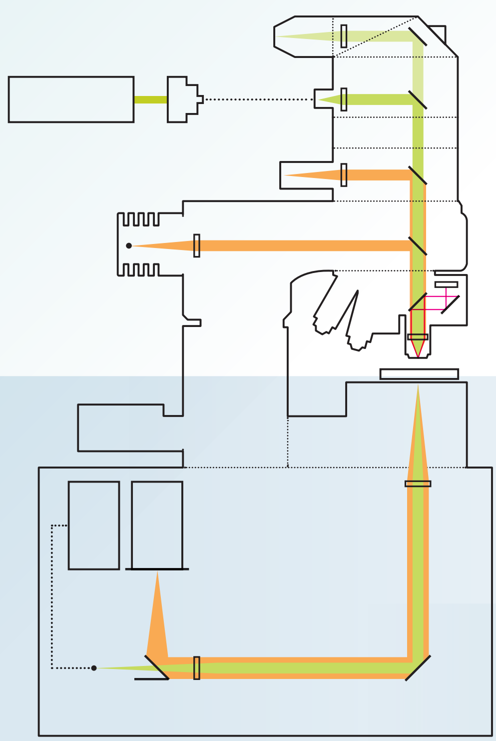
alpha 300 S and alpha300 R

Modularity and Combinations

Beam Path Options

Beam Path Options

For applications requiring alternative beam path options, the alpha300 can easily be configured in a conventional or inverted setup. Additional excitation or detection possibilities from below extend the experimental degrees of freedom and make the system even more versatile.



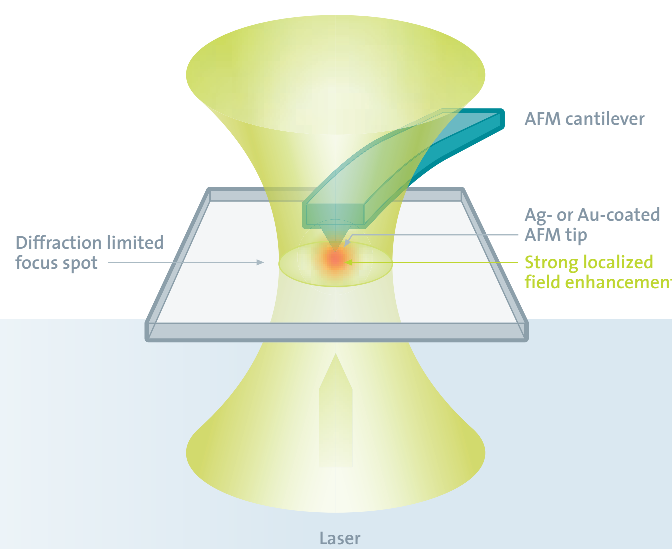
Tansmission or inverted beam path options available for the alpha300 series

WITec TERS Module for the alpha300 Series

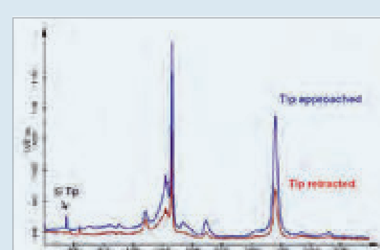
Tip-Enhanced Raman Spectroscopy (TERS) enables the acquisition of chemical information with a lateral resolution far below the diffraction limit.

The TERS tip illumination can be performed from either above, below or from the side. The WITec alpha300 microscope series accomodates all excitation approaches: The inverted microscope is ideal for TERS experiments on transparent samples while the upright microscope and side illumination option facilitate TERS measurements of opaque samples. WITec's unique alpha300 microscope systems provide optimized instrumentation for TERS experiments with Raman and AFM techniques combined in one instrument.

TERS Working Principle



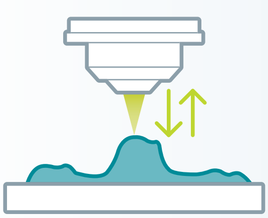
alpha300 TERS experiment on a carbon nanowire: The enhancement of the spectral intensity in TERS-mode is clearly visible.



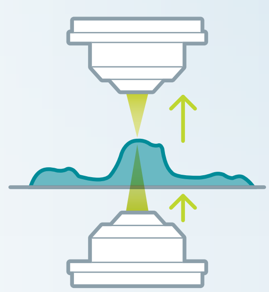
Excitation and Detection Options

The WITec alpha300 microscope series features several beam path geometries for a large variety of excitation approaches: The inverted microscope is ideal for experiments on transparent samples (e.g. in life sciences) while the upright microscope and side-illumination option enable measurements of opaque samples. Thus WITec's unique alpha300 microscope systems provide optimized instrumentation for many different types of experiments.

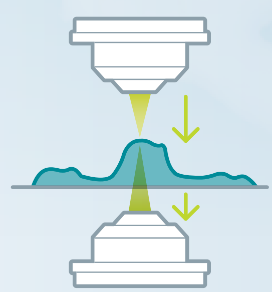
excitation & detection
from above



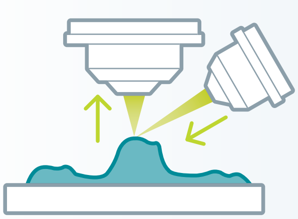
excitation from below
detection from above



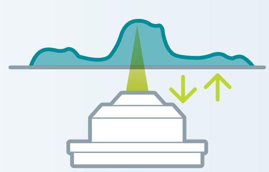
excitation from above
detection from below



excitation from the side
detection from above



excitation from below
detection from below



Modularity and Combinations
Electronics & Software

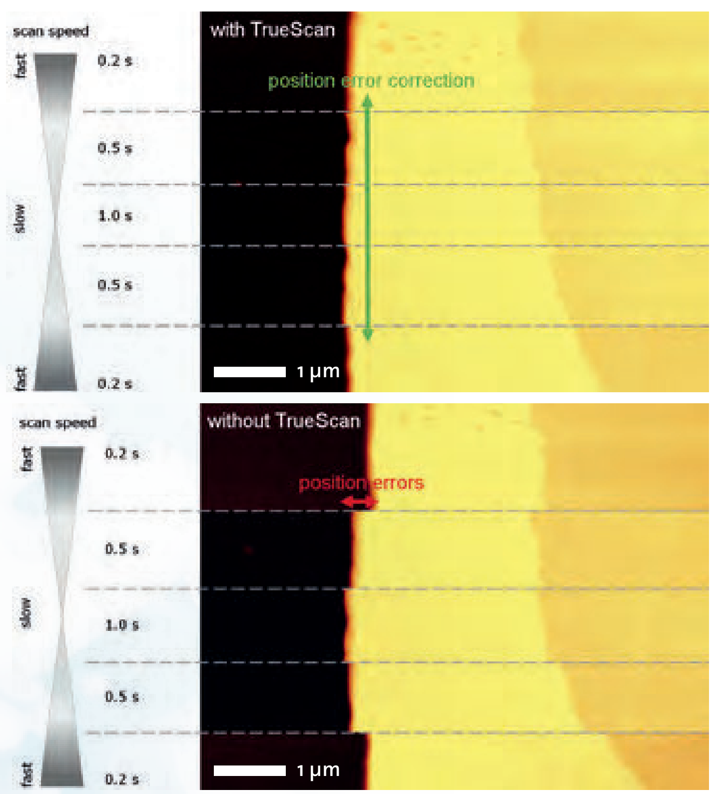
alphaControl

alphaControl is a patented digital microscope controller based on the system-on-a-chip concept. The digital component of the system is entirely realized within one Field Programmable Gate Array (FPGA). This architecture results in speed, flexibility, accuracy, expandability and precise timing, while enabling user-friendly operation of the various microscope setups and extensions with a single hardware device.

Key Features

- TrueScan™
- TruePower™ laser power determination for up to 4 lasers
- Automated high-speed cantilever approach
- High-speed frequency scan
- Automated light intensity adjustment
- High-speed overload protection for photon-counting detectors
- Two built-in fully digital lock-in amplifiers (real amplitude and real phase up to 500 KHz)
- Fully digital feedback-control
- Super-speed USB 3.0 interface
- Digital piezo controller interface
- Real-time rotation matrix and real-time translation for XYZ scans
- Precise timing
- Complete access to internal signals
- Expandable

TrueScan™

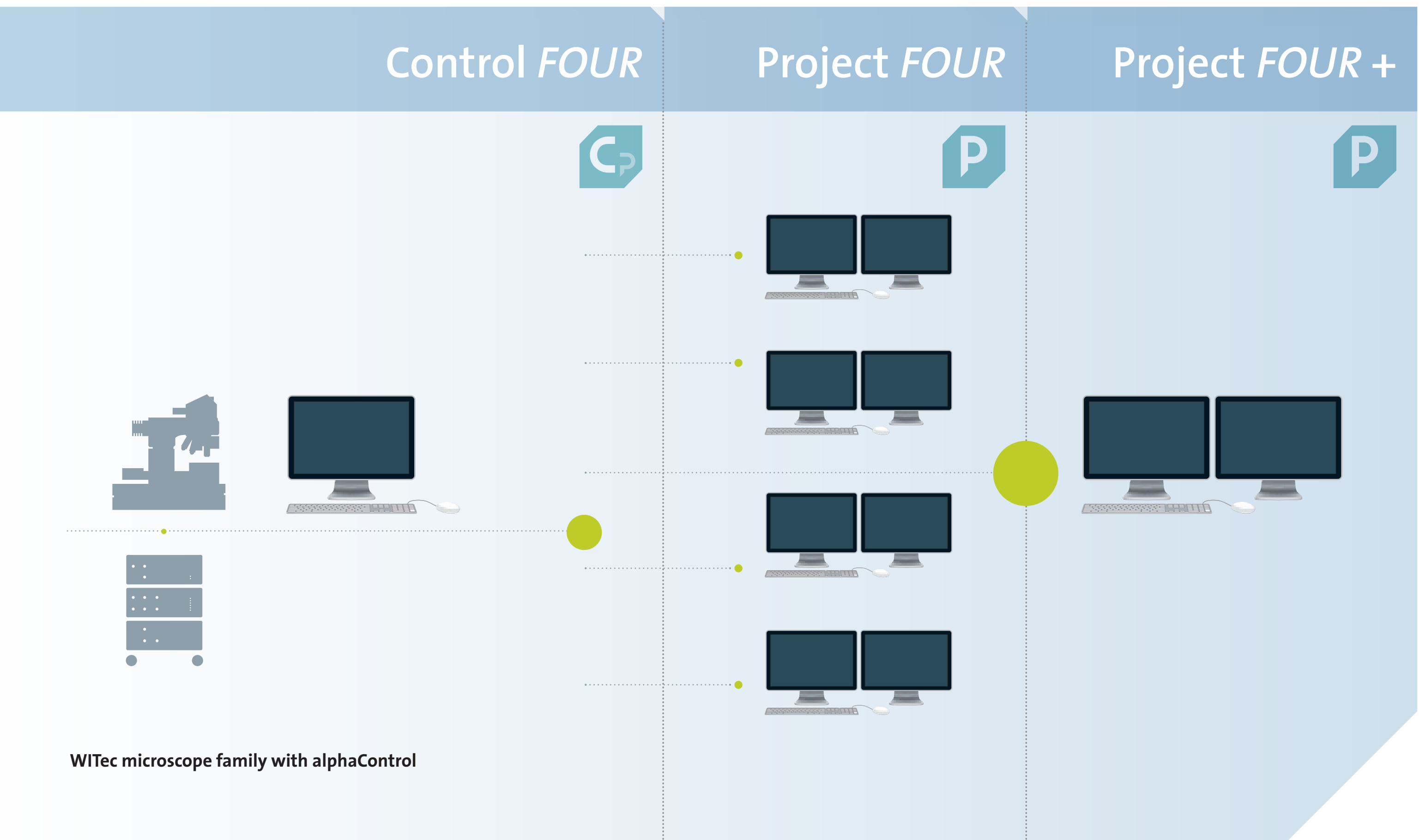


TrueScan™ is an integrated scan engine including dynamic position-error correction, continuous scanning without time gaps and script-based nanolithography. While a closed-loop scan system eliminates static position-errors, TrueScan™ additionally incorporates dynamic position-error correction capabilities.

WITec Suite

Powerful Software Tool

- Sophisticated data acquisition, evaluation, post-processing and image generation for Confocal Raman Microscopy, AFM and SNOM.
- The software architecture and graphical user interface offers an integrated and consolidated functionality incorporating every technique and measurement mode.
- Suitable for all experience levels and user requirements through an individually-adjustable user interface.



WITec Control *FOUR*

- Control experiment and instrument settings
- Acquisition of image and/or spectroscopy data
- On- and offline data analysis and image processing

WITec Project *FOUR*

- Offline data and image processing
- Licensed for an unlimited number of users

WITec Project *FOUR+*

- Advanced offline data and image processing
- Chemometric post-processing features and superior data analysis tools: Cluster Analysis, Principal Component Analysis, Spectral Demixing, Advanced Spectral Fitting, Image Correlation and many more
- Single user license

Modularity and Combinations
Components & Accessories

Stages

Sample Positioning and Scanning Stages

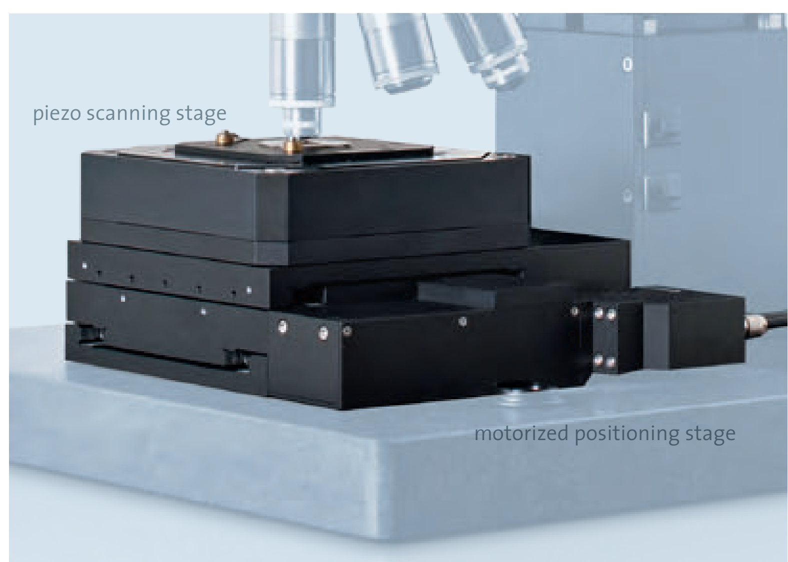
WITec offers manual, stepper motor-driven and piezo-actuated stages to accommodate a wide variety of samples and applications.

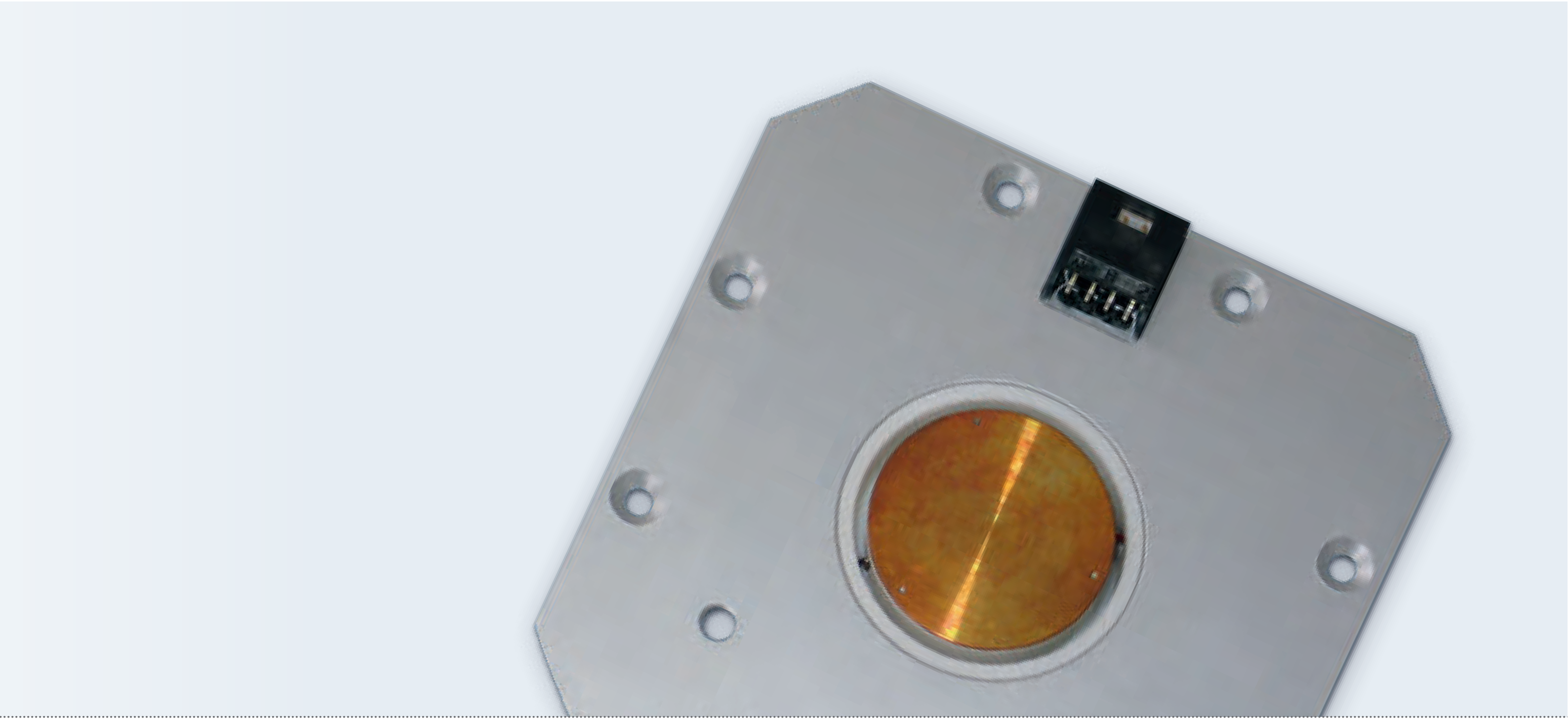
- Manual translation stage for accurate sample positioning
- Motorized translation stages for large scale positioning, mapping and imaging
- Piezo-driven scanning stages with closed-loop operation

The stages features several travel ranges for the highest flexibility.

Heating & Cooling Stages

For experiments requiring an accurate temperature control, the alpha300 series can be equipped with heating and cooling stages with ranges from -269°C up to 1500°C (4 K - 1773 K).



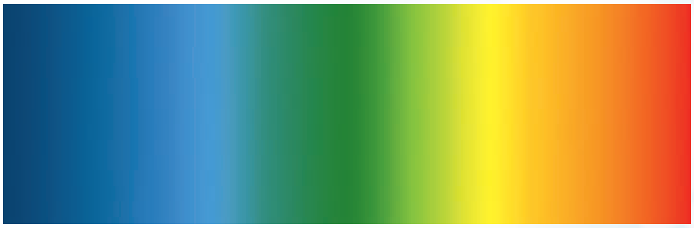


Sample Mounting Stages

A selection of mounting stages is available for securing samples of varied shapes and environmental requirements. Microscope slides, Petri dishes, NUNC flasks and cylindrical samples such as stents can all be accommodated.
The integration of third-party cryostats is available upon request.

Laser Sources

Excitation laser sources for SNOM, Raman and PL imaging can be individually chosen and attached in concert to the microscope via optically matched and reliable fiber coupling. Available laser wavelengths range from the UV to the NIR to fulfill a variety of experimental excitation requirements. A virtually unlimited number of lasers can be attached to the alpha300 microscope. Switching between different lasers is a matter of simply rotating a wheel in the coupling unit.



Laser Power Adjustment with TruePower:

TruePower allows automated and software-controlled absolute laser power determination and adjustment in 0.1 mW steps.

Benefits:

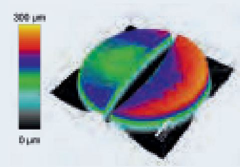
- Reproducibility in measurement conditions
- Optimal laser power determination for preservation of delicate samples
- Power series measurements enabled; laser power-induced spectral changes made quantifiable
- Automated documentation of laser settings
- Feedback-controlled adjustment

Customized Solutions

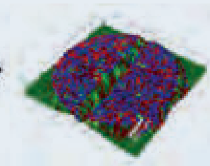
If your application requires other components, WITec looks forward to discussing your individual requirements and helping to get your experiment up and running. The inherent modularity of our product line allows additional high-quality parts and detectors to be easily integrated.

Modularity and Combinations
Components & Accessories

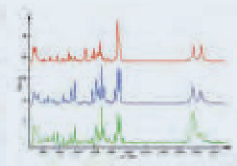
01



Height profile of a pharmaceutical tablet. (12 x 12 mm)

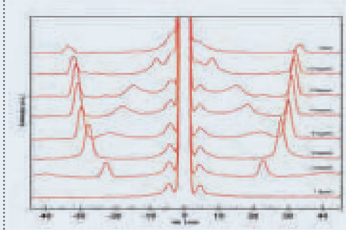


Topographic confocal Raman image along the tablet's true surface.

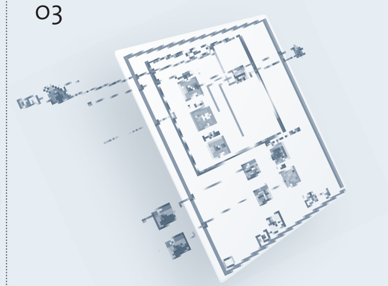


Corresponding Raman spectra, Red + Blue: API, Green: Excipient

02



03



01 | TrueSurface® Microscopy

The key element of this award-winning imaging mode is a topographic sensor. With this non-contact, purely optical profilometry technique it is possible to trace a sample's topography. The resulting map can then be followed in a subsequent Raman measurement so that the Raman laser is always kept in focus with the sample surface (or at any distance below the surface). The results are images revealing chemical and/or optical properties at the surface of the sample, even if the surface is rough or inclined. The analysis of large samples can benefit in particular from this imaging mode. No other technique (e. g. mapping with autofocus) can acquire a topographic Raman image as fast as TrueSurface® while simultaneously providing a z-resolution below 150 nm.

StrobeLock™

StrobeLock is a WITec extension that enables time-correlated single photon counting measurements of unprecedented accuracy. The available imaging modes include Fluorescence Lifetime Imaging and Time-resolved Luminescence Microscopy.

Anti-Stokes Extension

A wavelength-optimized filter unit for the detection of anti-Stokes Raman signals is available as an option for advanced Raman imaging experiments.

Raman Spectral Database & Library

Identification of unknown chemical species in a sample by means of the measured Raman spectra can be achieved by using the powerful Raman spectral database, which is offered as an add-on to the WITec Project software suite.

02 | RayShield™ Coupling Unit – Raman at Low Wavenumbers

The RayShield Coupler for the alpha300 microscope series allows the acquisition of Raman spectra to within 10 wavenumbers of the excitation line. This high-transmission coupler includes a specialized narrow-band filter set which is optimally aligned for the detection of Raman lines extremely close to the Rayleigh line while maintaining an ideal Rayleigh shielding. The RayShield Coupler is available for many laser wavelengths from 405 to 1064 nm.

Free-beam Coupling

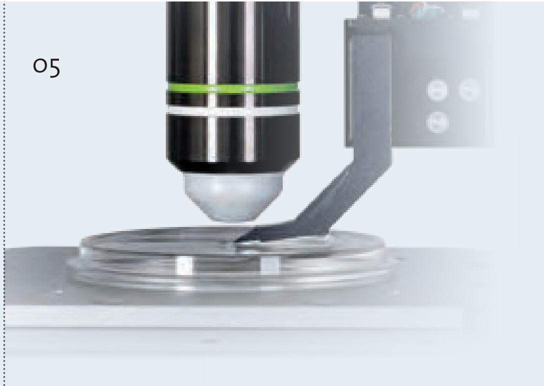
For advanced optical setups requiring the laser excitation source to be coupled directly into the microscope, which is for example necessary for deep-UV or pulsed excitation, the microscope can be equipped with a free-beam coupling unit.

Photoluminescence Detection

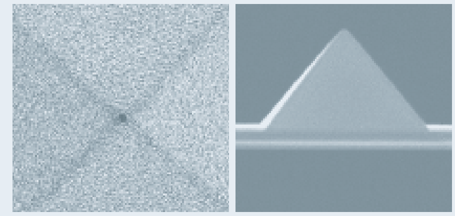
For the detection of photoluminescence spectra beyond 1.1 µm, an InGaAs detector can be easily attached to the spectroscopic setup. Raman experiments can be extended to acquire additional information in the near-infrared photoluminescence regime (or for 1064 nm Raman).

04

05



07



08

03 | LabVIEW™ Interface

The optional LabVIEW™ interface provides access for WITecControl in order to design and control individual measurement procedures with LabVIEW™.

AC (Tapping™) Mode for SNOM

The AC mode for WITec microscope systems allows state-of-the-art resonant intermittent-contact AFM and SNOM imaging specifically tailored for soft and delicate samples. Acoustic AC mode enhances the imaging capabilities of contact mode AFM on such samples, eliminating lateral forces and delivering optimized resolution.

04 | Enclosure & Rigid Support Frame

For maximum reduction of environmental interference such as acoustic or vibrational noise, the WITec support frame and enclosure system greatly contributes to achieving exceptional imaging results. The enclosure can be configured as an air-tight option to allow control of the gas-phase during the experiment. Equipped with an interlock, safety regulations (e.g. laser class I requirements) can also be easily accommodated.

05 | Imaging in Liquids

Imaging in liquids can be easily performed by using a water immersion objective in optical mode or the liquid imaging extension for AFM and SNOM modes. A specialized cantilever holder and inertial drive allows operation in fluids (e.g. in Petri dishes).

07 | AFM & SNOM Cantilevers

WITec provides several types of high-quality AFM-cantilevers for various AFM imaging modes. WITec is the only company capable of producing highly reliable SNOM cantilever sensors with apertures ranging from 60 nm to 100 nm. Each SNOM cantilever is individually tested before shipment.

08 | Objectives

A wide range of objectives for various microscopy techniques are available to meet virtually any experimental requirement.

DaVinci Nanolithography

Advanced nanotechnology often requires accurate and reliable nano-manipulation or nanolithography tools for precise surface structuring. The WITec DaVinci nanolithography package allows these kinds of experiments in AFM as well as in optical modes with an integrated laser shutter control.

Featured Light Microscopy Techniques

The alpha300 series offers a selection of sample survey and data acquisition methods such as: fluorescence contrast imaging, DIC, dark field microscopy, petrography or polarization-dependent measurements.

WITec

Since its founding in 1997, WITec has established itself as a market leader in the field of nano-analytical microscope systems (Raman, AFM, SNOM). As reflected in WITec's maxim "Focus Innovations" our success is based on constantly introducing new technologies and a commitment to maintaining customer satisfaction through high-quality, flexible and innovative products.

Recent Awards

2008
- R&D 100 for the alpha500

2011
- PITTCON Editors' Gold Award for TrueSurface Microscopy

- R&D 100 for TrueSurface Microscopy

- Microscopy Today Innovation Award for TrueSurface Microscopy

2012
- Photonics Prism Award Winner (TrueSurface Microscopy)

2015
- Photonics Prism Award 2015 Winner (RISE Microscopy)

- Achema Innovation Award 2015 (*apyron* automated Raman imaging system)

WITec Milestones

1997
- SNOM system with unique cantilever SNOM sensors
- Pulsed Force Mode

1999
- Confocal Raman Microscope (WITec CRM 200) for fast 3D Raman imaging

2003
- WITec Mercury 100 Atomic Force Microscope
- Digital Pulsed Force Mode
- World's first integrated Raman/AFM combination

2006
- Modular alpha300 series with FPGA-based control unit alphaControl

2008
- alpha500 series for large-area and automated multi-point measurements

2010
- TrueSurface Microscopy for confocal microscopy along with large-area optical profiling

2014

RISE Microscopy: First integration of Raman Imaging and Scanning Electron Microscopy for correlative Raman-SEM Imaging

2015

Automated Raman imaging system *apyron*

2016
- alpha300 series design evolution
- alpha300 *access*

To be continued ...

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WITec Product Line

alpha300 series

The alpha300 series for high-resolution 3D Raman imaging and Scanning Probe Microscopy is one of the most advanced and flexible nano- and macro-analytical research tools available. A modular setup allows for a variety of configurations or extensions to meet individual scientific requirements or budget environments.

alpha300 *access*

access is a micro-Raman single-spot analysis and mapping microscope. It was specifically engineered for budget-conscious customers with high demands on instrument performance. The high-quality WITec microscope architecture of the *access* is the basis for its full upgradability. Whenever needed, *access* can be easily and quickly adapted to new requirements. Customized solutions for e.g. scan stages, spectrometers, cameras and lasers can be added and even advanced Raman techniques can be integrated.

alpha300 microscope series

alpha300 *access*

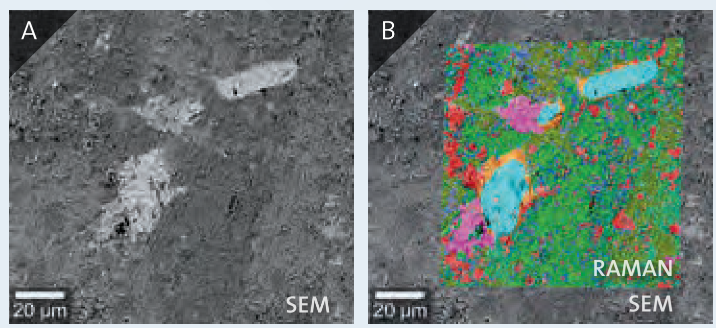
apyron

The WITec *apyron* is an intuitive automated microscope system for Raman spectroscopy and chemical imaging. The push-button principle of the system has the advantage of drastically reducing the time required to become familiar with the operation of the instrument, which accelerates the initiation of measurements and increases the rate of sample turnover greatly compared to conventional systems. With the *apyron's* straightforward interface the user can concentrate entirely on the experiment without being distracted by complex operating procedures.

apyron automated Raman imaging system

RISE Microscopy®

RISE Microscopy® is a correlative technique that combines Raman Imaging and Scanning Electron microscopy into one integrated system, allowing ultra-structural surface properties to be linked to molecular compound information. With this combination samples are automatically transferred from one measuring position to the other within the vacuum chamber of the SEM for the entirety of the measurement procedure, thus streamlining the workflow and drastically improving the instrument's ease of use.



A) SEM image of a geological sample (diorite). **B)** SEM image overlaid with the Raman image. The different colors in the Raman image illustrate the various molecular compounds.

RISE Microscopy for correlative Raman-SEM imaging

WITec alpha300 Series

alpha300 A alpha300 R alpha300 RA alpha300 S

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