C103-E139

SHIMADZU
Excellence in Science

Infrared/Raman Microscope

AIRsight

AIRsight™

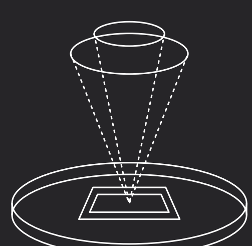
Raman and FTIR microscopy in perfect harmony

Infrared Spectroscopy and Raman Spectroscopy

Infrared and Raman Microscope Based on a Combination of Two Analytical Techniques to Provide Complementary Molecular Information

This simple system improves the efficiency of analytical operations by making it easy to perform all process steps from sample observation to data analysis.

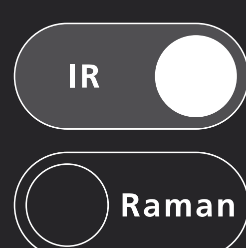
3S Microscope



Same position

is measured by IR and Raman

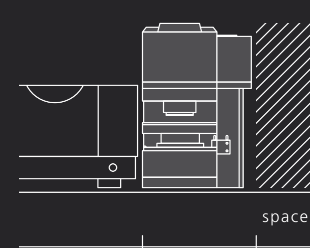
No need to search for the same position



Smart software

controls IR and Raman

One easy-to-use software

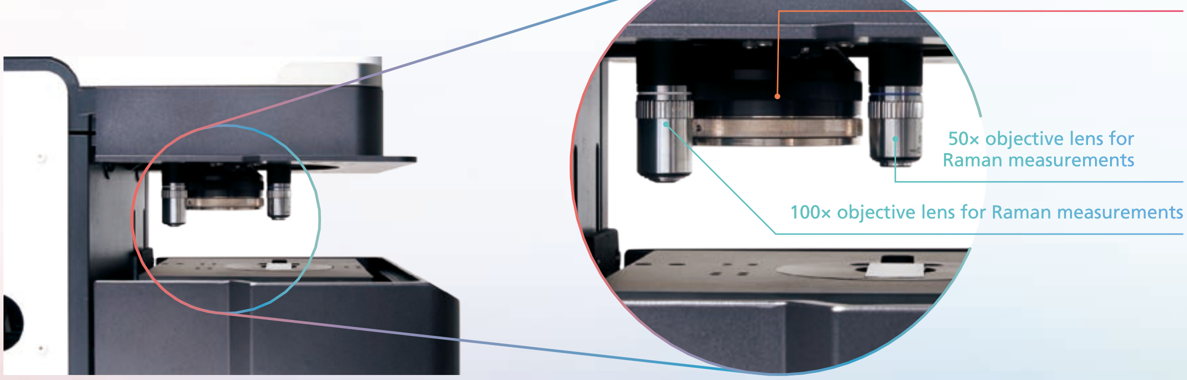


Single system

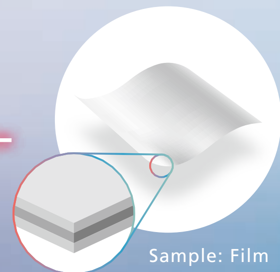
saves space

Small footprint

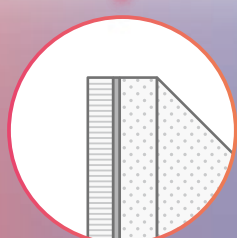
Our Two-In-One Solution!

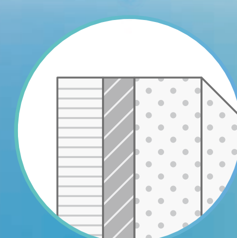


Infrared



Raman

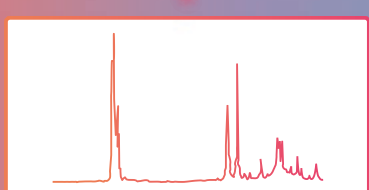


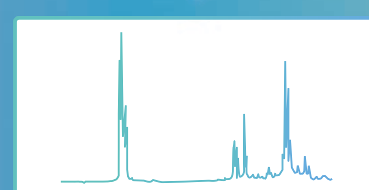


Same position

is measured by IR and Raman

Both infrared and Raman spectra can be measured from the same position in the extremely small area without moving the sample.





Smart software

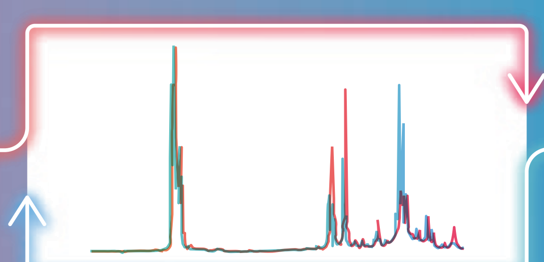
controls IR and Raman

Easily switch between infrared and Raman measurements in the software.

Single system

saves space

Enables both infrared and Raman measurements in only one instrument.



Our Two-In-One Solution!

Applications

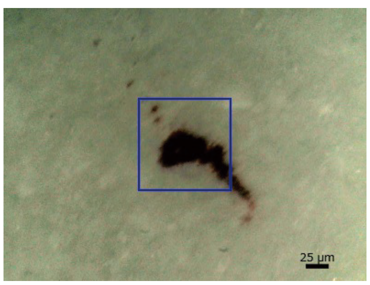
Contaminant

Infrared Raman

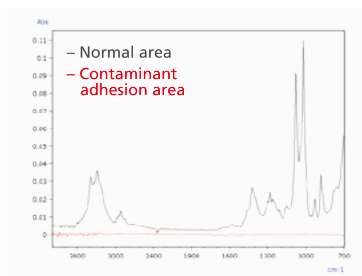
For more details, click here.

Application News No.01-00394

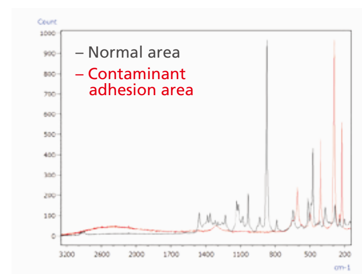
This is an example of analyzing a contaminant (simulated sample) attached to the surface of a pharmaceutical tablet. Obtaining both infrared and Raman measurements from the same spot increases the accuracy of qualitative analysis to help identify the cause of contaminants.



Microscope Image of Contaminant



Infrared Spectra of Normal and Contaminant Adhesion Areas with Normal Area Identified as Mannitol



Raman Spectra of Normal and Contaminant Adhesion Areas with Contaminant Identified as Iron Oxide

Pigment

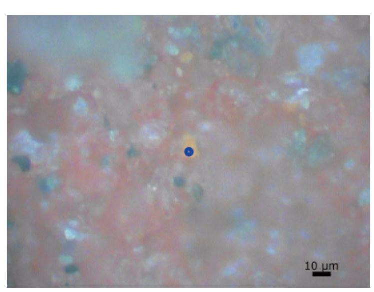
Infrared Raman

For more details, click here.

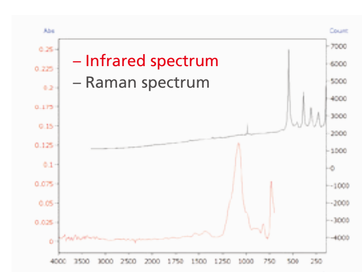
Application News No.01-00395

This is an example of analyzing pigment applied to wood.
Because AIRsight microscopes can measure trace quantities, they are especially useful for measuring precious samples with historical value.

Appearance of Pigment Applied to Wood



Microscope Image of Pigment Applied to a Wood Surface



Infrared and Raman Spectra of Pigment with $BaSO_4$ Identified from the IR Spectrum and Pb_3O_4 from the Raman Spectrum

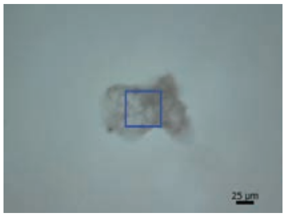
Microplastic

Infrared   Raman

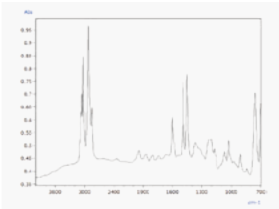
This is an example of analyzing a microplastic particle. The ability to measure infrared and Raman spectra from a wide range of microplastic particle sizes, from a few micrometers to several tens of micrometers in diameter, makes the system ideal for monitoring survey and research applications.

For more details, click here.

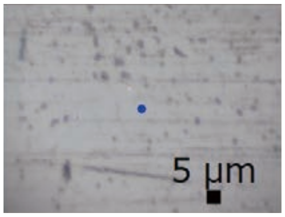
Application News No.01-00396



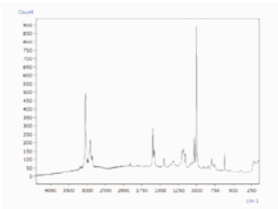
Microscope Image of Microplastic



Infrared Spectrum of 115 µm Long (Major Axis) and 53 µm Wide (Minor Axis) Microplastic Identified as Polystyrene



Microscope Image of Microbead



Raman Spectrum of 1 µm Diameter Microbead Identified as Polystyrene

Carbon Material

Raman

This is an example of analyzing a diamond-like carbon (DLC) film.
Raman measurements can determine bonds and structures in carbon materials with high sensitivity for use in quality control of DLC films.

For more details, click here.

Application News No.01-00397

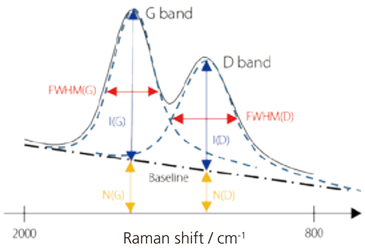


Diagram of Evaluation Parameters for Raman Spectrum of a DLC Film

	I(D)/I(G) Disturbances in Crystal Structure	FWHM(G) Crystallinity, Young's Modulus, and Density	log(N(G)/I(G)) Hydrogen Concentration
CH_4_center	0.32	182.17	-0.29
CH_4_periphery	0.32	181.40	-0.28
C_2H_2_center	0.34	190.85	-0.44
C_2H_2_periphery	0.34	190.25	-0.44

Results from Evaluating DLC Film (Formed with Either CH_4 or C_2H_2 Gas) on Two Types of Silicon Wafers (Measured in Two Locations—Near the Sample Center and Periphery)

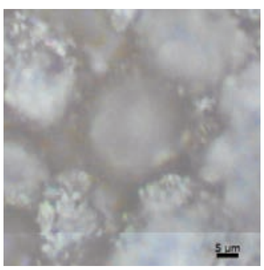
Applications

Li-Ion Battery

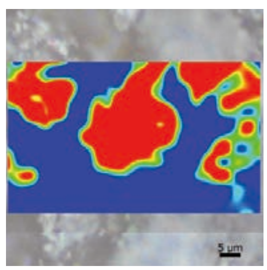
Raman

This is an example of analyzing the negative electrode material from a lithium-ion battery.
Raman area mapping can be used to visualize the detailed distribution of components and structural characteristics in substances (crystallinity, defects, etc.). Therefore, it is useful for evaluating products and materials in R&D applications.

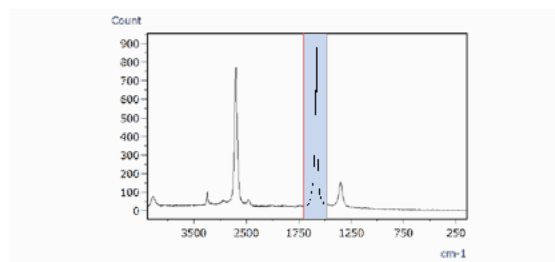
Note: In the chemical image shown, the red areas indicate high concentrations of the component and blue areas indicate low concentrations.



Microscope Image of Negative Electrode Material



Raman Area Mapping Results
Chemical Image of Graphite (G-Band)

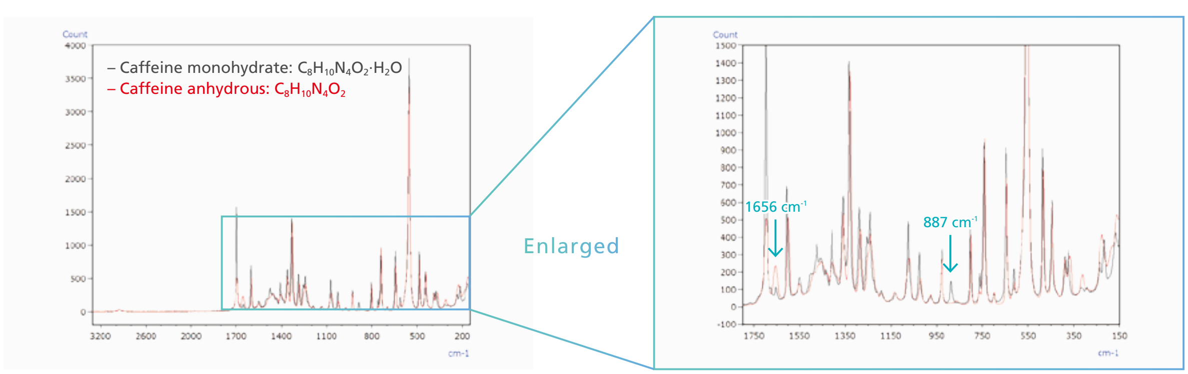


Chemical Image Created from Peak Area Values between 1482 and 1703 cm^{-1}

Polymorphic Crystal

Raman

This is an example of analyzing monohydrate and anhydrous forms of caffeine.
Raman spectra can differentiate between compounds that have identical chemical structures but with different crystal polymorphisms. Evaluating the crystal form of substances with different solubility or efficacy characteristics is useful for controlling crystal formation during pharmaceutical manufacturing processes.



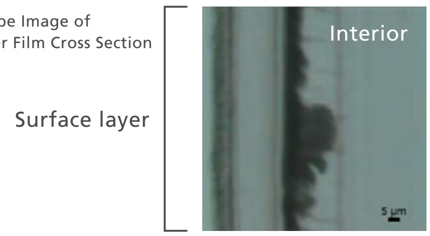
Raman Spectra of Caffeine Monohydrate and Caffeine Anhydrous

Enlargement of Raman Spectra
(Peak differences indicated with blue arrows)

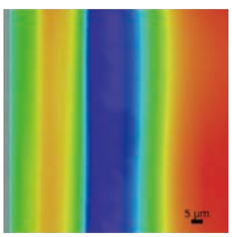
Multilayer Film

Infrared　Raman

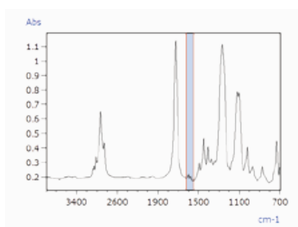
Microscope Image of
Multilayer Film Cross Section



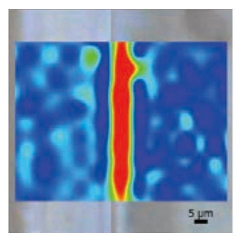
This is an example of analyzing a multilayer film.
The distribution of each component can be visualized by using infrared and Raman area mapping to analyze a cut cross section from the film.



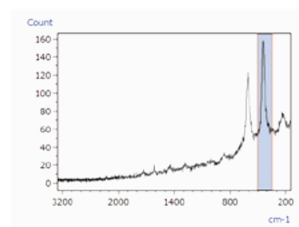
Infrared Area Mapping Results
Chemical Image of Phthalate Esters



Chemical Image Created from Peak Areas between 1551 and 1624 cm^{-1}



Raman Area Mapping Results
Chemical Image of Titanium Oxide (Rutile)

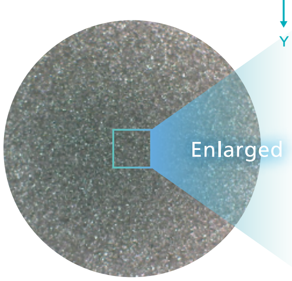


Chemical Image Created from Peak Area Values between 345 and 508 cm^{-1}

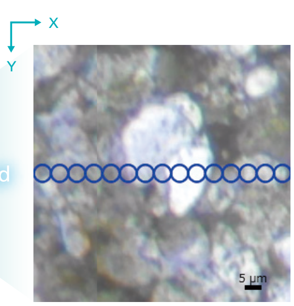
Automotive Paint Coating

Raman

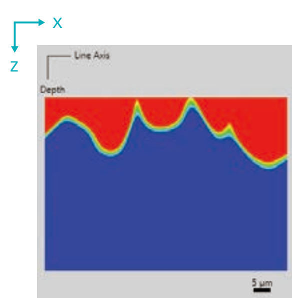
This is an example of analyzing an automotive paint coating. Samples with characteristics that make it difficult to cut a cross section can be evaluated by analyzing the component distribution in the depth direction by Raman spectroscopy and evaluating the degradation status or other criteria from the surface.
A separate mapping program (P/N 206-35093-41) is required.



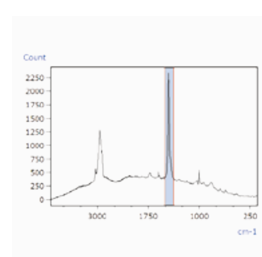
Shiny Exterior



Microscope Image of Automotive Paint Coating
(Blue circles: Line axis in X-direction)



Raman Depth (Line) Mapping Results
Chemical Image of Acrylic Resin



Chemical Image Created from Peak Area Values between 1383 and 1510 cm^{-1}

AIRsight

Characteristic Features

Same position

is measured by IR and Raman

Both FTIR and Raman Spectra Can Be Measured without Moving Samples

Because samples do not need to be moved, both infrared and Raman spectra can be measured from the same position in an extremely small area. That means information about both organic and inorganic substances can be obtained from the same position, which can significantly improve the accuracy of qualitative analysis.
In addition, Shimadzu's proprietary wide-view camera and microscope camera (for infrared measurements) or objective lens (for Raman measurements) help improve sample observation efficiency. The wide-view camera not only enables observation of large areas up to 10 × 13 mm, but it also supports variable digital zooming. Furthermore, it shares positional information with the microscope camera and objective lenses.
The microscope camera can be used to observe areas as small as 30 × 40 μm, the 50× objective lens to observe areas as small as 15 × 20 μm, and the 100× objective lens to observe extremely small areas as small as 7.5 × 10 μm.

Smart software

controls IR and Raman

One Software to Measure and Analyze Both FTIR and Raman Spectra

You can easily switch between infrared and Raman measurements with a click. In addition, infrared and Raman spectra can be superimposed and displayed, and various analyses can be performed.

Single system

saves space

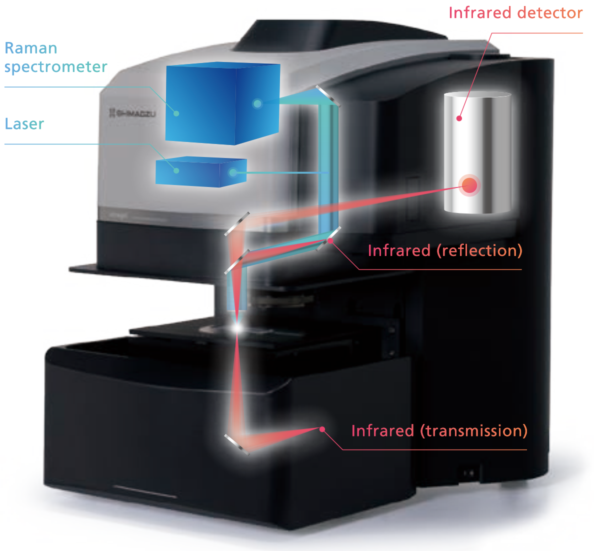
Obtain Organic and Inorganic Information with One Instrument

Infrared microscopes can analyze organic substances, but it is difficult to obtain information for many inorganic substances.
On the other hand, Raman microscopes can obtain information about inorganic substances such as titanium oxide and carbon, in addition to organic substances.
In contrast, a single AIRsight unit can analyze mixtures of both organic and inorganic substances.

AIRsight Features for Raman Measurements

Illustration of Infrared and Raman Light Paths

Infrared light path   Raman light path



☑ Confocal optical system used

Enables Raman measurements with excellent spatial resolution

☑ Equipped standard with 532 nm and 785 nm lasers

Characteristics of the lasers

532 nm : Light scatters more easily, making it easier to obtain peak intensities.

785 nm : Less affected by fluorescence, making it more suitable for fluorescent samples.

☑ Systems can be equipped with either a 50× or 100× objective lens (or both)

Selectable depending on the target measurement area

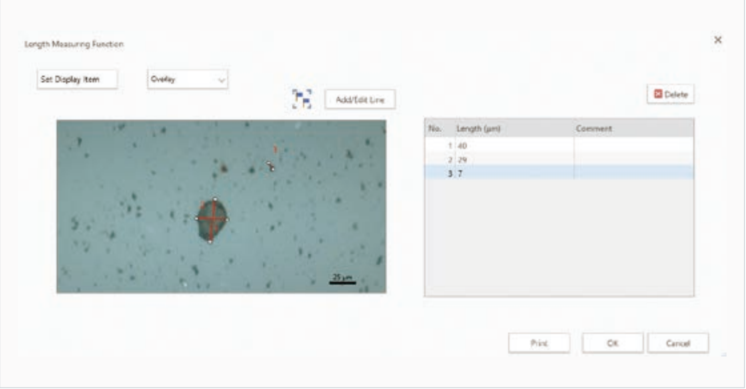
☑ Includes XYZ correction for lens switching between infrared and Raman measurements

Enables both infrared and Raman measurements from the same location.

Length Measurement Function

Infrared   Raman

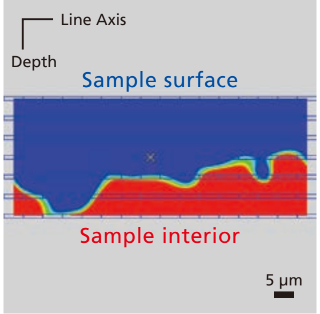
AMsolution software now includes functionality for measuring lengths, including the lengths of objects in infrared Raman microscope images. Also, length measurement results can be output with a single button click.



Depth Measurements

Raman

Enables Analysis in the Depth Direction (Z-Direction)



Example of Depth Measurements (at Line)

Raman measurements can measure depth either at a single point or along a line*. If a transparent sample, such as plastic or glass, has a thickness (depth) dimension, the laser light components that can penetrate the sample can be used to measure the sample interior. Even if the sample is colored or cloudy, measurements are generally possible as long as the interior can be observed.

* Measuring depth (at a line) requires using a separate mapping program (P/N 206-35093-41).

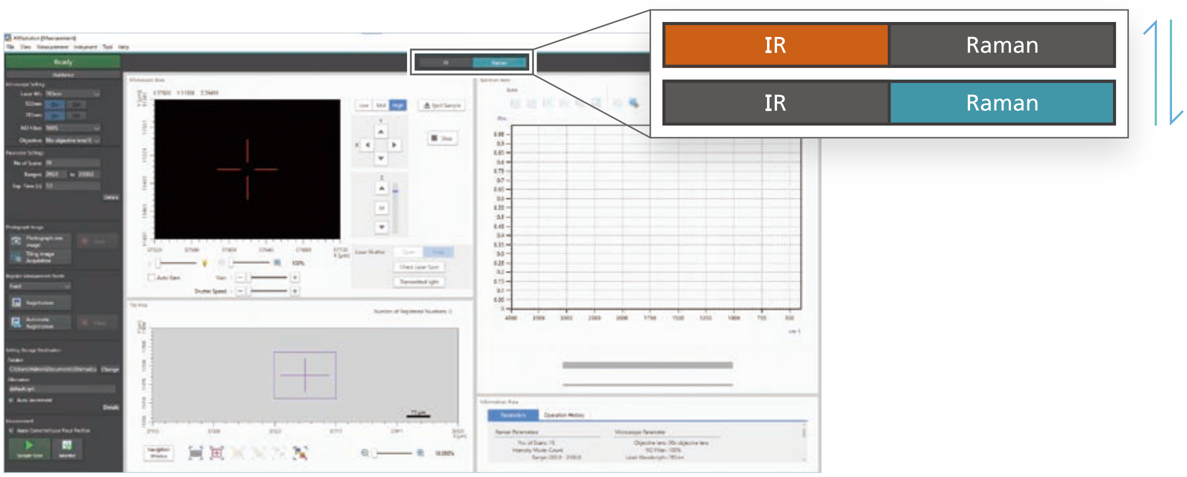
AMsolution Software

AMsolution

AMsolution includes measurement software (AMsolution Measurement) and analysis software (AMsolution Analysis). The measurement software can control both infrared and Raman measurements via the same window. That means all processes, from image acquisition to measuring infrared and Raman spectra at the same location, can be performed smoothly. The analysis software can overlay and search infrared and Raman spectra, create libraries, and so on.
The data measured in infrared mode can be imported to LabSolutions IR and analyzed.*1
The data measured with AIMsolution, a software program for infrared microscopes, can be analyzed with AMsolution, a software program for AIRsight.
*1 Only with LabSolutions IR Ver. 2.31 or later

AMsolution Measurement
Measurement Software

AMsolution Analysis
Analysis Software



Optional Software

Mapping Program

The line or area mapping modes can be selected for either infrared or Raman measurements, whereas the depth (line) mapping mode can be selected for Raman measurements*2. The mapping range, measurement interval, and other parameters can be specified directly on the synthesized visual image.
For infrared measurements, in addition to typical transmission and reflection mapping modes, an ATR microscope mapping measurement can be selected (which requires an optional ATR objective mirrors and pressure sensor).
Using the measurement results, a chemical image can be created based on peak heights/areas, multivariate analysis (PCA/MCR), or similarity to a target spectrum in order to visualize the distribution of components that otherwise cannot be confirmed visually.
*2 Functionality for random mapping of up to 60 points is included standard.

Instrument Validation

A validation program is included standard with the AMsolution measurement program for inspecting and validating the performance of Shimadzu infrared and Raman microscopes. The infrared mode is validated using a polystyrene film in accordance with the Japanese Pharmacopoeia, US Pharmacopeia, European Pharmacopoeia, and Chinese Pharmacopoeia. The Raman mode is validated using polystyrene pellets to inspect wavenumber accuracy in accordance with the Japanese Pharmacopoeia, US Pharmacopeia, and European Pharmacopoeia. That means analysts can inspect the basic performance of the instrument themselves to ensure that highly reliable data is obtained.

Infrared Mode Inspection Parameters

- Shape and size of power spectrum
- Based on polystyrene film spectrum:
  - Resolution
  - Wavenumber accuracy
  - Wavenumber reproducibility
  - Transmittance (or absorbance) reproducibility
  - Peak resolution function

Note:
- The wavenumber reproducibility is an inspection parameter only required for the Japanese Pharmacopoeia.
- The Peak resolution function is an inspection parameter only required for the Chinese Pharmacopoeia.
- The inspection parameter of US Pharmacopeia is only wavenumber accuracy.

Raman Mode Inspection Parameters

- Based on polystyrene pellet spectrum:
  - Wavenumber accuracy

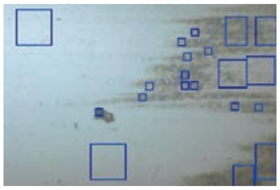
Library Creation Function

Library

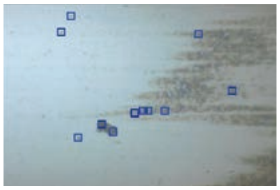
Functionality for creating libraries is included standard with the AMsolution analysis program. Analysts can create their own library by registering infrared and Raman spectra they acquire. Created libraries can also be used for searches. Registering the materials used in products and the substances used in manufacturing processes and using them as a library can improve the accuracy of searches.

Automatic Contaminant Recognition System

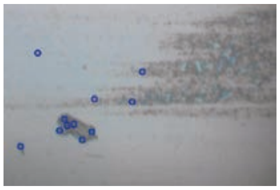
Functionality for automatically recognizing contaminants is included standard. The analyst simply clicks one button for the software to automatically recognize contaminants. Two types are available for the infrared mode: the standard type or the micro type for extremely small areas, which can be selected based on the purpose of analysis. Samples can either be measured with the automatically selected measurement positions left unchanged or the analyst can add or delete measurement positions. A sample image is automatically saved for each measured spectrum. That makes it easy to confirm the sample or measurement positions later.



Infrared (Standard Mode)



Infrared (Micro Mode)



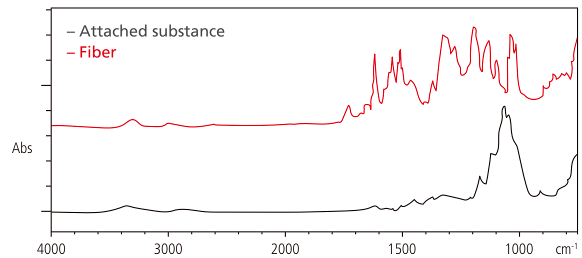
Raman

Accessories

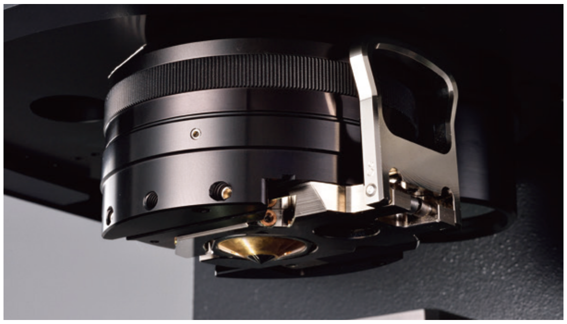
Optional Products for Infrared Measurement

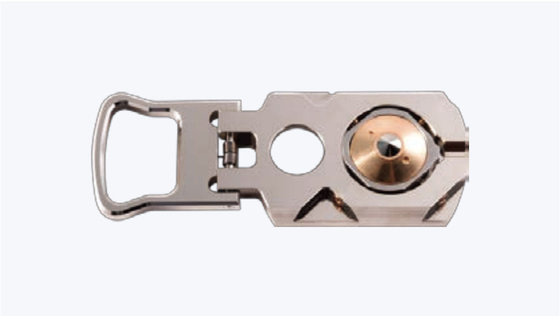
ATR Reflecting Objective Mirror

Featuring a cone-type prism, this single-reflection objective mirror results in 15× magnification and a 45-degree mean incident angle. The slide-on type prism makes it easy to switch back and forth between visible observation and infrared measurement modes. The mirror is especially useful for analyzing samples that do not transmit or reflect infrared light easily, such as paper or plastic samples, or stains and other extremely thin areas.



Spectrum of Substance Attached to a Fiber, Identified as a Phenol-Based Resin



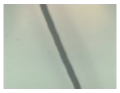


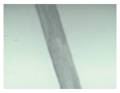
ATR Pressure Sensor

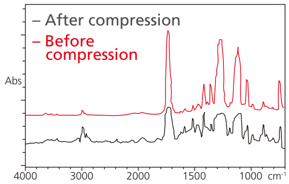
This pressure sensor is for ATR measurements using an ATR objective mirror. It prevents prism damage due to excessive pressure. It can also be used to automatically measure how tightly the sample is pressed against the prism.

Type CII Diamond Cell

This compression cell is used to compress micro samples very thin for direct measurement under the microscope. It can be used for samples such as plastics and fibers. This CII cell features a large thin window plate made of artificial diamond (1.6 mm diameter).







Infrared Spectra of a Single Fiber

Libraries

Infrared — Libraries Containing about 12,000 Spectra

Systems are equipped standard with an extensive selection of libraries, including proprietary Shimadzu libraries and libraries for substances ranging from typical reagents to macromolecules. That means the standard configuration provides plenty of data for qualitative analysis without purchasing additional libraries.

Main Contents

Shimadzu Food Additives Library (substances listed in official analysis methods for food additives)	General reagents	Pharmaceuticals
Pesticides	Polymers	Inorganic substances

Total of about 12,000 spectra

Optional Libraries

Contaminant Library for LabSolutions™ IR P/N 206-33179-91

Shimadzu's new proprietary library is especially useful for analyzing contaminants in tap water and foods. The library includes information from actually collected contaminant samples and information about service parts commercially marketed for tap water applications. It also includes a collection of X-ray fluorescence profiles (PDF files). Consequently, it can significantly improve the accuracy of contaminant searches. Unlike previous libraries, this library of mixture information covers the extensive knowledge and experience necessary for qualitative analysis.

Thermally Degraded Plastics Library*1 P/N 206-33039-91

Unlike previous libraries, this library includes information about plastics that have degraded due to oxidation associated with heat. The library is especially useful for analyzing contaminants, which are commonly degraded.

*1 Spectra were measured and acquired at the Hamamatsu Industrial Research Institute of Shizuoka Prefecture and compiled as a library by Shimadzu Corporation.

UV-Degraded Plastics Library*2 P/N 206-31808-41

Unlike previous libraries, this library includes information about plastics degraded by ultraviolet rays.
Because many contaminants are degraded, this library is especially useful for such cases. It is also useful for analyzing microplastics.

*2 Plastics degraded using an Iwasaki Electric super accelerated weathering tester were measured and compiled as a library by Shimadzu Corporation.

Raman

Wiley Raman spectrum libraries can be added. Wiley offers libraries of spectra from a wide range of compounds, including monomers, polymers, inorganic compounds, and compounds related to biochemistry or forensic chemistry.

Database Example

Product Name	Database Code	Number of Spectra
Sadtler Controlled & Prescription Drugs 1-2	RZ, RZ2	1,850
Sadtler Flavors & Fragrances	FFR	600
Sadtler Inorganics	RI	1,630
Sadtler Polymers & Monomers (Basic) 1	QR	1,680
Sadtler Polymers & Processing Chemicals	RA	495
Sadtler Standards 1-6	RST1, RST2, RST3, RST4, RST5, RST6	6,000
KnowItAll Raman Spectral Library (Annual Subscription)	—	25,000

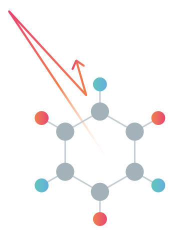
AIRsight

Infrared Spectroscopy and Raman Spectroscopy

Differences between Infrared Spectroscopy and Raman Spectroscopy

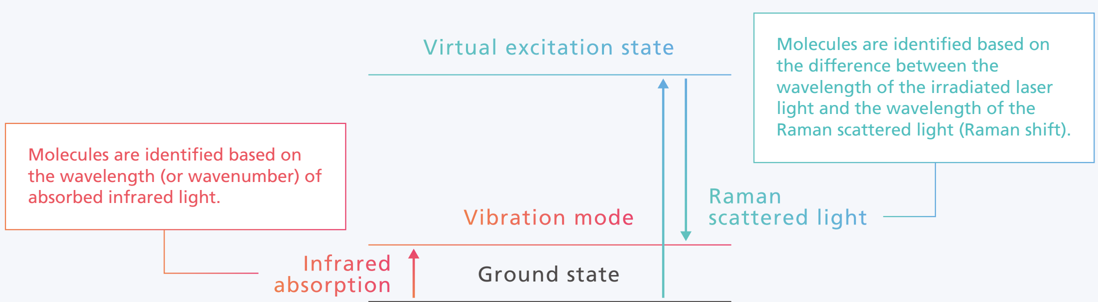
Infrared Spectroscopy

Samples are irradiated with infrared light to measure how much light is transmitted through the sample and how much is reflected.



Raman Spectroscopy

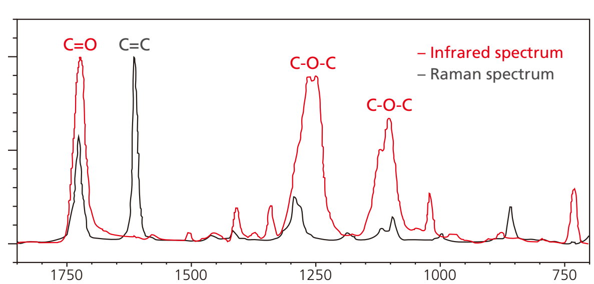
Samples are irradiated with laser light to measure the amount of Raman scattering that occurs from the sample.



Enables Acquisition of Mutually Complementary Molecular Information

Infrared Spectroscopy is Better-Suited	Raman Spectroscopy is Better-Suited
Polar bonds O-H, N-H, C=O, C-O-C	Non-polar bonds C=C, S-S, C-S

Infrared and Raman Spectra of Polyester
(Laser Wavelength: 532 nm)



Infrared Spectroscopy

Applicable components:

Plastics, organic food components, and some inorganic components

Features

- Extensive spectral libraries available
- Widely used, resulting in plentiful application examples
- Rarely damages samples
- ATR (optional), transmission, or reflection methods can be selected depending on the sample

Raman Spectroscopy

Applicable components:

Carbon materials (CNT, DLC, diamond, etc.), pigments, additives and other inorganic substances, and some organic substances

Features

- Especially well-suited for analyzing carbon materials (carbon nanotubes, diamond, etc.)
- Enables analysis in the depth direction
- Transparent materials (glass, etc.) do not absorb visible laser light, so samples can be measured directly in containers
- High spatial resolution (extremely small areas can be targeted)

Examples of Problems Solved

Contaminant components cannot be identified with an infrared microscope alone.

Contaminant was identified based on both infrared and Raman measurement results.

The target area is too small to be measured with an infrared microscope.

The infrared and Raman microscope enabled even smaller areas to be targeted and measured.

Measuring the same sample location with both infrared and Raman is desired.

The infrared and Raman microscope enabled the same location to be quickly measured without moving the sample.

Detailed analysis of both organic and inorganic components is desired.

Combining infrared and Raman spectroscopy enabled material analysis.

System Configuration Examples

IRXross™ + AIRsight
W1086 × D668 × H604 mm

IRAffinity™-1S + AIRsight
W1055 × D668 × H604 mm

IRTracer™-100 + AIRsight
W1136 × D705 × H604 mm

AIRsight, LabSolutions, IRXross, IRAffinity and IRTracer are trademarks of Shimadzu Corporation or its affiliated companies in Japan and/or other countries.

SHIMADZU

Shimadzu Corporation
www.shimadzu.com/an/