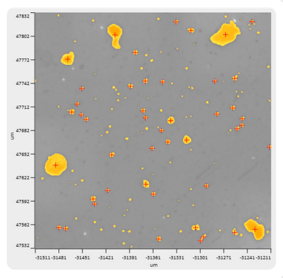
PHOTOTHERMAL
SPECTROSCOPY CORP

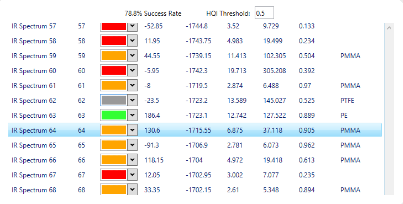
featurefindIR

Automated, rapid, sub-micron IR and chemical ID of particles and microplastics

- Automated measurement and Chemical ID of microplastics from sub-micron to millimeters
- Measures large numbers of microplastics and particles
- Automatic search and detection of particles
- Automatic measurement and chemID



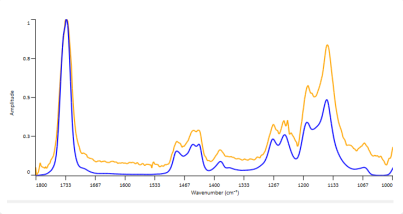
Automated, search, detection and selection of microplastics



78.8% Success Rate HQI Threshold: 0.5

IR Spectrum 57	57	-52.85	-1744.8	3.52	9.729	0.133	
IR Spectrum 58	58	11.95	-1743.75	4.983	19.499	0.234	
IR Spectrum 59	59	44.55	-1739.15	11.413	102.305	0.504	PMMA
IR Spectrum 60	60	-5.95	-1742.3	19.713	305.208	0.392	
IR Spectrum 61	61	-8	-1719.5	2.874	6.488	0.97	PMMA
IR Spectrum 62	62	-23.5	-1723.2	13.589	145.027	0.525	PTFE
IR Spectrum 63	63	186.4	-1723.1	12.742	127.522	0.889	PE
IR Spectrum 64	64	130.6	-1715.55	6.875	37.118	0.905	PMMA
IR Spectrum 65	65	-91.3	-1706.9	2.781	6.073	0.962	PMMA
IR Spectrum 66	66	118.15	-1704	4.972	19.418	0.613	PMMA
IR Spectrum 67	67	12.05	-1702.95	3.002	7.077	0.235	
IR Spectrum 68	68	33.35	-1702.15	2.61	5.348	0.894	PMMA

Rapid, automated spectroscopic measurement and chemID



Verification of measured spectra against reference spectra

featurefindIR™

Detect, select, measure, identify

Many IR and Raman based applications require the measurement of small particles, often numbering in the hundreds if not thousands of particles. Most notably, such applications include microplastic identification and the characterization of other particles, such as environmental aerosols, pharmaceutical nasal sprays, and organic contaminants.

Optical Photothermal Infrared spectroscopy (O-PTIR) on the mIRage and mIRage-LS accurately measure and chemically identify particles and micro-plastics from sub-micron to mm's in size, overcoming the limitations of conventional FTIR and Raman techniques.

Detect, select, measure, identify

featurefindIR provides rapid, automated detection, spectroscopic measurement, and chemical identification of microplastics and other particles, significantly improving the productivity of measurement and providing a basis for measurements of large number of samples in applications including but not limited to microplastics, defect contamination and cells analysis, as well as many other sample types.

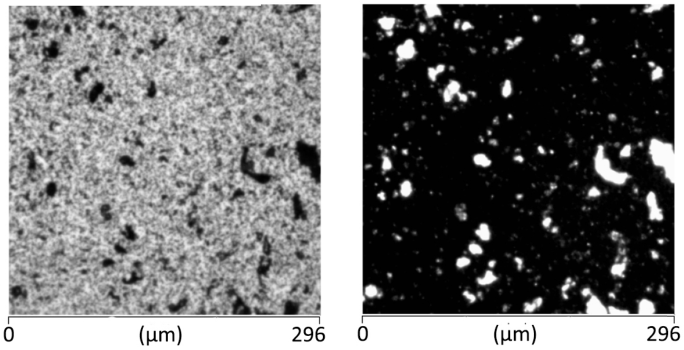


Figure 1: Left, sample and field of view, with regular brightfield imaging, showing reduced particle contrast due to the porous gold coated filter background. Right, microplastics on gold coated polycarbonate filter demonstrating enhanced optical contrast enabling a more sensitive and accurate particle detection.

Particle data collection efficiency

Microplastics, particles and organic contaminants can sometimes be difficult to find in a larger population of general contaminants. For maximum flexibility featurefindIR enables use of a variety of image inputs for more accurate and sensitive detection and location including:

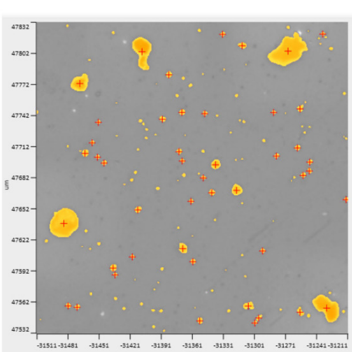
Single IR wavelength images.

The use of a cross polarizer (patent pending) for improved contrast as seen in Figure 1 for more sensitive and accurate particle detection and location.

Fluorescence imaging for the use of Nile Red (or similar) stains as input images to help locate only the polymeric particles, improving throughput by neglecting non-polymeric particles typically not of interest.

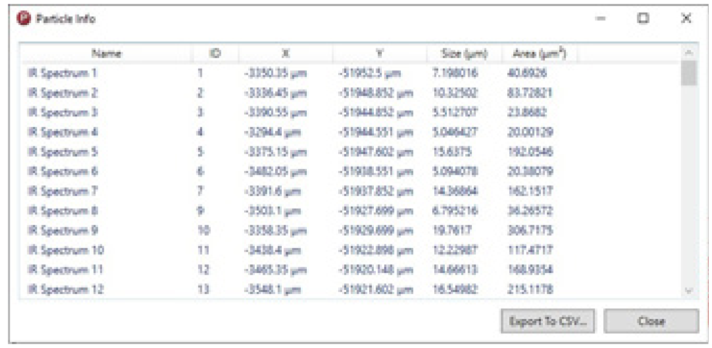
Autofluorescence images can provide for enhanced optical contrast using the intrinsic fluorescence of the samples, without the need for external dyes.

Once the image is captured, tools are provided for accurate selection of the required particles, shown in Figue 2. This is based on size, image intensity of particles of interest as well as adding or deleting particles from the automated selection.



ID	X (µm)	Y (µm)	Size (µm)	Area (µm²)
1	-31300.9	47541.93	3.15	7.81
2	-31354.08	47543.96	4.96	19.342
3	-31297.22	47546.76	4.22	13.971
4	-31257.29	47552.32	6.54	33.6
5	-31472.34	47557.08	3.92	12.038
6	-31481	47558.44	3.95	12.23
7	-31307.18	47558.25	7.97	49.882
8	-31231.59	47556.32	23.06	417.596
9	-31435.74	47588.31	3.15	7.81
10	-31437.64	47594.93	5.86	26.937
11	-31360.73	47601.03	4	12.596
12	-31419.1	47605.68	3.15	7.81
13	-31293.42	47611.39	3.58	10.089
14	-31370.39	47613.7	8	50.285
15	-31485.14	47637.91	27.07	575.464
16	-31413.82	47650.99	5.57	24.382

Figure 2: featurefindIR particle map highlights particles based on user selection criteria


Particle Info

Name	ID	X	Y	Size (µm)	Area (µm²)
IR Spectrum 1	1	-3350.35 µm	-51952.5 µm	7.198016	40.6926
IR Spectrum 2	2	-3336.45 µm	-51948.852 µm	10.32502	83.72821
IR Spectrum 3	3	-3390.55 µm	-51944.852 µm	5.512707	23.8682
IR Spectrum 4	4	-3294.4 µm	-51944.551 µm	5.046427	20.00129
IR Spectrum 5	5	-3375.15 µm	-51947.602 µm	15.6375	192.0546
IR Spectrum 6	6	-3482.05 µm	-51938.551 µm	5.094078	20.38079
IR Spectrum 7	7	-3391.6 µm	-51937.852 µm	14.36864	162.1517
IR Spectrum 8	9	-3503.1 µm	-51927.699 µm	6.795216	36.26572
IR Spectrum 9	10	-3358.35 µm	-51929.699 µm	19.7617	306.7175
IR Spectrum 10	11	-3438.4 µm	-51922.898 µm	12.22987	117.4717
IR Spectrum 11	12	-3465.35 µm	-51920.148 µm	14.66613	168.9354
IR Spectrum 12	13	-3548.1 µm	-51921.602 µm	16.54982	215.1178

Export To CSV... Close

Figure 3: featurefindIR particle Info summary provides dimensional information and location of particles

Automatically measure and identify

Once particle locations and sizes are determined, the mIRage system automatically moves to all the measurement locations and performs rapid, automated IR spectroscopic measurements.

At completion of the measurement a Particle Info summary table lists the positions and certain dimensions of each particle where a key spectrum was acquired. This table can be transferred to the featurefindIR µChemical ID report or exported as a CSV file for external processing in databases such as KnowItAll® shown in Figure 3.

featurefindIR µChemical ID reporting

The featurefindIR µChemical ID report automatically analyzes all user selected spectra within a PTIR Studio file and correlates them against a reference set of spectra in an integrated database. A hit quality index (HQI) is reported back for every measured spectrum. If the HQI is above a user set threshold, the best match chemical ID is also reported. An overlay is displayed between the measured and reference spectra. Color coding is available for visual support in assessing the quantity of spectra with specific plastics types being assigned specific colors as a visual aid. Additionally,

IR Spectrum 68	68	33.35	-1702.15	2.61	5.348	0.894	PMMA
IR Spectrum 69	69	-51.15	-1703	18.349	264.43	0.806	PS
IR Spectrum 70	70	50.45	-1695.35	11.678	107.106	0.846	PMMA
IR Spectrum 71	71	112.4	-1692.5	10.136	80.695	0.687	PMMA
IR Spectrum 72	72	-35.9	-1681.15	7.105	39.646	0.721	PMMA
IR Spectrum 73	73	6.2	-1679.4	8.532	57.175	0.615	protein
IR Spectrum 74	74	-2.9	-1677.45	6.184	30.034	0.981	PMMA
IR Spectrum 75	75	127.2	-1674.4	3.243	8.262	0.823	PMMA
IR Spectrum 76	76	-68.6	-1677.95	16.622	217.001	0.904	PMMA
IR Spectrum 77	77	72.3	-1671.95	4.936	19.139	0.875	PMMA

Figure 4a: µChemID database output provides comprehensive analysis of microplastics size and chemical ID

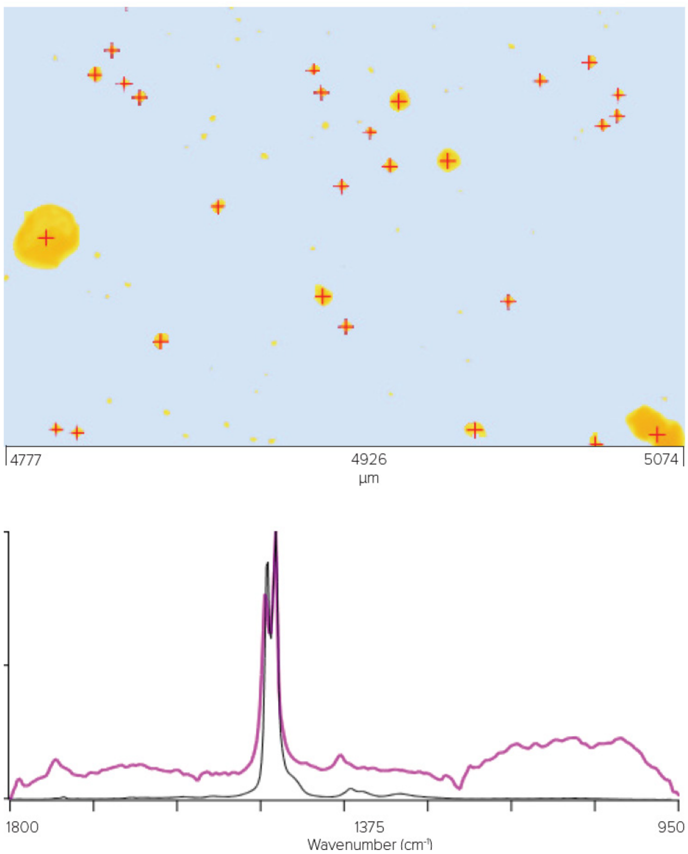


Figure 4b: µChemID database provides measured and reference spectra and particle location.

quantitative checks can be performed by selecting each result to reveal an overlay of detailed spectra with the closest OPTIR reference match which is shown in Figures 4a and 4b.

Measurement of small <30µm particles

Representative O-PTIR spectra were collected from a range of different polymer particles covering a range of microplastics sizes. These measurements were focused on the smaller range of microplastics, <30µm that are typically beyond the spatial resolution limits of conventional direct IR microscopes (FTIR or QCL).

Figures 5 and 6 show excellent sensitivity and spectral profiles for all polymer types, even demonstrating the collection of virtually identical spectra from 3µm and 20µm PMMA particles. A feat that traditional IR cannot achieve, not only because of spatial resolution limits but also due to dispersive scatting artefacts which render such traditional techniques sensitive to artefacts from differences in particle morphology (shape and size).

O-PTIR spectra reference database

The O-PTIR reference spectra database includes high quality spectra for 20 of the most common polymers found in microplastic samples as well as reference spectra forseveral typical non-plastic environmental particles, likecellulose protein, sand, shell and more. Users can readily add additional reference spectra to the database either from existing databases or by measuring O-PTIR spectra on known materials and/ or from public domain sources.

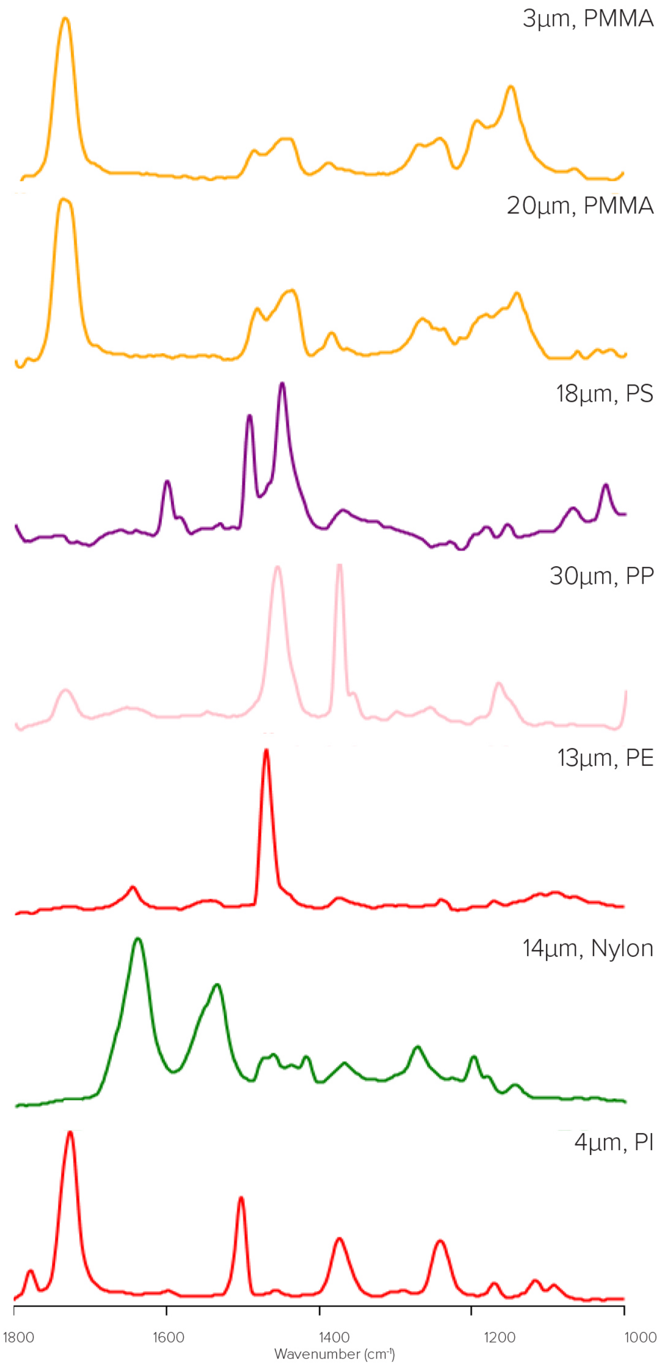
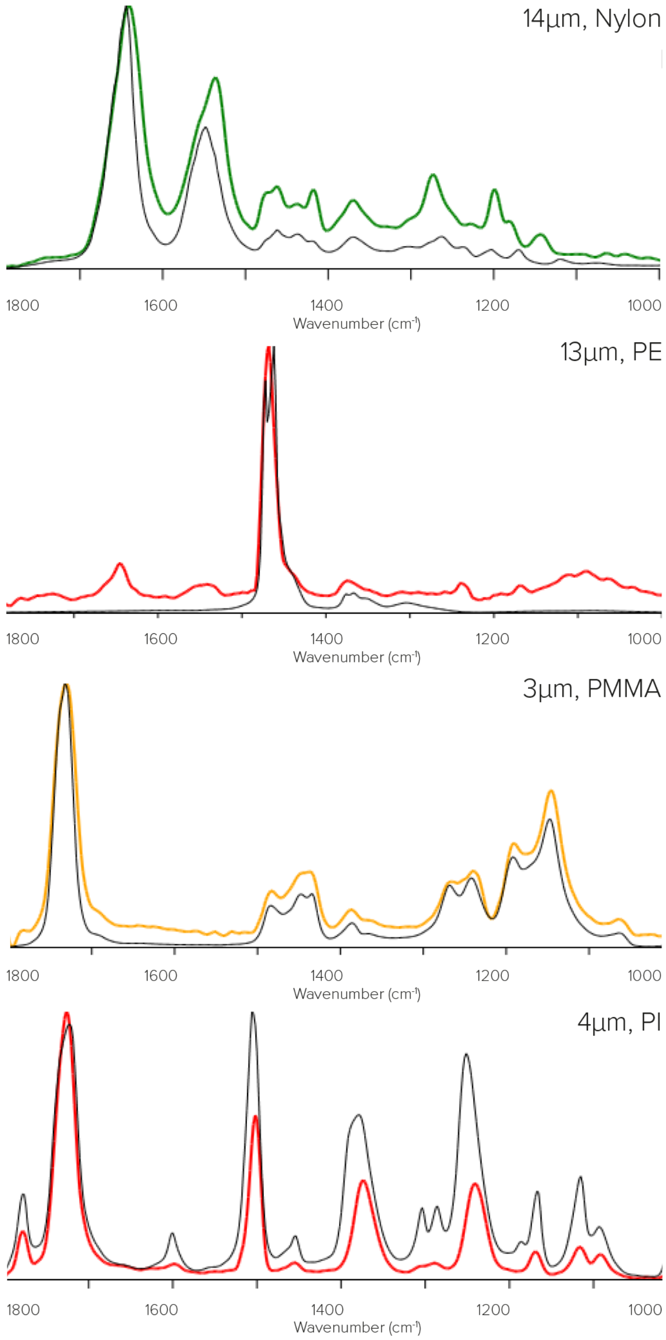


Figure 5: Stacked representative, IR spectra across a wide range of typical microplastics and across a wide range of particle sizes, spanning the challenging <30µm range. Of note is that even articles of 3µm and 30µm from the same material show virtually identical IR spectra.

Summary

featurefindIR provides researchers an automated process for rapidly measuring a large number of relevant microplastics.



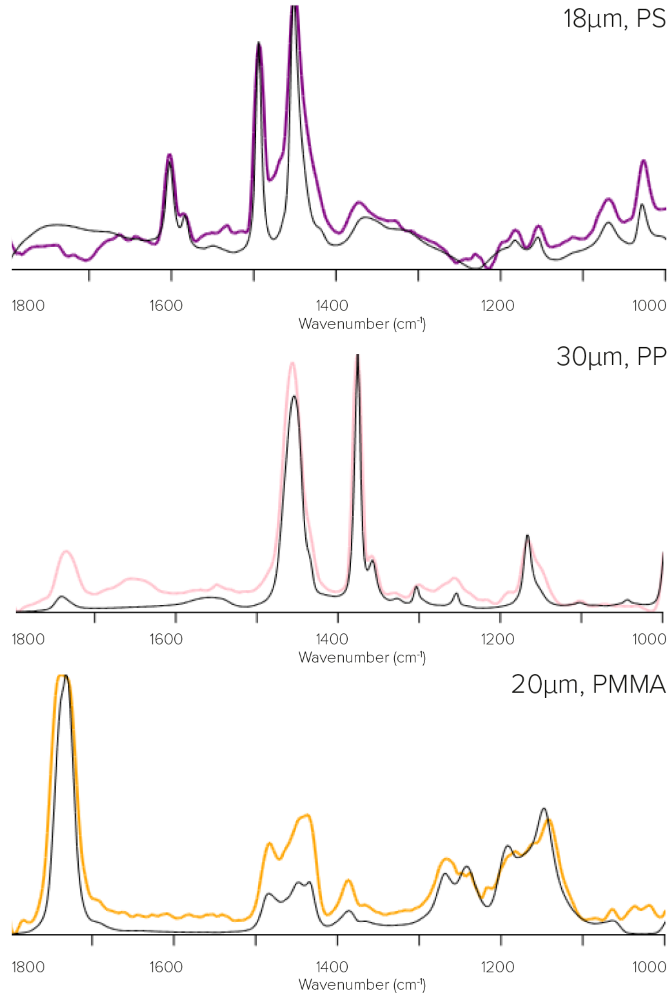


Figure 6: IR spectra overlaid in reference library spectra (black), showing excellent agreement, across all size ranges and plastic types

This provides dimensional information and determines their chemical ID with a dedicated µChemical ID database. All data can be exported through CSV for further analysis as required. featurefindIR improves productivity of measurement by providing different methods for identifying microplastics types, such as single wavelength imaging and fluorescence images. It is a complete solution for measurement of microplastics ranging from submicron to millimeter in size. featurefindIR is available as an upgrade on existing standard mIRage and mIRage-LS systems, the µChemical ID database is available as an option.

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