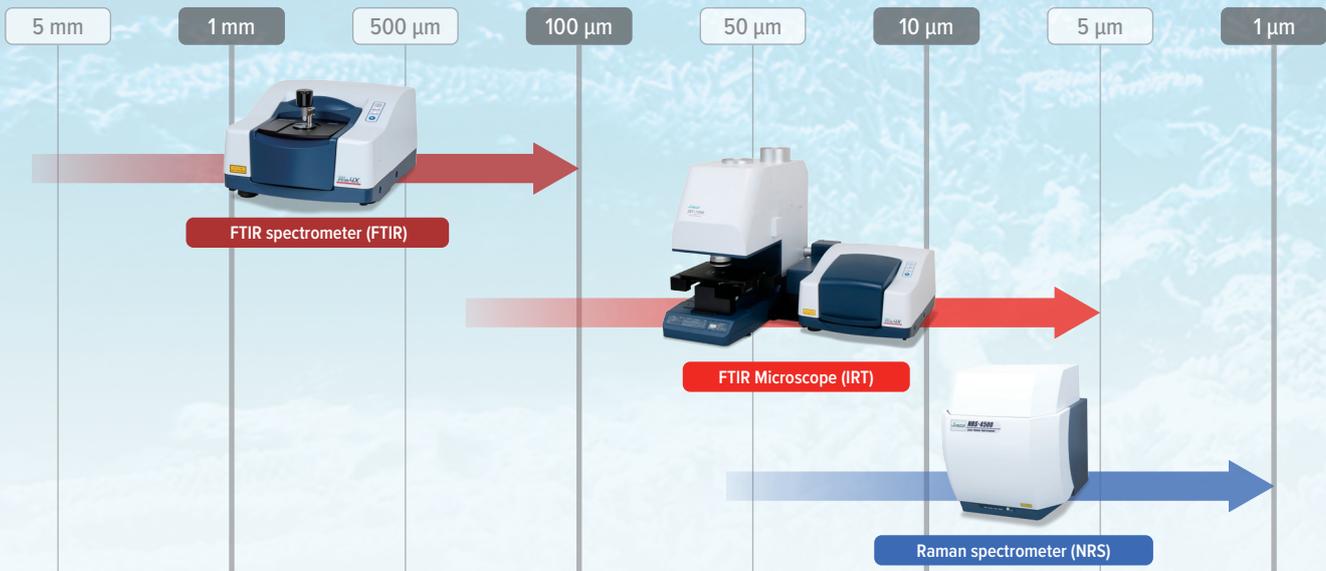# Microplastics Analysis

— Analytical methods with FTIR and Raman —

Microplastics Analysis

Microplastics, which are generally less than 5 mm in size, have raised concerns about accidental ingestion by marine organisms, contamination of commercial drinking water, and health hazards to those who consume them. As a result, there is a growing movement to investigate the effects of the microplastics. JASCO FTIR and Raman spectrometers can easily perform various types of microplastics analysis.

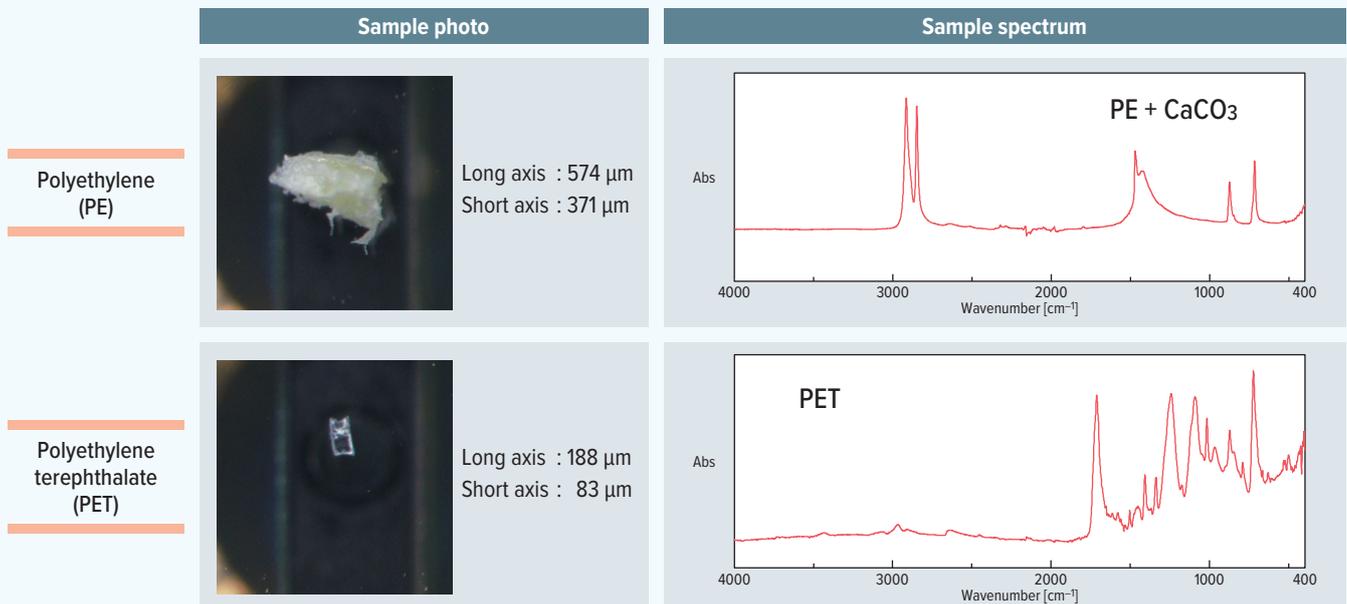## Use of different instruments depending on size

JASCO offers instruments capable of analyzing microplastics in a wide range of sizes from a few millimeters to sub-micron orders.

| 5 mm | 1 mm | 500 µm | 100 µm | 50 µm | 10 µm | 5 µm | 1 µm |

FTIR spectrometer (FTIR)

FTIR Microscope (IRT)

Raman spectrometer (NRS)

FTIR spectrometer

FTIR

FTIR spectrometer can be used for qualitative analysis of microplastics over several hundred microns. The measurement results of polyethylene (PE) and polyethylene terephthalate (PET) are shown here.

	Sample photo		Sample spectrum
Polyethylene (PE)		Long axis : 574 µm Short axis : 371 µm	$PE + CaCO_3$ Abs 4000 3000 2000 1000 400 Wavenumber [cm^{-1}]
Polyethylene terephthalate (PET)		Long axis : 188 µm Short axis : 83 µm	PET Abs 4000 3000 2000 1000 400 Wavenumber [cm^{-1}]

FTIR — FTIR spectrometer   **IRT** — FTIR Microscope   **NRS** — Raman Microscope
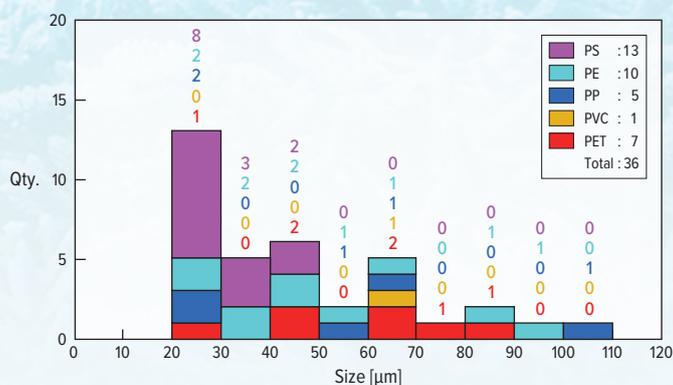
FTIR Microscope

FTIR microscope can be used to analyze microplastics as small as 5 μm to 10 μm in length. Qualitative analysis is of course possible, imaging measurements can be used to visualize the distribution of components, and particle size analysis is also possible. These are example imaging analysis data about several kinds of filtrated samples using of polytetrafluoroethylene (PTFE) filter as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET) and polyvinyl chloride (PVC) in water.
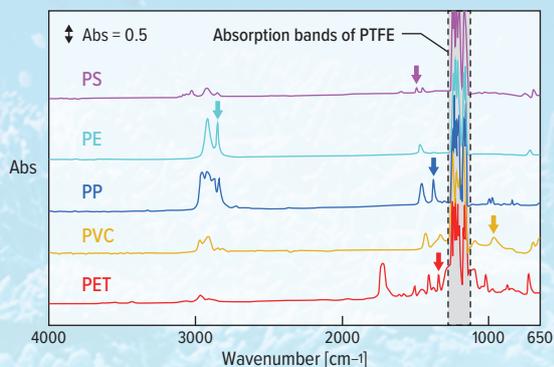
Averaged spectra of each component
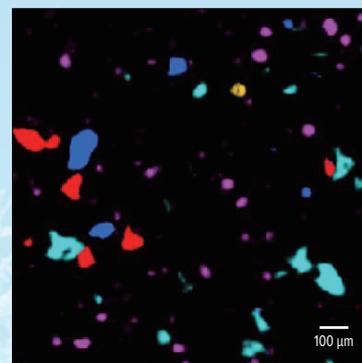

Chemical Image (peak height)

Stacked histograms by component

Those samples and data obtained by FTIR microscope were provided by TOSOH Analysis and Research Center Co., Ltd. **Application Data** 100-MT-0262

Raman Microscope

Raman microscope can be used for microplastics sample analysis as sub-micron order. In addition to qualitative analysis, mapping measurement enables visualization of component distribution as well as FTIR microscope, and particle size analysis is also available. Here are the results of our measurements of Airborne Microplastics (AMPs).
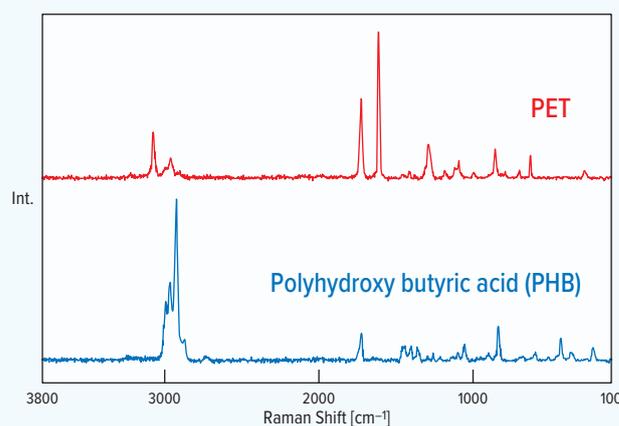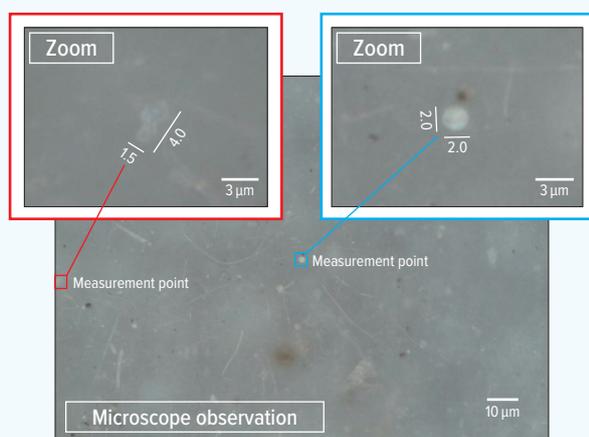
Measurement Results of Airborne Microplastics (AMPs)

Those samples were provided by Prof. Okochi of Waseda University. **Application Data** 100-AN-0031

Macro analysis of Microplastics

Microplastics from several mm to several hundred μm can be easily measured using FTIR ATR method. ATR is a contact sampling method in FTIR reflection measurement.

Fourier Transform Infrared Spectrometer : FTIR

The FT/IR-4X is a powerful Mid-IR FTIR spectrometer, with many features that you find in a research grade instrument, which has high resolution, High S/N and high sensitivity analysis performance.

FT/IR-4X with ATR PRO 4X VIEW

ATR PRO 4X VIEW : ATR PRO ONE X VIEW

FTIR

ATR PRO 4X VIEW / ATR PRO ONE X VIEW are ATR accessories for FTIR that allow you to measure sample while observing sample surface through crystal. This observation function helps to confirm proper sample contact condition even for several hundred μm order samples and enables to measure it. Images and spectra of samples closely adhering to the ATR crystal can be saved in a single file.

ATR PRO 4X VIEW and ATR PRO ONE X VIEW

Close contact with ATR crystal sample (PP) image

100 μm

Application Data   030-AT-0275

USB Microscope kit

FTIR

This USB Microscope kit is a complete package for microscope observation for FT/IR-4X. This kit can be added to ATR accessory and observation view on the top of crystal can be obtained before measurement. Furthermore, such observation view data and spectra data can be saved in the same file. Even if sample is quite small, this kit supports to handle sample setting with each because sample can be set on ATR crystal while checking the observation view from USB microscope.

* Any accessories from ATR PRO 4X, ATR PRO 4X VIEW, ATR PRO ONE X and ATR PRO ONE X VIEW are necessary.

FT/IR-4X with USB Microscope kit

SWITCH with EASE between

USB microscope — **IMAGE** ACQUISITION

&

ATR — **MEASUREMENT**
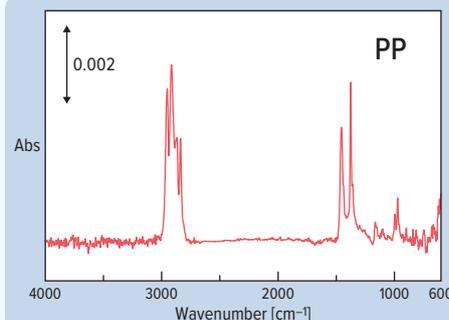
USB microscope **IMAGE** ACQUISITION

ATR **MEASUREMENT**

- USB microscope image
- Measurement Spectrum
- ATR close-up image *

SAVE in 1 FILE

* Sample observation image that contacted with ATR crystal can be obtained with use of ATR PRO 4X VIEW or ATR PRO ONE X VIEW.

1000 μm

0.002

PP

Abs

4000   3000   2000   1000   600
Wavenumber [cm⁻¹]

Sample: Microplastics collected from lake water

Those samples were provided by e-kagaku Biwako Environment Project 2021 (SEP2021).   Application Data   030-AT-0275

Advanced Spectra Search

It has two functions "Classification" and "Spectra Search", which support analyzing spectra easily and precisely. The "Classification" function recognizes 35 types of compounds based on a machine learning from various materials and high molecular spectra. It also shows key bands of compound so that an operator confirm a validity of results. The "Spectra Search" function performs searching from approximately 600 spectra library.
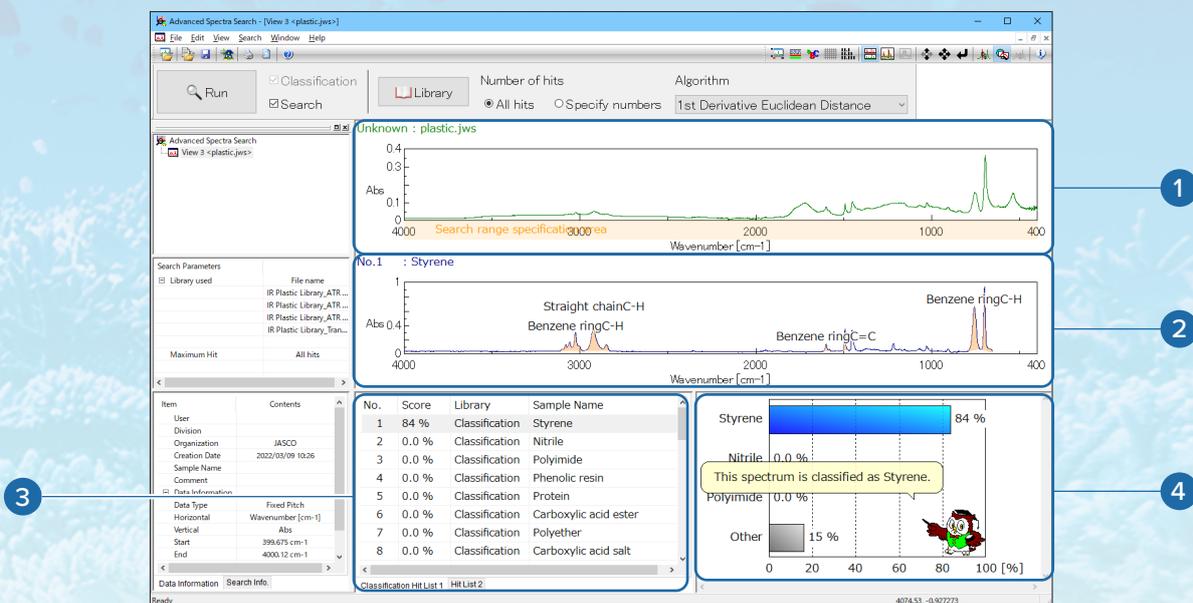
1 Measured spectrum	**2** Reference spectrum	**3** Result list	**4** Advice function
Easy to compare with **2**	A reference spectrum of the selected category	Score and sample name are displayed	Supports for understanding the result

Some microplastics are degraded in a certain environment and it might appear on the spectrum changes. It may show incorrect search results on a spectrum library search. The "Classification" function still works in such conditions because it focuses on key bands on the spectrum and is not affected by the degradation. The Advanced Spectra Search is a useful software for analyzing microplastics in various types and conditions.

Application Data   280-AN-0274

IR plastics library

FTIR   IRT

This is a dedicated library for microplastics including 39 types, 153 IR spectra. It improves the search result of a spectra library. It also includes cellulose and rubbers in the library, which are typically found in environmental conditions to identify whether it is plastic or not.

Library list

Low-density polyethylene, LDPE	High-density polyethylene, HDPE	Polypropylene, PP	Polyvinyl chloride, PVC
Polystyrene, PS	Foamed polystyrene	Polyamide, PA	Polycarbonate, PC
Poly(ethylene terephthalate), PET	Polyester	Polyurethane, PU	Poly(methyl methacrylate), PMMA
Polyvinyl alcohol, PVA	Polyimide	Poly(butylene succinate)-poly(lactic acid) copolymer, PBS-PLA copolymer	Artificial turf
Polytetrafluoroethylene, PTFE	Acrylonitrile butadiene styrene, ABS	Epoxy resin, EP	Phenol formaldehyde, PF
Polyethersulfone, PES	Polyetherimide, PEI	Polyphenylene sulfide, PPS	Polybutylene terephthalate, PBT
Acrylic fiber	Cellulose acetate	Aramid	Cupro, Cuprammonium rayon
Polynosic, Modal	Viscose rayon	Silk	Wool
Cotton	Cellulose	Styrene-butadiene rubber, SBR	Ethylene-propylene rubber
Isobutylene-isoprene rubber, IIR	cis-1,4-Polyisoprene rubber	trans-1,4-Polyisoprene rubber	

Application Data   280-AN-0274

Microplastics obtained with filtration

Microplastics smaller than hundreds of µm can be measured with the micro FTIR and micro Raman while they are placed on the membrane filter. JASCO micro FTIR and Raman measure one/multi points, imaging with the exactly same point, area between both instruments.

Micro FTIR spectrometer

Micro FTIR observes and measures small samples with microscope function. It also performs imaging measurements, creates chemical images and particle analysis. Micro FTIR obtains information of materials such as polyethylene and polypropylene.

IRT-7200 with FT/IR-4X

Micro Raman spectrometer

Micro Raman has higher spatial resolution compared to the micro FTIR, so it can measure microplastics in the µm range which are difficult to measure with the micro FTIR. The micro Raman also detects additives, pigments in addition to base materials.

NRS-4500

VFS-25-1 Filtration set

FTIR **IRT** **NRS**

Combined with the filtration set and 25 mm dia. membrane filter, microplastics are filtered on it. Various types of materials and pore size filters are available (sold separately).

* Aspirator or dry scroll pump is required separately.

Membrane filter
(sold separately)

Lineup of membrane filter

No.	Material	Pore size
1	P T F E	10 µm
2	P T F E	5 µm
3	P T F E	1 µm
4	Alumina	0.2 µm

Filtration set

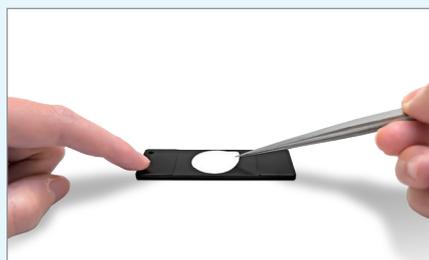Application Data   110-MT-0271

SH02-FH Filter holder

IRT **NRS**

This is a dedicated holder for the 25 mm dia. membrane filter. It can be set on the sharing holder and used on the micro FTIR and Raman.

* SH-02 sharing holder plate or iQ frame is required.

Set the membrane filter.

Fix with the plate cover.

Set on the sharing holder.

Application Data   030-MT-0276   030-AN-0040

Advanced Search NAV

Conditate measurement positions are automatically recognized in real time. These dedicated points can be registered as measurement positions at once. It is possible to target measurement positions in detail by setting parameters related to such characteristics. The acquired spectrum is matched with JASCO's original database, and the names of the hit substances are displayed on the observation image.

* Only the NRS series can narrow down the number of measurements point.

NARROW DOWN THE MEASUREMENT POINTS

TARGETING by SIZE

AUTOMATIC RECOGNITION

SIZE SMALL ●···Detection parts   SIZE LARGE ●···Detection parts

TARGETING by COLOR

AUTOMATIC RECOGNITION

COLOR RED ●···Detection parts   COLOR BLUE ●···Detection parts

S6 S5 S4 S3 S2 S1

PS PS PET PMMA TiO₂ TiO₂
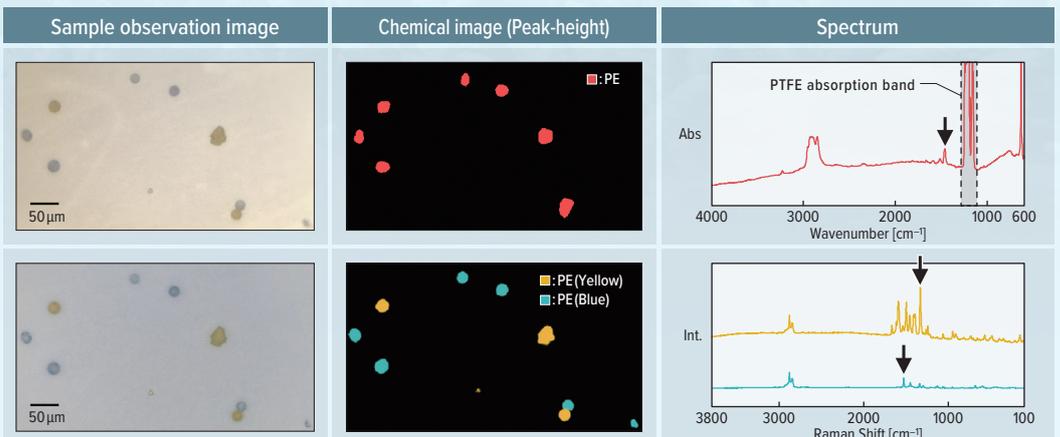
Real-time component identification

Application Data   260-AN-0018

iQ Frame

The iQ Frame easily measures the same minute region and the same point IR spectroscopy and Raman spectroscopy. Both methods are known as a complementary method to analyze information of molecules. For this reason, the iQ Frame has a multilateral analysis result can be obtained by combining both measurements.

Sample observation image	Chemical image (Peak-height)	Spectrum

IR spectroscopy

50 µm | ■:PE | PTFE absorption band / Abs / 4000 3000 2000 1000 600 / Wavenumber [cm⁻¹]

Raman spectroscopy

50 µm | ■:PE (Yellow) ■:PE (Blue) | Int. / 3800 3000 2000 1000 100 / Raman Shift [cm⁻¹]

Example of composite analysis of IR and Raman by the iQ Frame.

Application Data   100-MT-0270   100-AN-0034

JASCO Particle Analysis

The JASCO Particle Analysis program enables the acquisition of shape and color information about sample from color maps and observation images. Histograms, frequency distributions, and correlation distributions can be created based on the obtained information. Additionally, it is also possible to create the stacked histograms for each component.
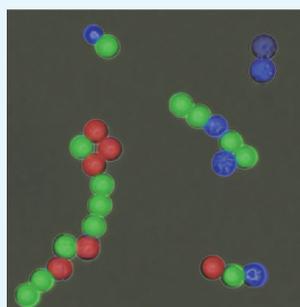
Measurement result

No.	Image	Centroid-X	Centroid-Y	Size
1		9.8	8.2	10.482
2		16.2	15.2	9.480
3		102.6	17.3	9.364
4		26.7	30.7	9.667
5		39.4	40.4	9.648
6		42.1	50.0	9.641

Character of each particles
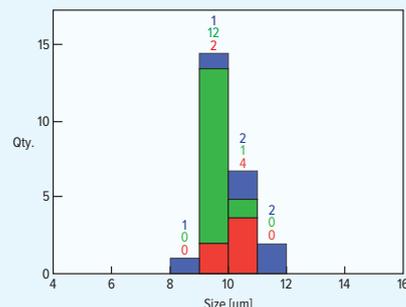
Stacked histogram

Application Data   100-MT-0270   100-AN-0034

LIST OF ACCESSORIES FOR EACH MODEL

FT/IR-X series (FT/IR-4X, FT/IR-6X, FT/IR-8X)

ATR PRO 4X	ATR PRO 4X Single reflection ATR accessory with iQX Accessory, for FT/IR-4X only
ATR PRO 4X VIEW	ATR PRO 4X VIEW Single reflection ATR accessory with camera with iQX Accessory, for FT/IR-4X only
ATR PRO ONE X	ATR PRO ONE X Single reflection ATR accessory with iQX Accessory, for 6X/8X
ATR PRO ONE X VIEW	ATR PRO ONE X VIEW Single reflection ATR accessory with camera with iQX Accessory, for 6X/8X
	USB Microscope set (Custom-made) 　Components 　　USB Microscope for observation 　　USB Microscope-ATR Mounting unit for ATR PRO 4X, ATR PRO 4X VIEW, ATR PRO ONE 　　Mask for microscope observation 　　Micro Imaging Analysis Program (including Scale Correction function) 　* ATR PRO 4X, ATR PRO 4X VIEW, ATR PRO ONE or ATR PRO ONE VIEW is required.
ADSS-4X	ADSS-4X Advanced Spectra Search program for Spectra Manager 2.5
LIB-PLA-ADSS	LIB-PLA-ADSS IR plastics library　* ADSS-4X is required

IRT series and NRS series Microscopes

JPA	JASCO Particle Analysis
SH02-FH	SH02-FH Filter holder　* SH02 Sharing holder plate (SH02, SH02-IR or SH02-RM) is required.
SH02	SH02 Sharing holder plate (plate only)
VFS-25-1	VFS-25-1 Filtration set for micro plastic preparation, 25 mm dia. 　Components 　　Suction filter bottle, Funnel, Base, Clamp, Silicone stopper 　* This set does not include an aspirator or dry vacuum pump.
MF25-PTFE10	MF25-PTFE10, PTFE Membrane Filters for VFS-25
MF25-PTFE5	MF25-PTFE5, PTFE Membrane Filters for VFS-25
MF25-PTFE1	MF25-PTFE1, PTFE Membrane Filters for VFS-25
MF25-AL02	MF25-AL02, Aluminum Oxide Membrane Filters for VFS-25

IRT series (IRT-7200, IRT-7100, IRT-5200)

ASN-IR-X	ASN-IR-X IR Advanced Search NAV for Spectra Manager 2.5
ADSS-4X	ADSS-4X Advanced Spectra Search program for Spectra Manager 2.5
LIB-PLA-ADSS	LIB-PLA-ADSS IR plastics library　* ADSS-4X is required.
SH02-IR	Sharing holder & iQ Frame for IR

NRS series (NRS-4500, NRS-5500, NRS-7500)

ASN-457	Advanced Search NAV
SH02-RM	Sharing holder & iQ Frame for Raman

JASCO

ISO-9001
ISO-14001
CERTIFIED

Products described herein are designed and manufactured by ISO-9001 and ISO-14001 certified JASCO Corporation

DE6608-2307-01