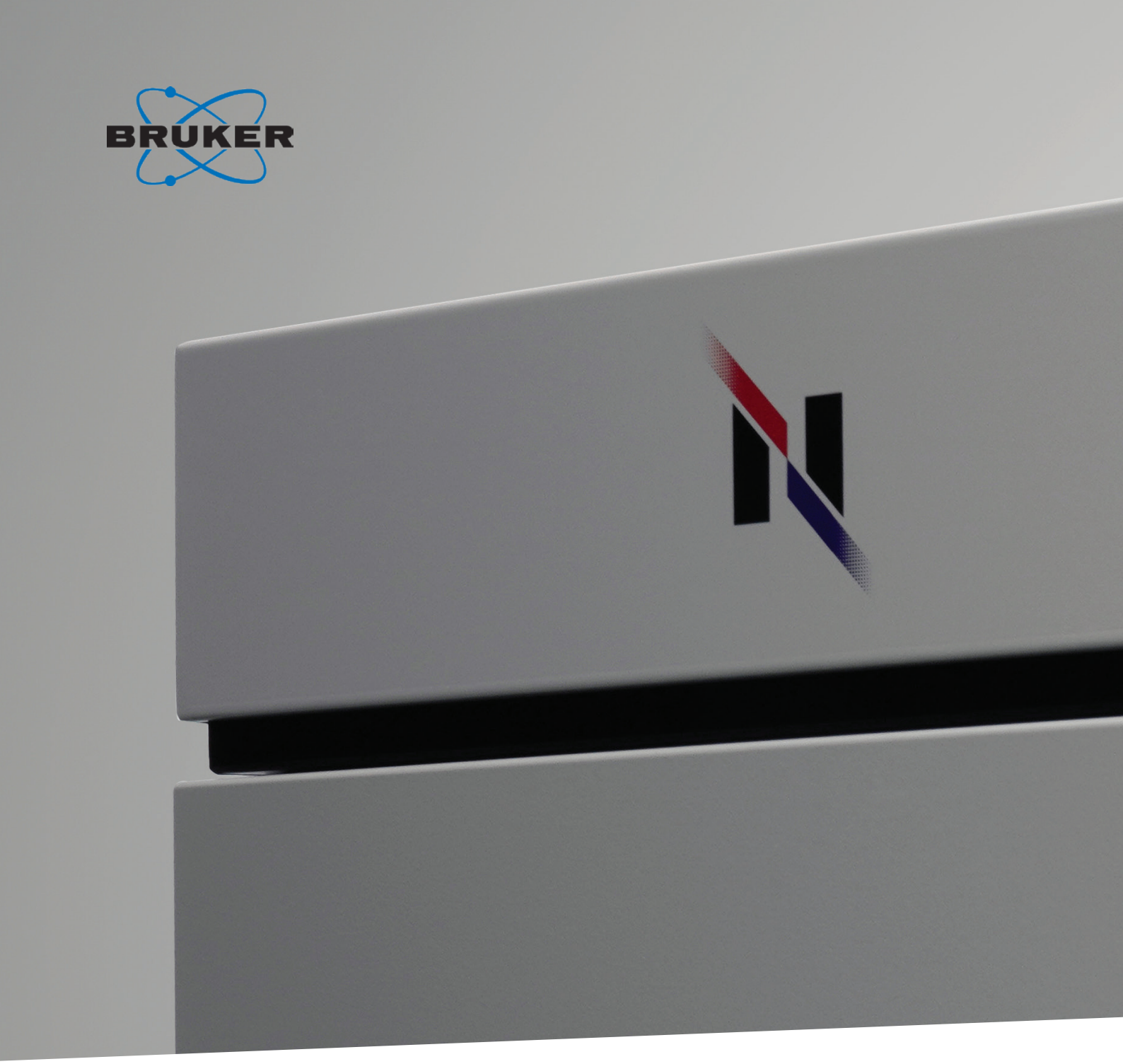


RAMANtouch, RAMANwalk, and RAMANdrive

Nanophoton Series Raman Microscopes

Rethink Raman Imaging.

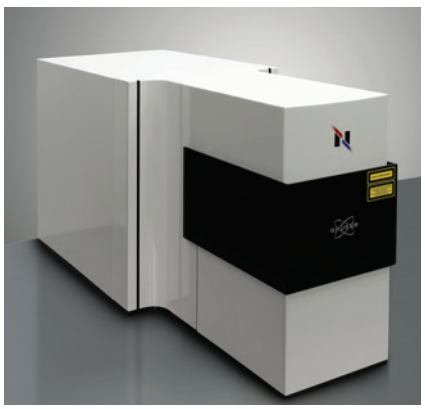
Innovation with Integrity

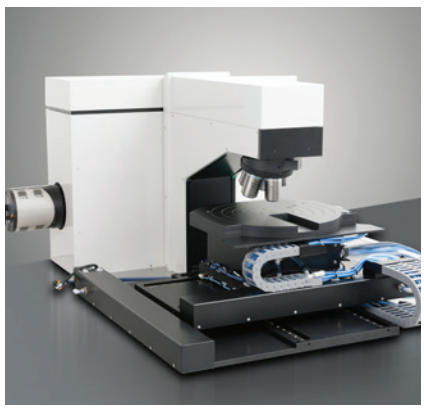
The Nanophoton Philosophy

Beauty in simplicity – Strength in innovation. Both define our Nanophoton series Raman imaging microscopes. By using galvanometric scanning, we provide the higher measurement speed, higher spectral quality, and unmatched performance needed to rethink Raman imaging.

Meet the **RAMAN**family

Every microscope in the RAMANfamily shares a key technological feature: our patented galvanic beam steering for controlling the optical path of laser excitation and Raman signal collection. This opens up new possibilities that each of the Nanophoton devices uses in its very own way.





RAMANtouch

It doesn't get any better than this. Unmatched Raman imaging speed combined with research grade spectral performance.

- Measure 400 spectra simultaneously with line illumination
- Ultra-fast 2D/3D Raman imaging
- Highest spectral and spatial resolution
- Completely automated
- Auto-calibration and auto-alignment
- Up to 4 lasers in parallel

RAMANwalk

Its unique approach makes it stand out from the crowd. It is smarter, faster, and easier to use compared to other traditional Raman microscopes.

- Reduce imaging time by smart acquisition algorithm
- Compact footprint & open access design
- Completely automated hardware
- Convenient 2D/3D Raman imaging
- Auto-calibration and auto-alignment

RAMANdrive

This Raman microscope addresses the needs of semiconductor applications, offering unique stability, speed, reproducibility, and accuracy for waver analysis.

- Raman imaging with 400 point line illumination
- Raman imaging of complete 12" wafers with dedicated 300 mm stage
- AreaFlash fast average imaging
- Interfacing to defect-inspection systems
- Cleanroom ready

Our Core Technology

Galvanometer scanners allow fast and accurate laser beam scanning and steering. This means the laser spot can travel across the sample, without moving the microscope's stage, speeding up analysis and eliminating vibrations. In combination with Nanophoton's patented line illumination technology, this sets the foundation for highest imaging performance on any sample.

Sample

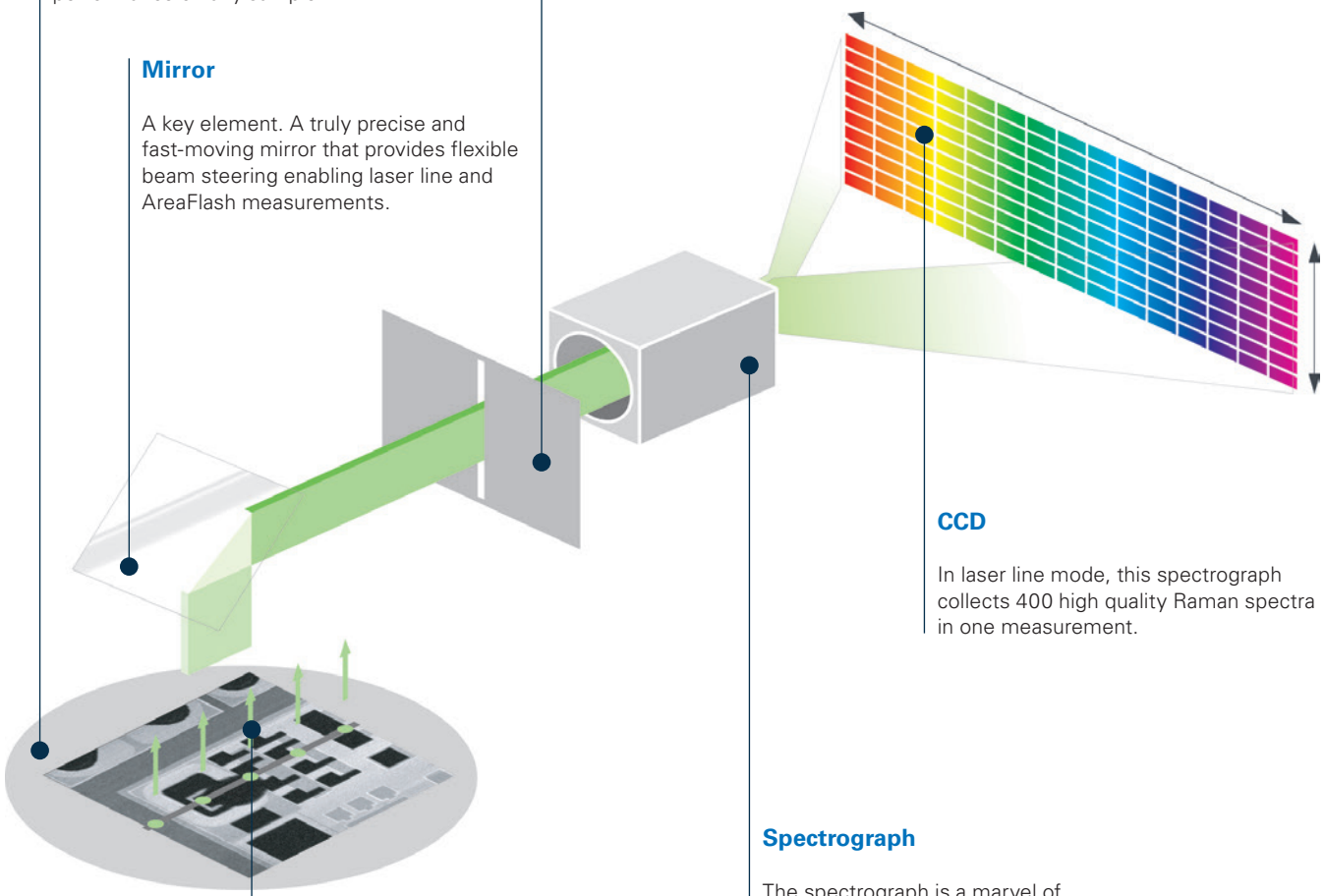
The RAMANfamily offers different measurement modes for highest performance on any sample.

Mirror

A key element. A truly precise and fast-moving mirror that provides flexible beam steering enabling laser line and AreaFlash measurements.

Confocal Slit/Pinhole

Depending on whether laser line or laser spot measurements are required a pinhole or confocal slit is used.



CCD

In laser line mode, this spectrograph collects 400 high quality Raman spectra in one measurement.

Spectrograph

The spectrograph is a marvel of engineering. It combines highest spectral resolution and throughput with a robust design.

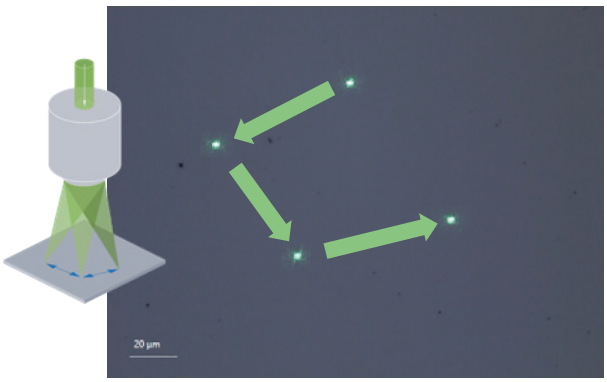
Laser Line/Laser Spot

Your requirement decides: Easily switch between point-wise measurements or fast Raman imaging by line illumination.

Measurement Modes

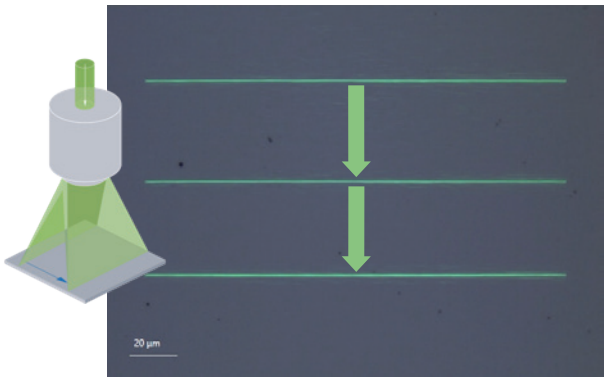
The RAMANfamily offers different measurement modes to deliver optimal performance for different samples. The dedicated illumination mode developed by Nanophoton has dramatically improved the speed of Raman imaging by re-forming point laser beams into line shapes to cover a larger sample area.

Laser Spot Illumination
RAMANdrive, RAMANtouch, RAMANwalk



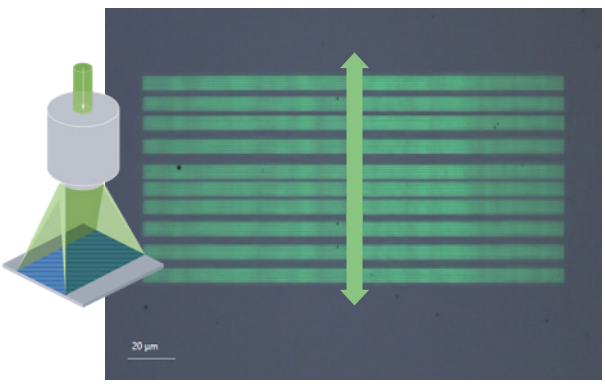
With laser beam scanning, both scanning speed and scanning accuracy are far superior to conventional motorized scanning. In addition, the measurement position can be specified by simply clicking on any position in the microscope image without requiring to move the sample.

Laser Line Illumination
RAMANdrive, RAMANtouch



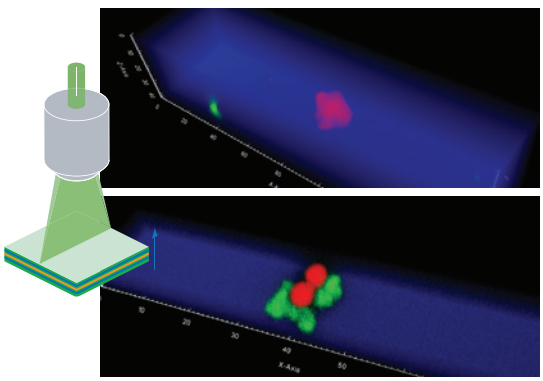
Using a laser line let's you spend your time 400 x more efficiently. Scattered light is detected by the two-dimensional CCD, obtaining 400 spectra with a single exposure. The Galvanometer scanners enable Raman imaging of several hundred thousand pixels within just a few minutes.

AreaFlash Illumination
RAMANdrive, RAMANtouch



The laser flashes across the sample, covering the entire field of view with a continuously moving laser line. AreaFlash provides an average spectrum of a large area (>1.5*1.5mm with 5x objective lens). With this, you can quickly obtain a comprehensive Raman image of a large area. For photosensitive samples, AreaFlash mode minimizes effective laser intensity, preventing alteration of the substances.

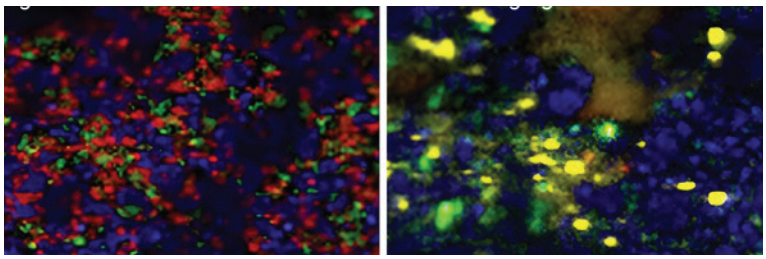
3D Imaging
RAMANtouch, RAMANwalk



Spot- and line illumination can be used to automatically perform 3D Raman imaging on transparent samples. The speed advantage of the line illumination technique for the first time gives access to three-dimensional information on chemical distributions within manageable timeframes.

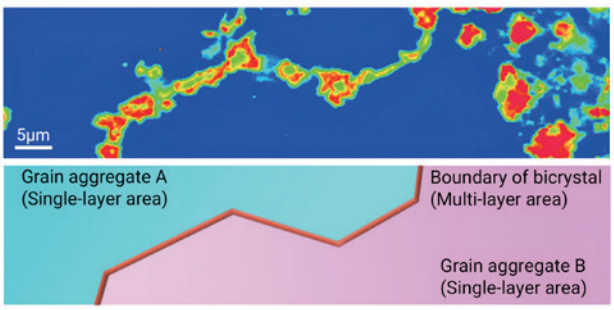
Raman Applications

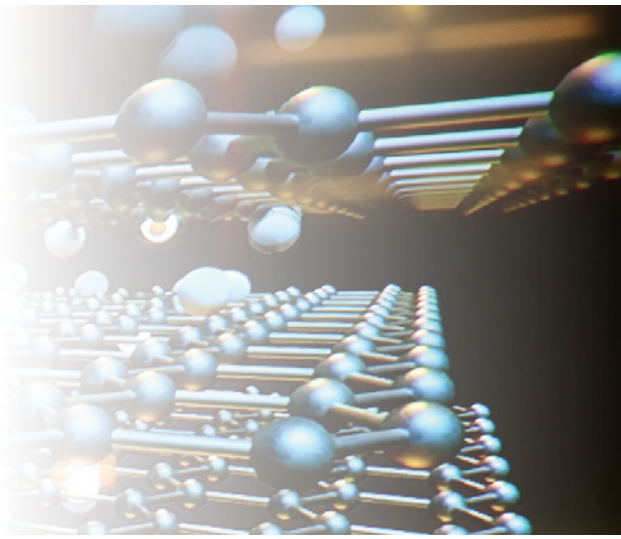
Battery Research - Monitoring Electrodes



This example focuses on improving high-capacity lithium-ion battery negative electrodes. The approach involves examining the structural changes of silicon through Raman imaging before and after charging. Raman imaging identifies the transformation of crystalline silicon into an amorphous state due to volume changes. This transformation can lead to issues like irreversible capacity loss, structural degradation, altered diffusion kinetics, and electrode instability.

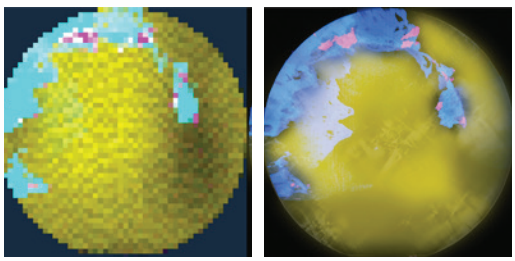
Carbon Materials - CVD Graphene Growth

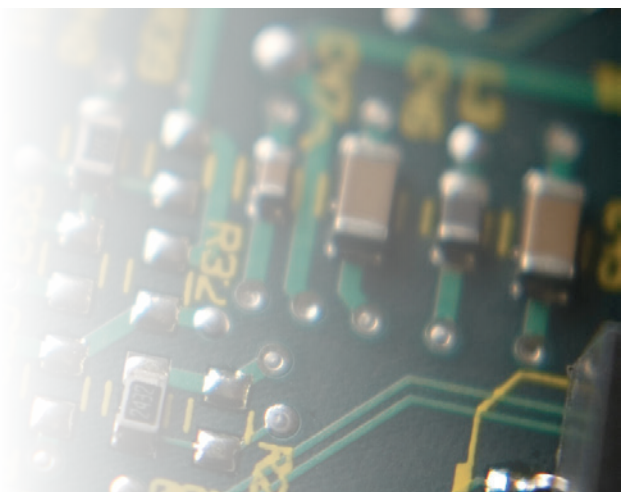




Graphene is used in electronics, energy storage, sensors, and materials reinforcement. This application highlights the use of Raman microscopy for quality control of graphene produced by Chemical Vapor Deposition (CVD). The study revealed that monolayer graphene forms within Nickel (Ni) grains, while multilayer graphene accumulates along grain boundaries – all important parameters to assess the graphene's quality.

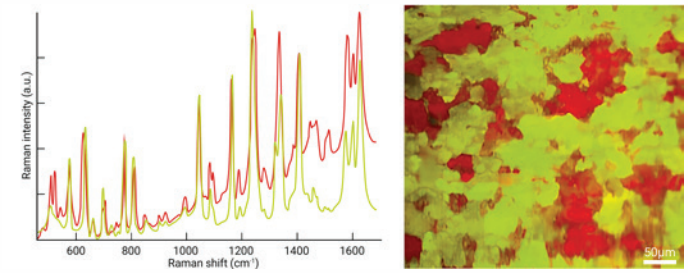
Semiconductor - SiC Polytype Distribution





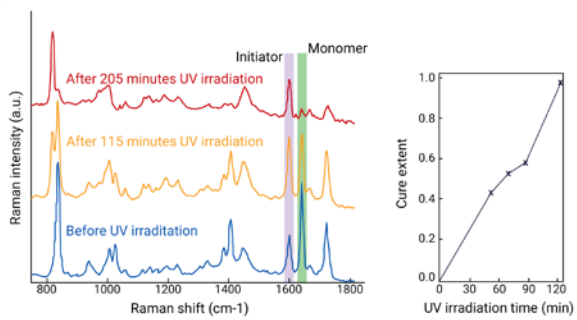
The RAMANdrive was used to assess differences in the crystal structure of an entire 4-inch SiC wafer in just 12 minutes. AreaFlash provided a low-resolution image in very short time (left), while laser line imaging revealed the finer details in the SiC polytype distribution (right). This approach efficiently balances quick initial assessment with the option for detailed analysis to drastically reduce total analysis time.

Pharmaceuticals - Distinguishing API Polymorphs

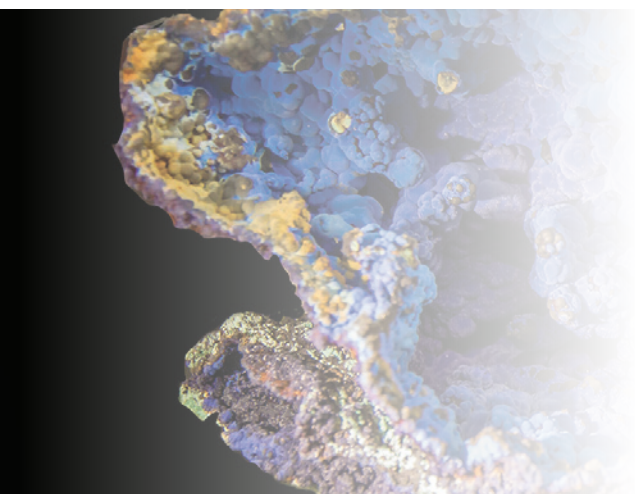


The crystallinity of a drug can affect therapeutic effects and absorption rates. Raman microscopy can assess the polymorphism of APIs non-destructively with no to minimal sample preparation. Here, the crystal polymorph distribution of mefenamic acid was determined, a painkiller with anti-inflammatory and antipyretic effects. The obvious differences in their Raman spectra were visualized in a Raman image, that clearly shows the random distribution of crystal form I (red) and form II (yellow).

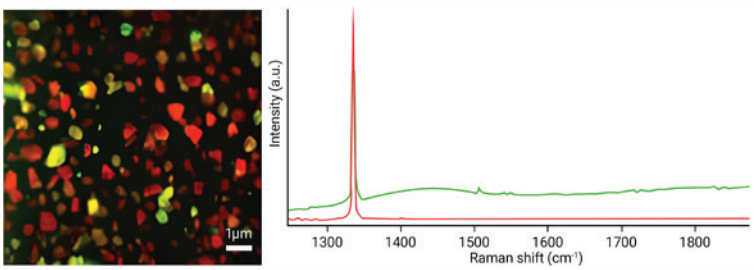
Polymers & Plastics - Distribution of Degree of Curing



Raman spectroscopy can monitor polymerization reactions and curing processes in real-time by tracking molecular changes in the resin. In this example, Raman spectra of a resin sample were continuously collected and examined before and after UV irradiation of 115 and 205 minutes respectively. The degree of resin curing was determined by the intensity ratio of the peaks at 1640 cm^{-1} and 1598 cm^{-1}.



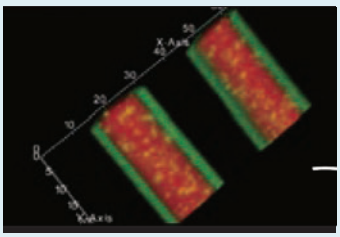
Minerals - Analysis of Diamond Abrasive Surface



Diamonds used for abrasive surfaces require high crystallinity and must be evenly distributed. In this example, Raman imaging was used to reveal both parameters. On the right, the green spectrum diamonds show lower crystallinity compared to the red spectrum diamonds. Further examination shows that diamonds cover about 68.94% of the abrasive area, with nearly 61% being high-crystallinity diamonds (red).

Hardware and Software

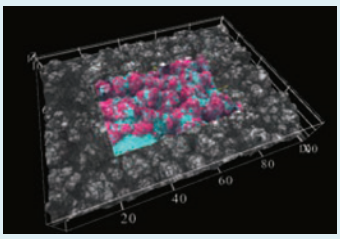
Advanced hardware and software for optimal results



3D Raman

Three-dimensional observation with high speed and high spatial resolution.

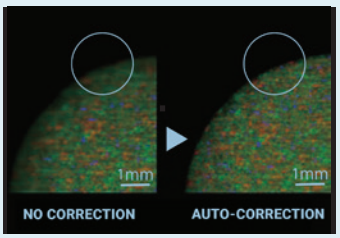
The advanced confocal system with a user-friendly GUI provides detailed 3D structures in transparent materials. This non-destructive technology with line illumination scanning achieves the highest-speed and highest-resolution imaging of Raman spectra in the world.



Z-Track

Tracking bumpy sample surfaces.

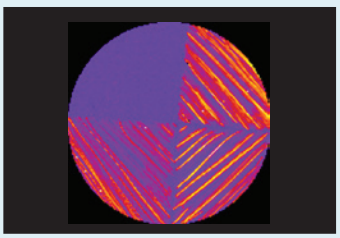
The surface profile of the sample is measured quickly and automatically from a series of optical microscope images at different heights. Raman mapping measurement is performed by adjusting the surface height at every laser focus location.



Wide-Field

High-speed wide field imaging follows the curve of the specimen surface.

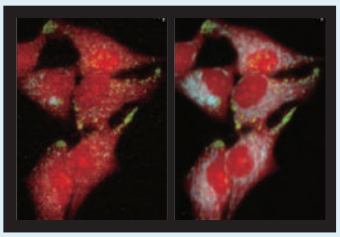
Combining the original laser scanning technology with stage scanning allows for scanning the entire sample surface using a high-speed imaging method. Samples with bumpy, tilted, or curved surfaces are also compatible with Z-Track and AreaFlash.



AreaFlash

High-speed bulk spectrum averaging.

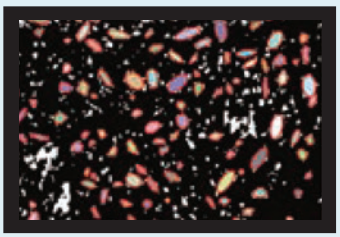
An averaged spectrum over a wide area in the FOV of the optical microscope can be obtained in a very short time. This technology is a powerful tool for fast screening and to monitor sample changes over time.



Processing

A variety of spectral preprocessing tools.

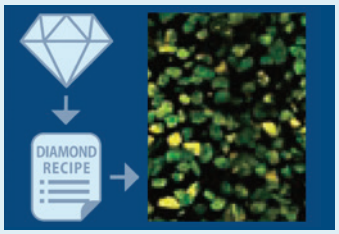
Baseline correction, differential spectrum processing, SVD noise removal and many other functions assist in reliable spectral analysis. A smoothing method with small influence on peak shape, the Kawata-Minami-Filter is also useful.



Imaging

Advanced spectral and image analysis algorithms.

Multi-peak fit algorithm, real-time multivariate analysis during measurement, image correlation analysis, particle size analysis and other advanced Raman imaging analysis algorithms are available.



Presetting

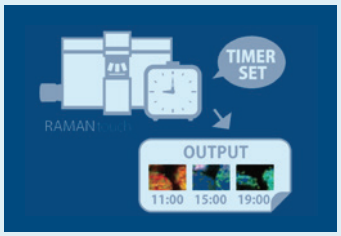
Select a measurement target from the recipe.

Complicated condition settings are no longer required. For first-time samples, all you have to do is select a similar substance from the registered recipes. For frequently measured materials, create your own unique "recipes"with the right measurement conditions.

Remote Use

You can measure and analyze even from remote locations.

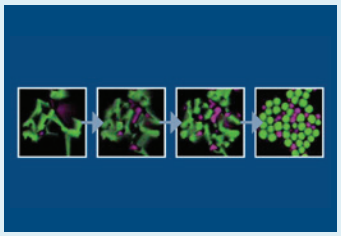
There's no need to always be next to the instrument to achieve excellent results. Once the sample is placed, RAMANtouch can be operated remotely from any computer.



Scheduling

Set your schedule in advance and focus on other tasks while the instrument does the job.

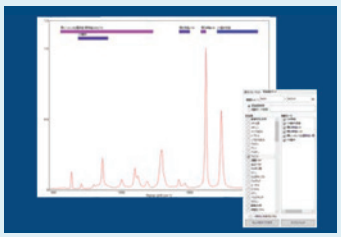
Minimized operator time. The reserved measurement function automatically performs measurements on a scheduled basis. Multiple measurement types and intervals are possible. If the focus shifts, it is automatically corrected to the preset condition before measurement.



Random Walk

Measurement time is reduced significantly by prioritizing relevant sample regions.

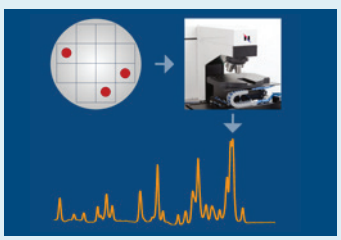
All Nanophoton Raman microscopes are equipped with a random walk scanning function, utilizing an ingenious beam scanning method based on stochastic process theory and information theory. Samples suitable for point scanning can also be scanned at high speed, leading to results in the shortest possible time.



Reporting

Substance identification support and report creation.

Functional group guide that displays peak appearance region of functional group, interfacing with external databases, spectral library construction by users. Convenient functions for results creation and data exporting.



Stage Navi

Enjoy convenient interfacing.

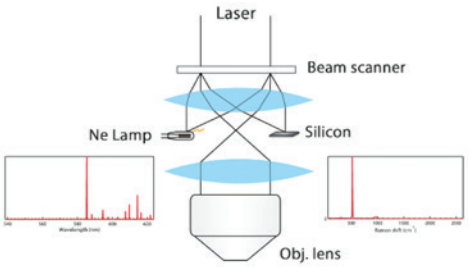
Simply upload data from your regular defect inspection tool and RAMANdrive identifies your areas of interest and moves the sample automatically to the requested positions for a detailed analysis.

Spectroscopy Benchmarks

Assured Maximum Performance due to Auto Alignment and Calibration

Nanophoton series microscopes feature automated alignment of the optical beampath. This assures maximum performance and long term stability without requiring manual adjustments. No expertise is needed to maintain a running instrument and high-quality measurements are guaranteed. Additionally, the RAMANfamily features an internal reference source and samples for calibration. This enables fully automatic wavenumber calibration without manual interaction with the system. Since wavenumber calibration can be performed even during measurement, it is possible detect smallest variations of Raman peaks with highest accuracy.

Internal neon lamp and silicon for reference



Automated Measurements with Automated Hardware

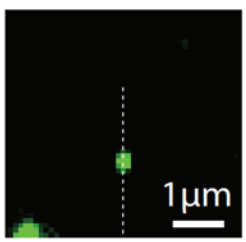
Nanophoton instruments boast with complete system automation. From laser selection and adjustment of excitation power to motorized nosepiece and sample stage, every aspect of the measurement is software controlled. Complete automatization saves time and simplifies the operation of the microscope while assuring excellent reproducibility of results. The automated hardware of the RAMANfamily even allows convenient remote operation and advanced task scheduling.

Automated nosepiece and stage

The Highest Resolution with any Objective Lens

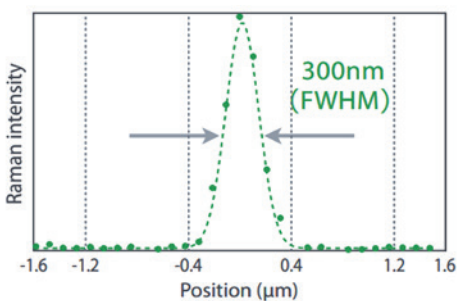
Independent of the choice of objectives or lasers, Nanophoton microscopes provide excellent spatial resolution thanks to their sophisticated confocal optical design. In the example of a 100x dry objective with 532 nm excitation, a lateral spatial resolution below 350 nm is demonstrated, achieving a depth resolution well below 1 µm. Also, with lower magnification lenses the resolution reaches their theoretical limit, allowing versatility in objective choice while assuring best imaging performance in any measurement.

Raman image 200nm bead



532nm / 100x, 0.90NA

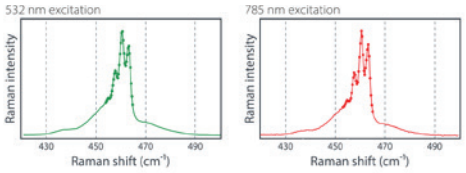
Signal intensity profile



High Spectral Resolution distinguishes Close Peaks

Highest spatial resolution and optimal throughput in a compact form factor. This is achieved using a powerful, pateted spectrograph design with 550 mm focal length. The spectral resolution is approximately 0.9 cm^{-1} (FWHM) when a 785nm laser excitation wavelength is applied using a 1200 gr/mm grating. Even the Raman peaks of carbon tetrachloride that are used to evaluate spectral resolution can be observed respectively at both 532 nm and 785 nm excitation wavelengths.

Raman spectrum of CCl_4



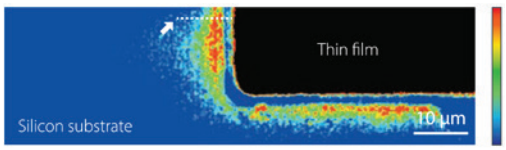
Excitation	532 nm	Excitation	785 nm
Grating	2400 gr/mm	Grating	1200 gr/mm

Stable Peak Positioning enables High Accuracy Stress Analysis

The Raman peak position of silicon at 520 cm^{-1} shifts when the crystal lattice is distorted by stress. It shifts to higher wavenumbers under compressive stress, and shifts to lower under tensile stress. The amount of shift is proportional to the amount of stress imposed. The image at right is the Raman image of a silicon wafer with a thin film formed on its surface, colored by the stress distribution. The graph of the silicon peak position along the white dotted line in the Raman image shows stress distribution analyzed at a high accuracy of over 0.1 cm^{-1}.

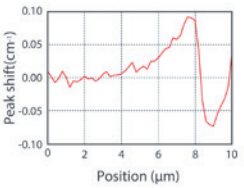
RAMANtouch has great repeatability and stability in Raman peak positions. The rightmost figure, which is a histogram of the peak positions of silicon, shows that the standard deviation of peak positions is within only 0.02 cm^{-1} (typical value using 532 nm laser excitation and 2400 grooves/mm grating).

Raman image of stress distribution on silicon wafer

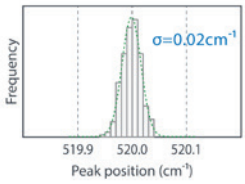


Excitation	532 nm	Number of spectra	60,000 (400x150)
Objective	100x, 0.90 N.A.	Measurement time	20 min
Grating	2400 gr/mm		

Profile of silicon peak positions along white dotted line in above image

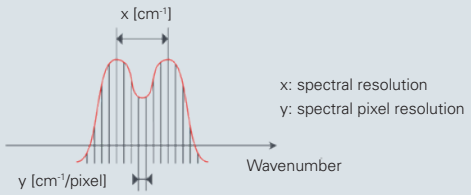


Peak position accuracy
Histogram of silicon peak positions



Differences between Spectral and Pixel Resolution

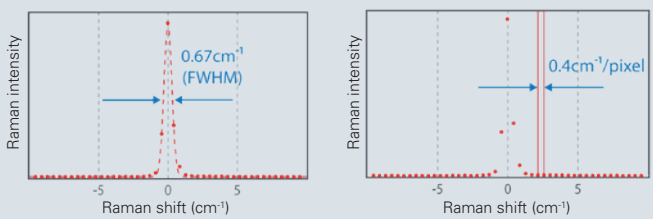
Pixel resolution indicates the area (cm^{-1}) per pixel of dispersed Raman light which hits the CCD. The more pixels the CCD has, the smaller the pixel resolution gets. However, smaller pixel resolution does not relate with higher spectral resolution.



Spectral resolution and pixel resolution

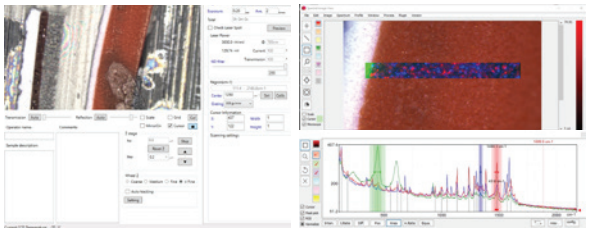
Spectral resolution
(FWHM of Rayleigh scattered light)

Spectral pixel resolution
(Sampling interval)



Excitation	785 nm	Grating	1200 gr/mm

YOU CAN COUNT ON US !
Raman is an exciting technology with incredible potential. Keep in touch with our engineers and specialists to unlock this potential by benefiting from our outstanding service and support team.



Our hardware? Simply mighty.

We follow a simple philosophy in our hardware design and believe that high-quality automation is the best way to achieve maximum robustness, reliability, and ease-of-use.

Your system will never let you down, thanks to extensive system intelligence and our customer-centric service solutions. Highest performance and ease of operation is guaranteed.

Our software? Mighty simple.

Our software is equipped with high-speed data processing capacity and miscellaneous analytical functions to support analysis of large, high-qualtiy Raman imaging datasets.

Flexible file export options allow merging Nanophoton's data with other microscopic datasets and further give access to the sophisticated flexible AI-based evaluation tools in OPUS.

Covered by one or more of the following patents: US11442259B2; US10352862B2; US9927297B2; US9582088B2; US9435741B2; US20140063226A1; US20140002819A1; US20130162990A1; JP6923180B2; JP5998342B2; US7561265B2; JP5779963B2.
Additional patents pending.

Laser class 1 product.

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