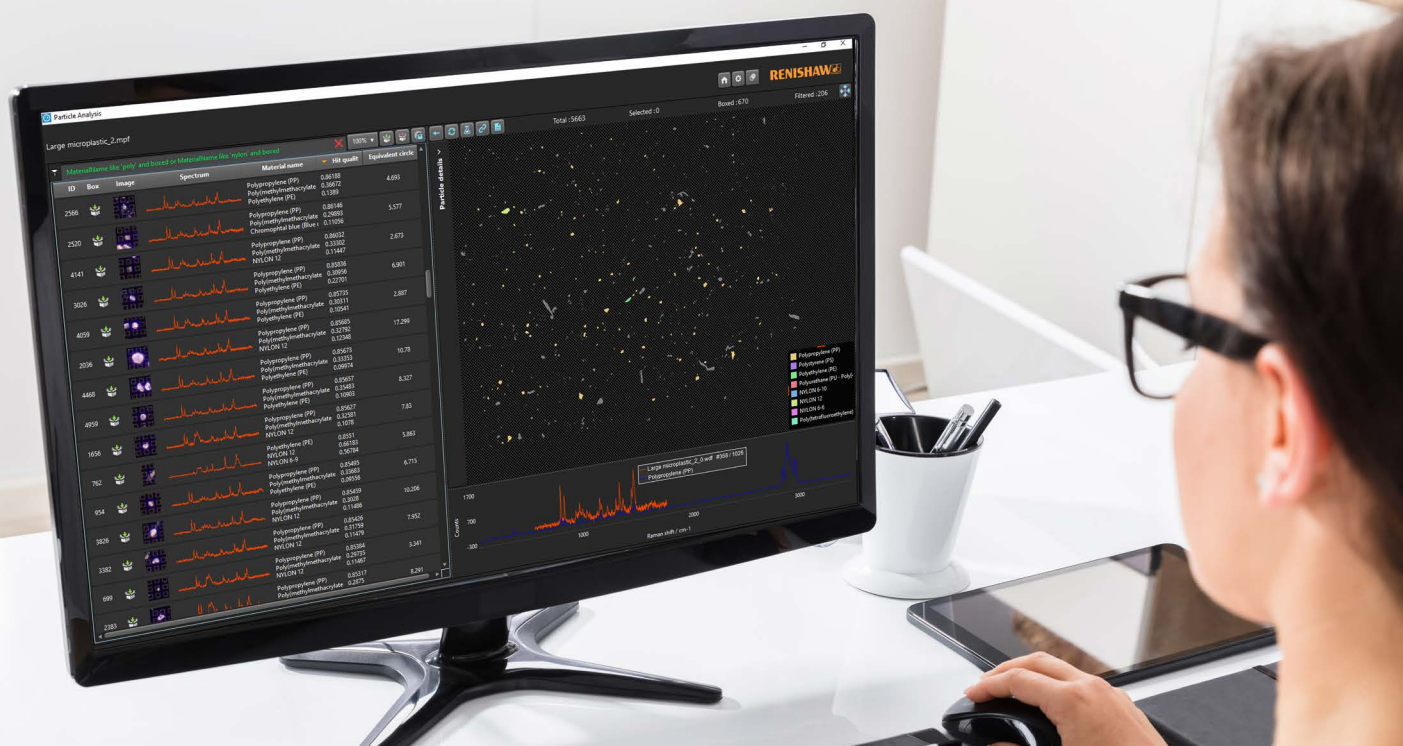


Particle Analysis module



Automated Raman particle analysis

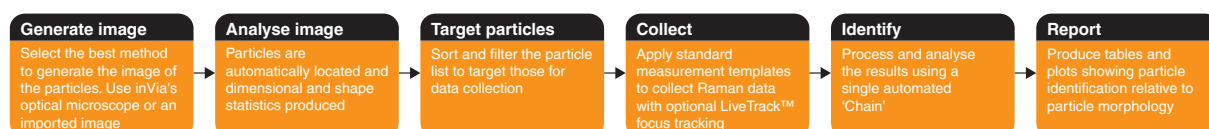
Raman spectroscopy can provide chemically specific, high spatial resolution information. Fast mapping methods—such as StreamLine™ mapping—enable the generation of chemical images. However, when investigating particles it is often advantageous to use an optical image to pinpoint analysis regions.

Renishaw's Particle Analysis module enables automated Raman data collection, analysis and reporting, from points determined from the analysis of images. These images can be from Renishaw Raman microscopes or other imaging systems such as fluorescence and scanning electron microscopes.

Easy to use, with an optimised workflow

The Particle Analysis Module within Renishaw's powerful Windows®-based Raman Environment (WiRE™) software enables you to focus on chemically identifying multiple particles and correlating this information with morphology parameters, such as diameter, length and aspect ratio.

The Particle Analysis Module guides you through this with a simple workflow. This workflow—combined with the high performance of Renishaw's Raman systems and capabilities such as LiveTrack™ focus tracking—results in a powerful and flexible system suitable for a very wide range of sample types. And, if your samples require something more bespoke—such as collecting multiple points from each particle—we've made sure that Particle Analysis is compatible with the WiRE software's batch mapping capabilities.



Generate image

Select the best method to generate the image of the particles. Use inVia's optical microscope or an imported image

Analyse image

Particles are automatically located and dimensional and shape statistics produced

Target particles

Sort and filter the particle list to target those for data collection

Collect

Apply standard measurement templates to collect Raman data with optional LiveTrack™ focus tracking

Identify

Process and analyse the results using a single automated 'Chain'

Report

Produce tables and plots showing particle identification relative to particle morphology

High resolution optical imaging

Using the Particle Analysis module on the inVia™ microscope starts with the production of a high quality image. A high sensitivity camera is used to produce optical images which provide the best contrast of the features to be analysed. Whether this is brightfield, darkfield, or polarised light, the inVia confocal Raman microscope acquires the best image.

You can image your sample in detail using a range of high quality objective lenses. Images can be digitally zoomed to see fine detail, if necessary. The imaged area is not limited to the field of view of the microscope, as larger areas can be created by automatic montage. Optionally image stacking can also be used; this generates an 'in-focus' image from a series of images at different sample heights. This is necessary for some samples, ensuring particle edges are well defined and thereby giving accurate particle statistics. You can use different objective lenses for the image capture and Raman data collection. You might use a low magnification objective to rapidly capture an image of a large area and a high magnification high aperture objective for efficient Raman data collection.

The Particle Analysis Module is supported by Renishaw's Correlate™ software module. This enables you to guide particle analysis using images from a variety of other microscopes, such as SEM, AFM and infrared microscopes. The Correlate software module takes care of the coordinate transformations so that the inVia microscope can accurately analyse the particles on the images from the other microscopes.

Features

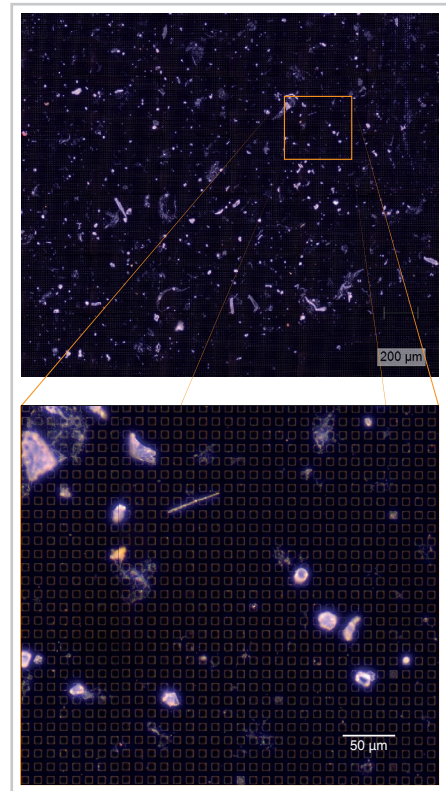
- High resolution video images with digital zooming
- Image stacking for an enhanced depth of field
- One click software switching between brightfield and darkfield imaging
- Direct Raman data collection using images from other microscopes using the Correlate software module
- Objective lens parcentricity calibration ensures that your objectives' focus points are all aligned, for both image collection and Raman data collection
- Images can be cropped so you can concentrate on a particular region

Image analysis to target the particles

You then set a threshold—either automatically or manually—to ensure the particles are well resolved and separated from neighbours. This can be done on the whole image or part of it to concentrate on the particles of interest. This key step ensures you have the best list of particles to choose for analysis.

Features

- Automatic and manual thresholding options
- Image brightness can be inverted to show particles more clearly
- Automatic resolution of particles from their neighbours.



High resolution reflected darkfield montage (20×) of particles filtered from bottled water showing particles and the regular array of filter pores (top). Digital zoom of the highlighted region, showing the high spatial resolution of the image (bottom).

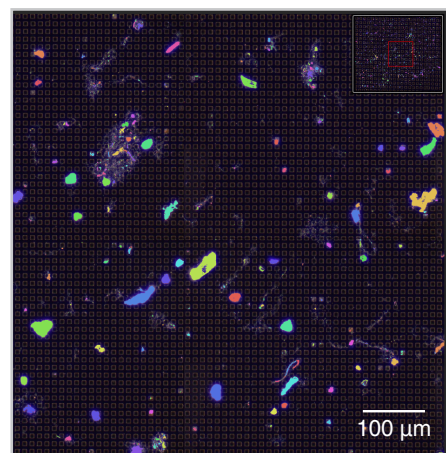


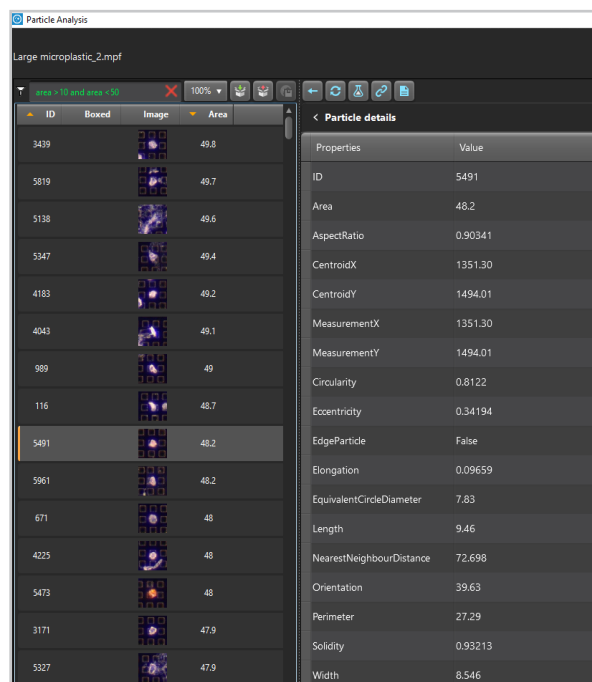
Image analysis applied. Particles are identified, coordinates stored and size statistics calculated. Each colour represents a separate identified particle.

Sort, filter and select for analysis

The analysis screen enables you to sort and filter the particle list. This makes it easy to navigate high numbers of particles. You can use particle metrics (such as size or shape) to select a subset of particles for Raman analysis. Or you can analyse a random percentage of particles, useful when particle numbers are very high; this gives you statistically significant data quickly without having to analyse every particle. Or, for more detail, you can select individual particles and quickly view their morphology metrics.

Features

- Sort and filter particles by morphology, shape, size etc
- Supports multiple simultaneous filters (e.g. filtering by both size and shape)
- Quick access to individual particle information
- Detailed colour thumbnail images of particles help you evaluate your sample



Particle list sorted by area and filtered to show particles with areas between 10 μm and 50 μm . Particle details for the selected particle are shown.

Optimise data collection

The selected particles are Raman analysed by selecting an appropriate measurement template. These templates define common data acquisition parameters, but you can modify them to change parameters such as acquisition time, laser power, and number of accumulations. The inVia Qontor®s LiveTrack option can be used to ensure each particle is in focus for data collection. The widest part of each particle is automatically determined and the microscope focused on its midpoint for data collection, ensuring particles of any shape can be analysed. This, and the sub-micrometre precision of the inVia microscope's sample stage, ensure the successful targeting of particles for analysis. It is easy to collect data from a subset of the particles using a different measurement template, should you need to change a parameter such as laser wavelength or acquisition time. Importantly, data collection can be performed using a different objective to that used for collecting the optical image. This ensures data collection is efficient and confocal without constraining the optical image size, and minimises measurement time.

Features

- Simple pre-defined templates save you time in setting up your measurements
- Quick adjustment of key measurement template parameters
- LiveTrack automatic focus-tracking so particles are in-focus regardless of size
- Intelligent determination of particle centres, even for odd shaped particles and fibres
- Analyse particles even if only their edges are visible
- Re-collect data from specific particles using different parameters
- Collect data using either a tightly focused laser spot, or a de-focused spot to produce an average
- Randomly analyse a defined percentage of a group of particles
- Compatible with the WiRE software's Batch Mapping capability, enabling the collection of multiple spectra or images from each particle

Automated processing and analysis

The particles can be chemically identified using Renishaw's Spectrum Search or Component Analysis routines. For studies where there is a high volume of samples, the process of data processing and analysis can be completely automated into a single 'Chain'. This simplifies this process into a one click operation.

Features

- Automated material identification by spectrum libraries
- Automated processing and analysis operations ('Chains')
- Easy re-analysis of particles

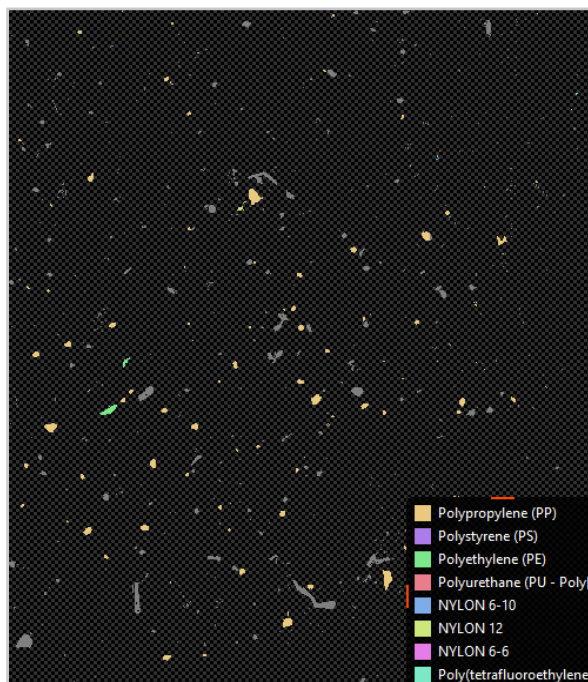
Reporting

The particle list gives a snap shot of the Raman spectrum, chosen particle morphology parameters, and the analysis results. You can easily evaluate the results, sorting the data by library search result or hit quality index (HQI – the measure of similarity to the library spectrum). Particles which have ambiguous results can then be omitted from reporting, or targeted for new data collection or analysis. The results are presented as a table of binned data, enabling detailed statistical analysis.

The individual particles on the image can be coloured by table list properties (e.g. area, diameter, HQI), or by material type. This makes it easy to review the results and reveals contiguous particles.

Equivalent circle diameter / μm	Total	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50
Polypropylene (PP)	180	44	49	45	24	12	3	2	1	0	0
Calcium carbonate	270	110	95	48	11	3	2	0	1	0	0
Hostafine yellow (Yellow dye)	13	7	4	1	0	0	1	0	0	0	0
Rutile (TiO ₂)	1	1	0	0	0	0	0	0	0	0	0
Beta-carotene	163	119	34	6	3	0	0	1	0	0	0
Other materials	43	23	13	3	2	0	1	0	0	1	0
Total	670	304	195	103	40	15	7	3	2	1	0

Report table.



Particle image with particles colour-coded by material. Particles not identified as polymers are shown in grey.

Features

- Output report table showing material, particle number and particle morphology
- Show all particles or a subset
- Automated binning of particle morphology data
- Custom reporting capabilities
- Colour particles by material, or other metrics such as morphology (area, aspect ratio) and analysis results (library hit quality index)
- Export results to create graphs and plots in external analysis packages and spreadsheets

Dedicated software for a range of applications

The Particle Analysis module makes targeted particle identification easy, and is applicable to a wide range of different applications. These include the analysis of filtered environmental particles, deposited pharmaceutical sprays and inhalers, forensic trace materials, graphene and other 2-D materials, and biological applications such as cytology.

Contact Renishaw's applications experts to discuss your specific particle analysis requirements and to learn more about how the Particle Analysis module can streamline your work and save time.

A range of related Renishaw literature is available. Please ask your local Renishaw representative for more information.

Renishaw. The Raman innovators

Renishaw manufactures a wide range of high performance optical spectroscopy products, including confocal Raman microscopes with high speed chemical imaging technology, dedicated Raman analysers, interfaces for scanning electron and atomic force microscopes, solid state lasers for spectroscopy and state-of-the-art cooled CCD detectors.

Offering the highest levels of performance, sensitivity and reliability across a diverse range of fields and applications, the instruments are designed to meet your needs, so you can tackle even the most challenging analytical problems with confidence.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Please visit www.renishaw.com/raman for more information.

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