*Fastest high definition Raman imaging*

Fastest Laser Raman Microscope

# RAMAN-11

nano photon

www.nanophoton.jp

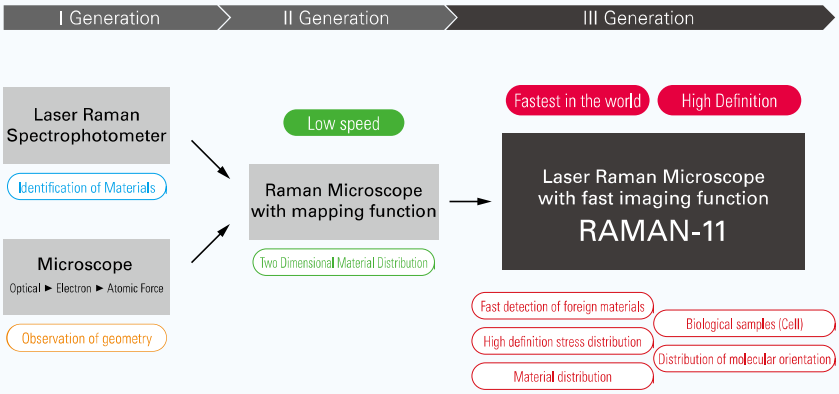
# Observation

## A New Generation in Raman Observation

RAMAN-11 developed by Nanophoton was newly created by combining laser microscope technology with Raman spectroscopy technology. The excellent performance of its fastest high definition Raman imaging has been realized only by Nanophoton, who has great expertise in laser microscope technology.

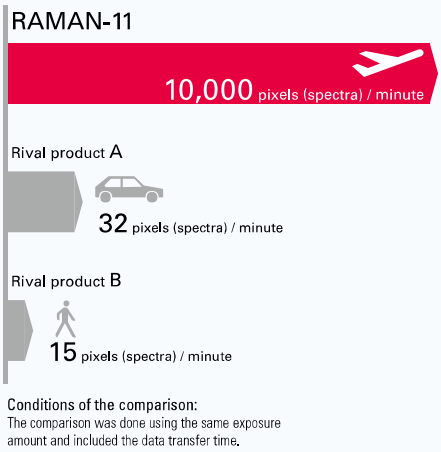
## A New Generation of Fine Material Imaging by Raman Microscopy

If the Raman Spectrophotometer which measured the Raman spectrum was the first generation, the Raman microscope which acquired Raman Imaging with a stage scan should be called the second generation. Now, the RAMAN-11, which enables us to observe the fastest high definition Raman imaging with a new method of optical scanning, should really be called the third generation of laser Raman microscope.

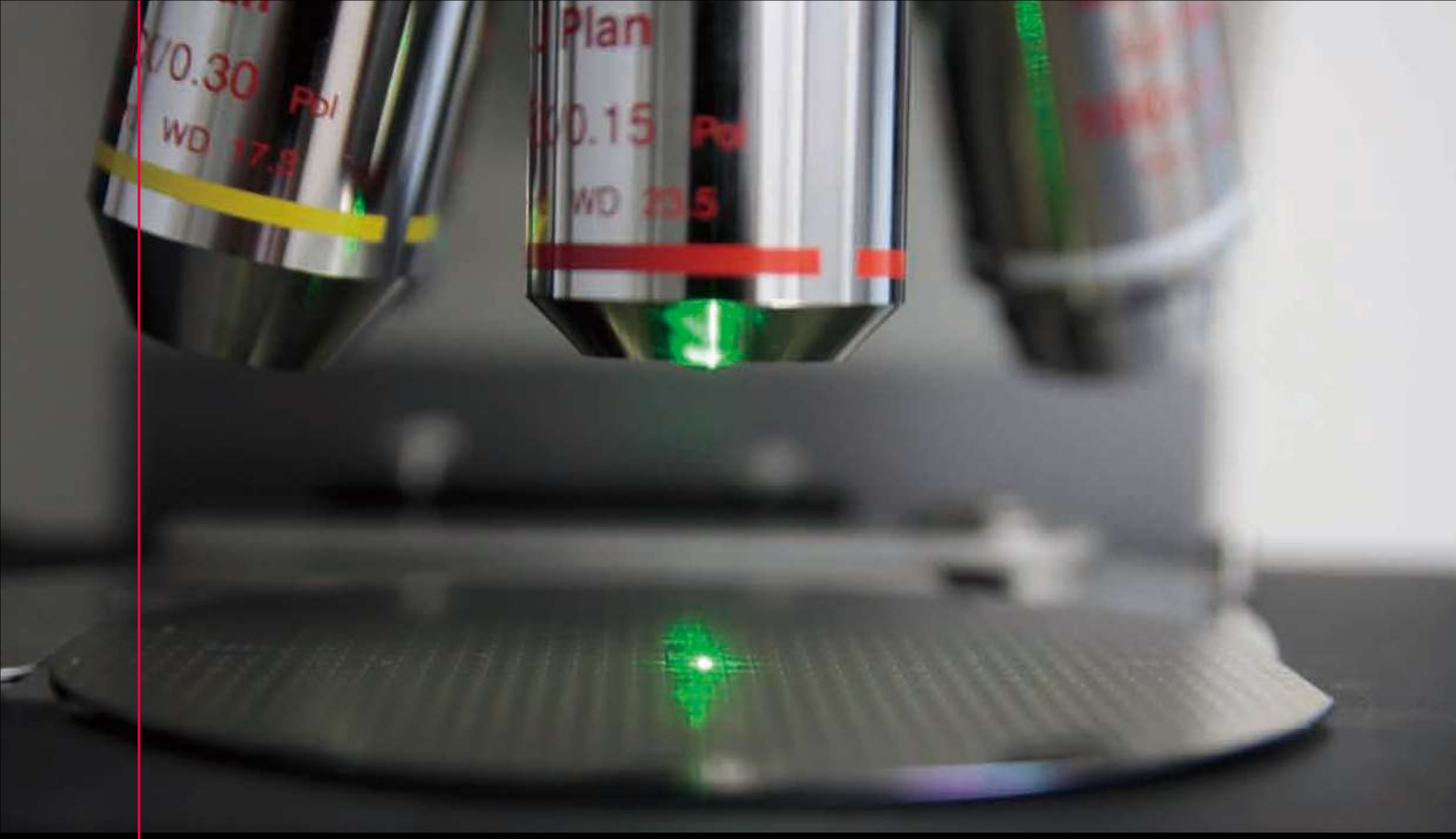



## Fastest High Definition Raman Imaging

The Raman imaging observation speed of the RAMAN-11 is 300 to 600 times faster than that of rival products and this difference in speed is relatively greater than the speed gap between a plane and a car.

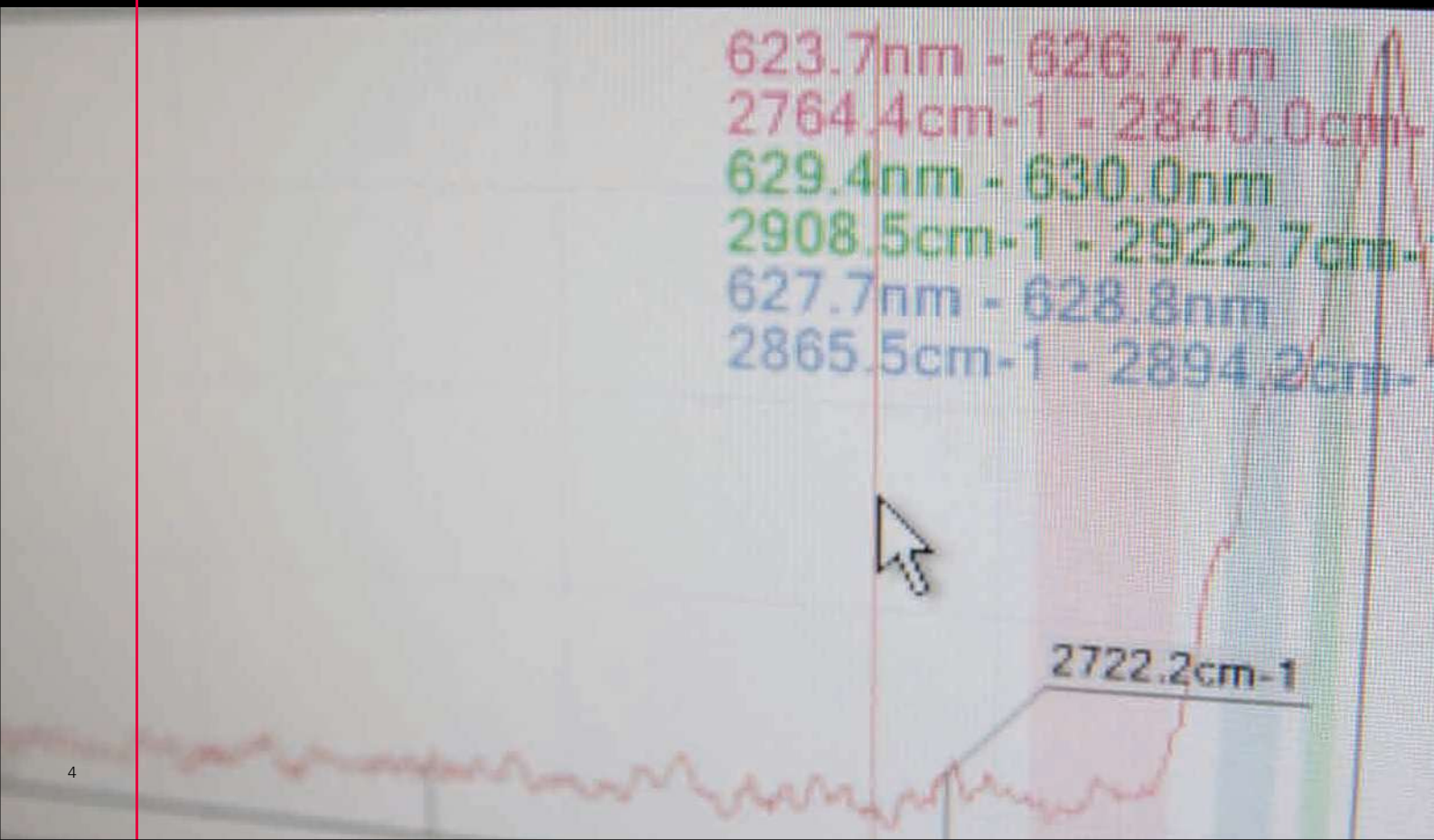



**Conditions of the comparison:**
The comparison was done using the same exposure amount and included the data transfer time.




# Application

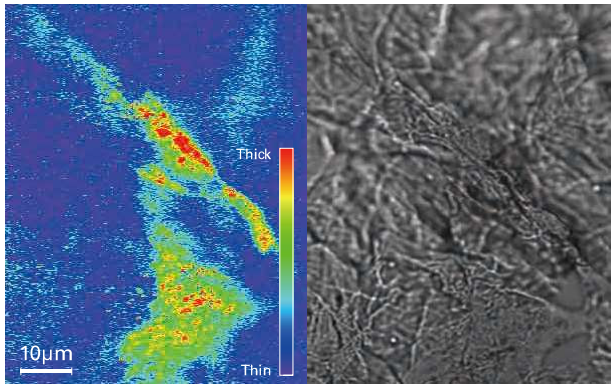
Fastest Raman imaging observation opens up new applications!



By realizing the fast and high definition imaging capability that had until now eluded us, the applications of RAMAN-11 are rapidly expanding into fields where it had traditionally been considered to be impossible to observe Raman images.

## Distribution of materials

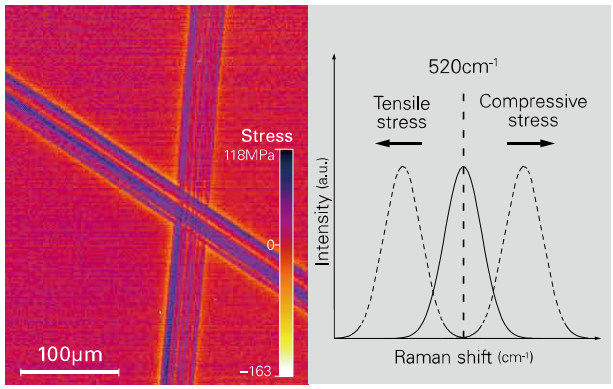
The left-hand figure shows the distribution of lotion on a layer of hard skin. By using Raman imaging, we can observe the materials even though they could not be measured (perceived) with a conventional optical microscope (the right-hand figure).




•150(x)×400(y)=60,000 Spectra •Measurement time: 5 minutes

## Stress distribution

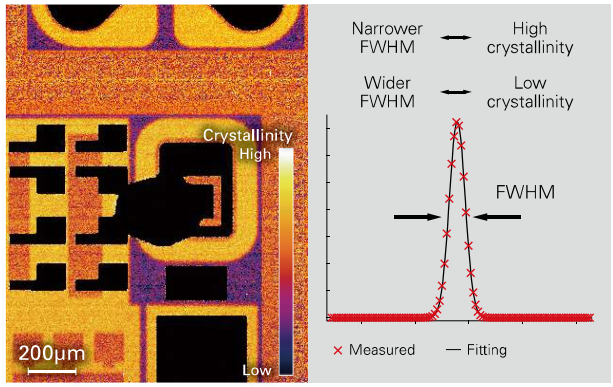
The detection of crystalline distortion, such as in silicon, is possible using Raman imaging. Looking at the Raman peak of silicon appearing at 520cm$^{-1}$, its peak position shifts in response to the distortion of the silicon crystal lattice caused by stress. The figure shows the stress distribution of the silicon crystal obtained by imaging the shift of the peak position. RAMAN-11 enables us to achieve the imaging by detecting just 0.1cm$^{-1}$ of the peak shift.




•320(x)×400(y)=128,000 Spectra •Measurement time: 16 minutes

## Crystalline evaluation

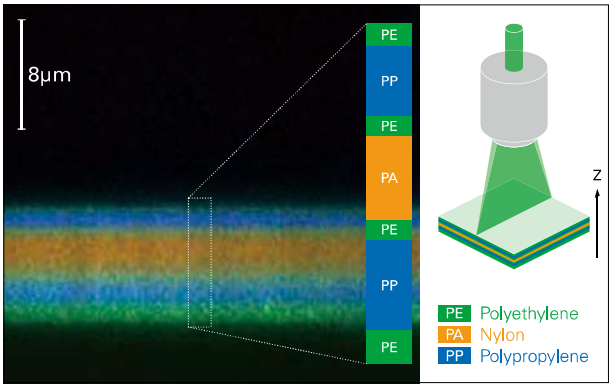
This observation image shows the crystal pattern generated with an ion implantation into silicon wafer. The crystalline structure can be evaluated by analyzing the peak width, because of the correlation between crystallinity and Raman peak width. Better crystallinity gives a narrower peak width.




•320(x)×400(y)=128,000 Spectra •Measurement time: 27 minutes

## Depth profile analysis

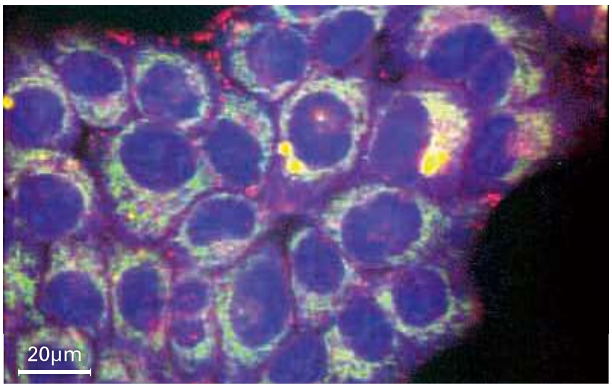
This is a cross-sectional Raman image of a multi-layer film observed non-destructively. By combining line illumination with confocal optics, the cross-sectional image can be non-destructively observed using depth profile analysis.




•300(x)×120(z)=36,000 Spectra •Measurement time: 8 minutes

## Biological samples

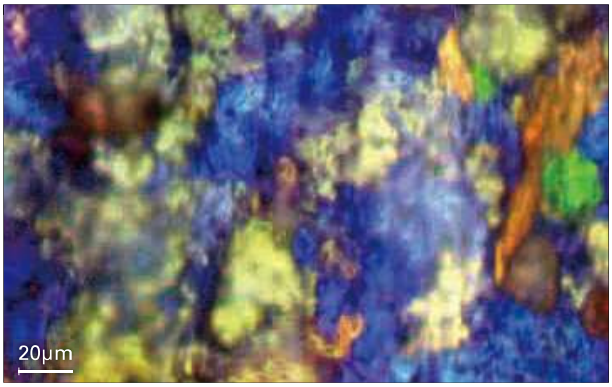
By adopting laser scanning, the vibration caused by stage scanning is eliminated. This enables us to observe samples such as biological samples in water. High speed imaging capability also enables the clear observation of cells that vary over time. The figure shows a Raman observation image of unstained human uterine cervix cancer cells.




•400(x)×400(y)=160,000 Spectra •Measurement time: 40 minutes

## Ingredients of a pharmaceutical drug

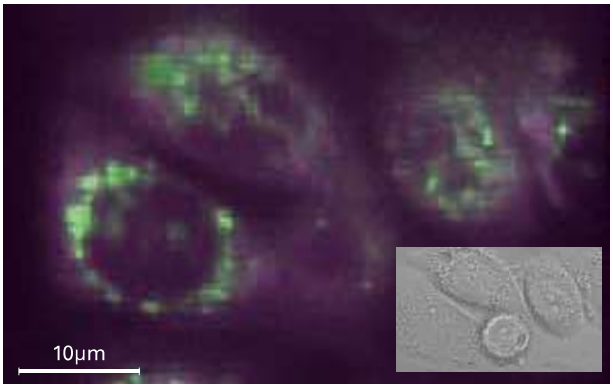
This Raman image shows the distribution of pharmaceutical ingredients and diluents on the surface of a tablet. The pharmaceutical ingredients exist as various polymorphic crystals. The polymorphs of the pharmaceutical ingredients can be non-destructively analyzed without contact using a small amount of the sample. The distribution of the grain size of each ingredient can also be observed.




•400(x)×220(y)=88,000 Spectra •Measurement time: 11 minutes

## Tracking of foreign matter (tracking)

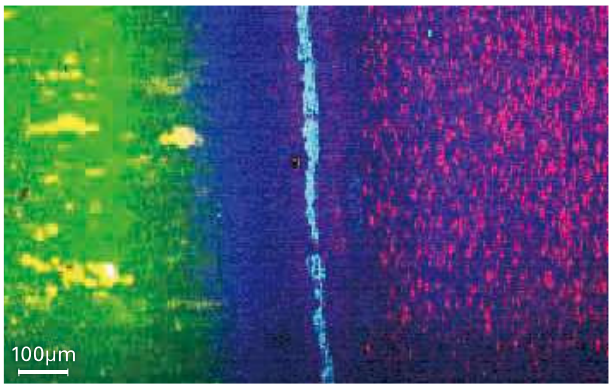
The figure shows an observation image of the distribution of anticancer drugs administered to cancer cells. It indicates that the anticancer drugs (foreign matter) are taken into cells and exist locally in the cell nucleus and around the outside of the nucleus. It is possible to clarify through what paths this foreign matter moves and locally exist, by observing the distributions.




•130(x)×200(y)=26,000 Spectra •Measurement time: 5 minutes
By courtesy of Professor Takamatsu at Kyoto Prefectural University of Medicine

## Distribution of compounds

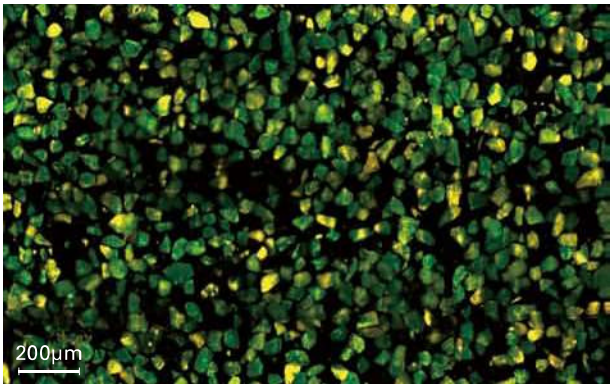
The figure shows an observation image of a superconductor.
R: Gd123/a/b oriented
G: $CeO_2$
B: Gd123
C: Gd123/underdoped
Y: $NiFe_2O_4$
RAMAN-11 enables to observe the distribution of various compounds used for advanced materials.




•265(x)×400(y)=106,000 Spectra •Measurement time: 120 minutes

## Observation of a wide-field of view

Raman imaging of large areas is possible by combining the motorization stage with the standard laser beam scanning function. The image shows the distribution of high quality diamonds (shown in green) and low quality diamonds (shown in yellow).

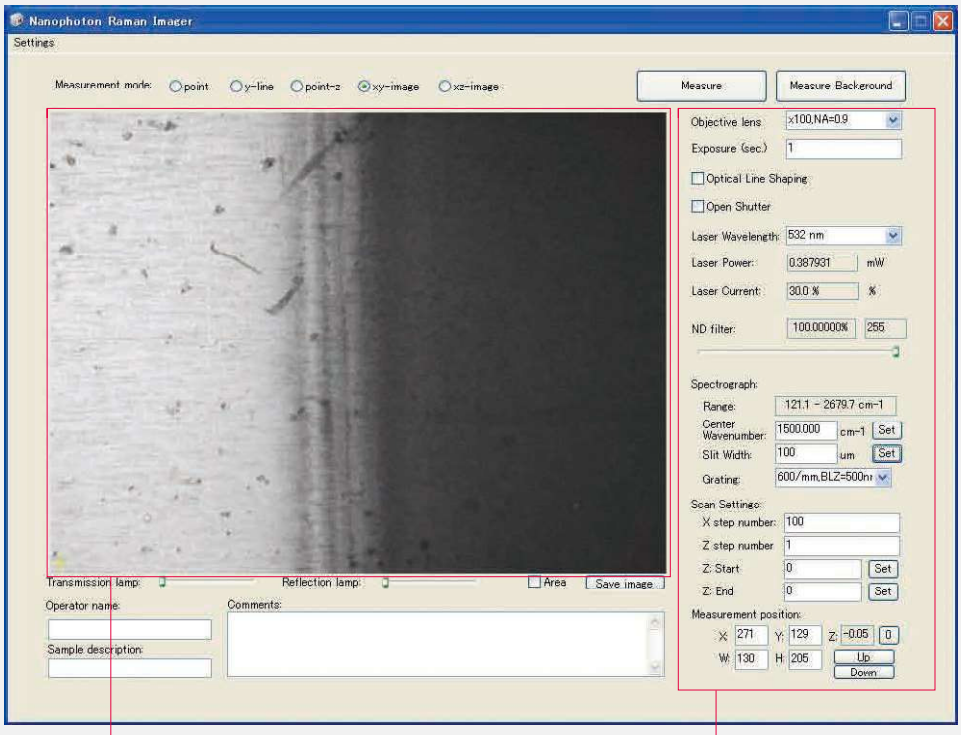



•2,000(x)×1,600(y)=3,200,000 Spectra •Measurement time: 140 minutes

# Software

RAMAN-11 supports various user applications through its robust functions and significant software operability.

## Main window




Microscope image

Measurement parameters

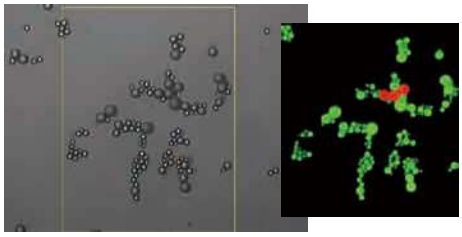
### Quick data acquisition

RAMAN-11 software consists of two different software programs. One is for measurement, and the other is for spectrum analysis. With the measurement software you can quickly and easily select a measurement area by directing a laser spot on a microscope image of the sample. In addition, the measurement procedure can be immediately started by setting the laser wavelength, strength, exposure time, range of spectrum measurement and so on.

## Plenty of functions to facilitate analysis

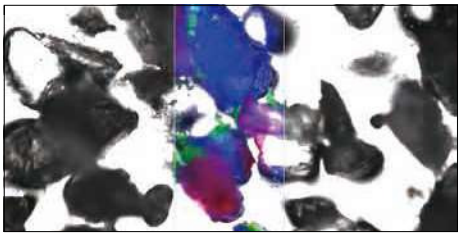
### Intuitive visualization

The distribution of Raman intensity, peak area, peak shift, intensity difference and intensity ratio can be intuitively and intelligibly visualized by assigning various colors with simple operation.



### Superimpose (a Raman image on a microscope image)

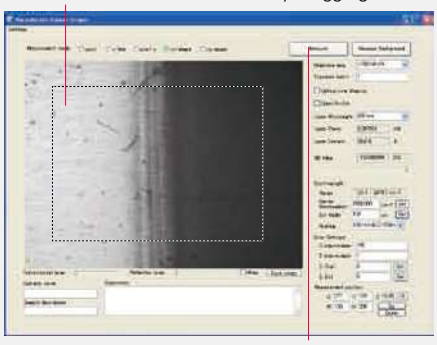
Analysis and verification are easy by superimposing the Raman image on the microscope image from transmitted or reflected light.



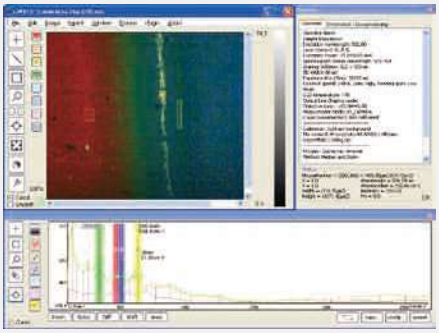
## High-speed and high-definition Raman imaging

The greatest characteristic of RAMAN-11 is that the Raman image can be easily and quickly acquired. Conventional measurement time needs several hours, but with RAMAN11 measurement is completed in several minutes. The operation is so simple that the operator only has to choose the measuring area with a mouse and then click the measurement button. The cross-sectional Raman image is also obtained by the cofocal optics, as well as the conventional Raman surface image.

[1] Select area of interest by dragging a mouse.



[2] Click a measurement button

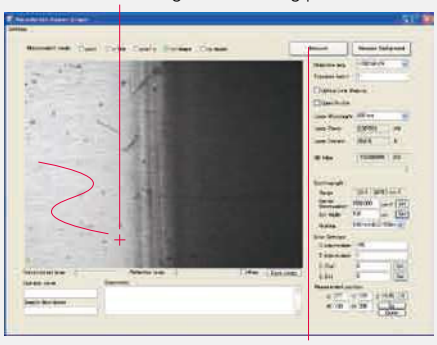


[3] Quickly acquire the Raman image

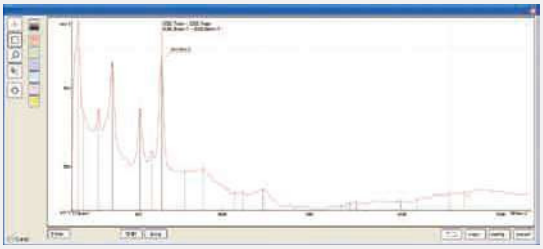
## The “ezPointing” spectrum measurement

The Raman spectrum of any point on the sample can be measured by simply clicking the mouse while the pointer indicates the measuring point. Due to the optical scanners, no stage movement is necessary.

[1] Assign a measuring point with a mouse



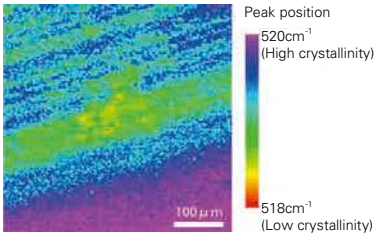
[2] Click a measurement button



[3] Acquire the spectrum of the selected point

### Peak-shift imaging

Even very small peak shifts can be clearly visualized by Gauss or Lorenz function fitting.




### Abundant data-handling functions

The following data handling functions are necessary to analyze the sample.

- Fluorescence and background rejection
- Peak dimension analysis
- Smoothing (x-y-z-λ, moving average, Savitzky-Gouy)
- Intelligent peak detection
- Median filter (x-y-z-λ)
- Binning (x-y-z-λ)
- Cosmic ray rejection filter
- Image processing with principal component analysis and least-square approach
- Component spectrum estimation by non-negative constraint

*Please consult with us about the customization of an analytical software.

# Innovation

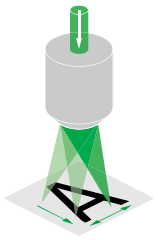
Nanophoton continues developing innovative technology to consistently lead the world as a specialized maker of laser microscopes. RAMAN-11 embodies those results.

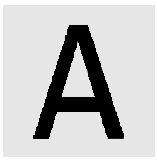
## Four technologies to ensure high-speed and high-definition imaging

### Laser beam scanning

- High-speed scanning is possible.
- The image is clear by vibration- and drift-free scanning.

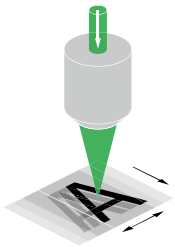
**Laser scanning** (Nanophoton)





Clear image
without vibration or drift

**Stage scanning** (Competitors)

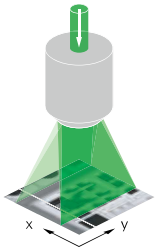


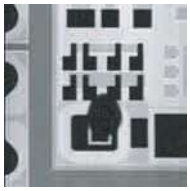
Streaked image
by vibration or drift

- Quick access to the aimed point (ezPointing)
- Ideal for observation in water or soft-material measurement

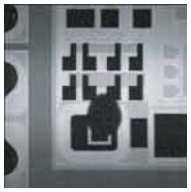
### Line illumination

- RAMAN-11 features line illumination to generate a line-shaped Raman-scattering light at once.
- Nanophoton developed original optics which enables uniform intensity distribution.



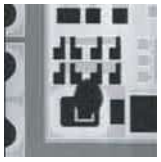
An image using
the RAMAN-11uniform
line illumination



Non-uniform line illumination
with the cylindrical lens
(conventional method)

- Damage reduction due to the light power distribution
- The switching time between point illumination and line illumination is about five seconds.

Imaging area comparison.
Both images were taken within the same exposure time.



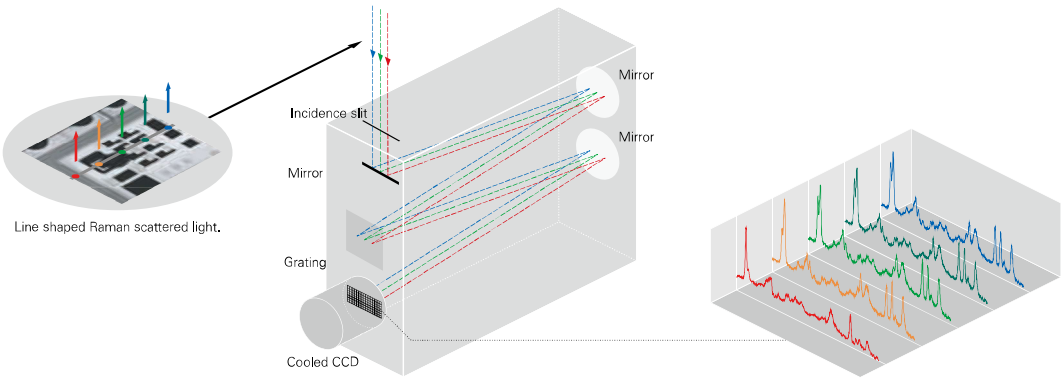
RAMAN-11

Conventional micro Raman mapping

The state-of-art optics enables revolutionary fast Raman imaging.

## Multi-spectrum simultaneous measurement

- The background of high-speed and high-definition imaging is to capture the line-shaped Raman-scattering light as 400 sets of individual spectra.

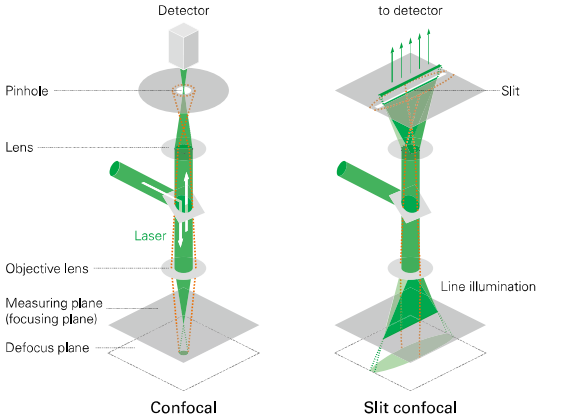



Line shaped Raman scattered light will be analyzed by a spectrometer. The line image of the object will be divided into 400 points (spectra) in lateral, while the each spectrum is being expressed with 1340 points.

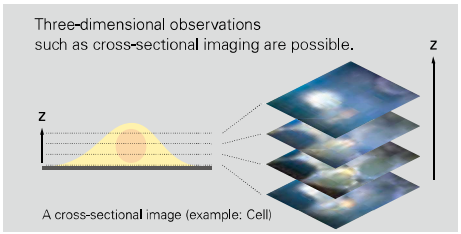
The 400 points are analyzed simultaneously

## Slit confocal (cofocal)

- Featuring confocal optics for high-resolution imaging
- Original confocal optics were developed to establish high-speed imaging.




Efficiently detect the line-shaped Raman-scattered light




- Three-dimensional resolutions
- Efficient capturing of the Raman-scattered light in a line shape
- Obtain a noiseless, clear image by blocking out the light from the area not in focus

## RAMAN-11, Specifications

| Main components | |
|---|---|
| Optical Microscope | Upright or Inverted type, should be selected at time of order. |
| Scanner | Galvanometer mirrors for fast X-Y imaging. |
| | A motorized stage for Z direction scanning with 50nm step width. |
| | Illumination mode is selectable from three modes. Point focus illumination, Line-shaped illumination and flying-spot line illumination. |
| Laser | Standard wavelength: 532nm and/or 785nm |
| | • 532nm laser<br>$TEM_{00}$<br>High brightness (500mW)<br>High intensity stability (<2% rms)<br>• 785nm laser<br>$TEM_{00}$<br>High brightness (500mW)<br>High intensity stability (<1.5% rms)<br>*Other laser wavelengths are available upon request. |
| Spectrograph | Three gratings with a motorized turret |
| | Imaging spectrograph eliminated astigmatism |
| | High efficiency coating |
| | Adjustable slit width by 1µm step (10–1000µm) |
| | Focal length: 500mm |
| | Accuracy: 0.2nm |
| | Repeatability: 0.05nm |
| Electrically cooled CCD Detector | 1340×400 Pixels |
| | Vacuum sealed (Metal seal) |
| | Cooling temp.: –70°C |
| | Read out noise: 5e⁻rms |
| | Pixel rate: 100kHz and 2MHz |
| | Dynamic range: 16bit |
| Imaging performance (with an objective lens (×100, NA=0.9)) | |
| Spatial resolution (X direction) | 350nm |
| Spatial resolution (Z direction) | 800nm |
| Field of view | 90×120µm |
| Spectroscopy performance (with a 1200/mm-groove grating) | |
| Spectral resolution | $1.6cm^{-1}$ |
| Raman shift detection range | $80–4000cm^{-1}$ |

## Examples of specifications by models

| Model | Features | |
|---|---|---|
| RAMAN-11-VIS | Laser | 532nm 0.5W |
| | CCD | Peak QE 50% at wavelength range of 450–975nm |
| RAMAN-11-NIR | Laser | 785nm 0.5W |
| | CCD | Peak QE 55% at wavelength range of 450–1050nm |
| RAMAN-11-VIS-NIR-HQ | Laser | 532nm 0.5W / 785nm 0.5W |
| | CCD | Peak QE 90% at wavelength range of 200–1075nm |

## Option

- Database (KnowItAll by Bio-Rad)
- Motorized stage for wide field of view observation
- Polarized Raman measurement
- Cooling/heating stage





nano photon

A-508, CASI, Osaka University
2-1 Yamadaoka, Suita, Osaka, Japan 565-0871
Phone: +81-6-6878-9911 FAX: +81-6-6878-9912
URL: www.nanophoton.jp
Email: info@nanophoton.jp