Brochure

The Thermo Scientific DXR3 Flex Raman

A Multimodal Instrument Ideal for Routine Analysis of Battery Components

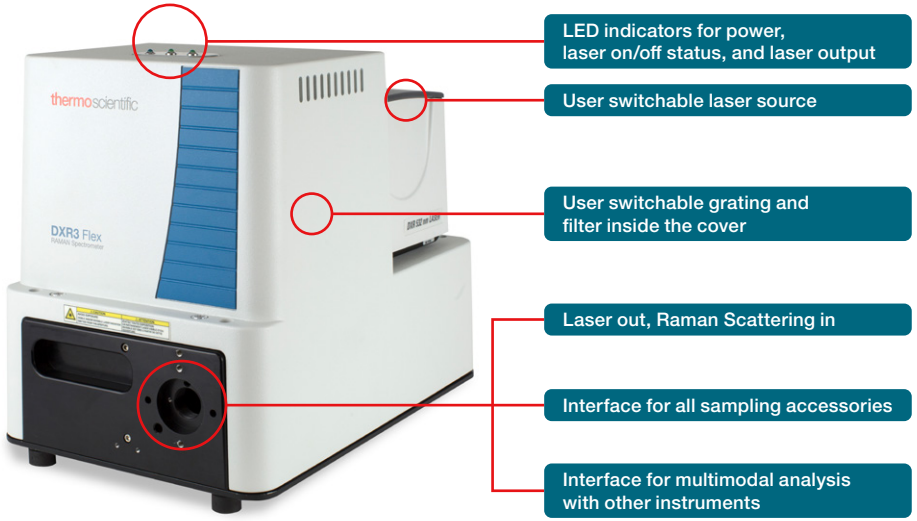
Raman spectroscopy, an information-rich analytical technique, is one of the top tools for battery component analysis. Combining multiple sampling modes in a single instrument adds the versatility and flexibility to analyze lithium-ion battery materials and products across various stages of production – from quality assurance on incoming materials to final product performance analysis.

Various modalities of the Thermo Scientific™ DXR3 Flex Raman spectrometer make it an excellent choice for battery component identification. There are many ways to apply this multimodal Raman system, making it a must-have tool for battery component analysis.

Here is a list of key features that the DXR3 Flex Raman Spectrometer has to offer:

- Research-grade Raman capabilities within a compact footprint.
- A user-switchable laser source, supporting 455 nm, 532 nm, 633 nm and 785 nm excitation lasers.
- Flexibility and versatility with macro-, micro-, and fiber optic sampling options to suit a wide range of applications.
- An open architecture that allows custom coupling to other analytical techniques.

Accessories and couplings give the DXR3 Flex even more capabilities. More information about these can be found on the following pages.

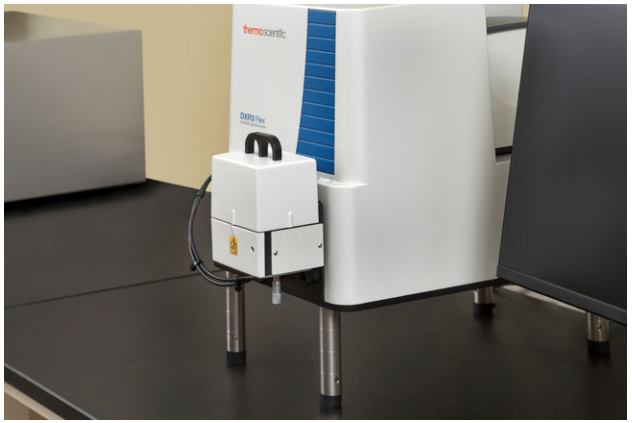


DXR3 Flex Macro Compartment Sampling Accessory

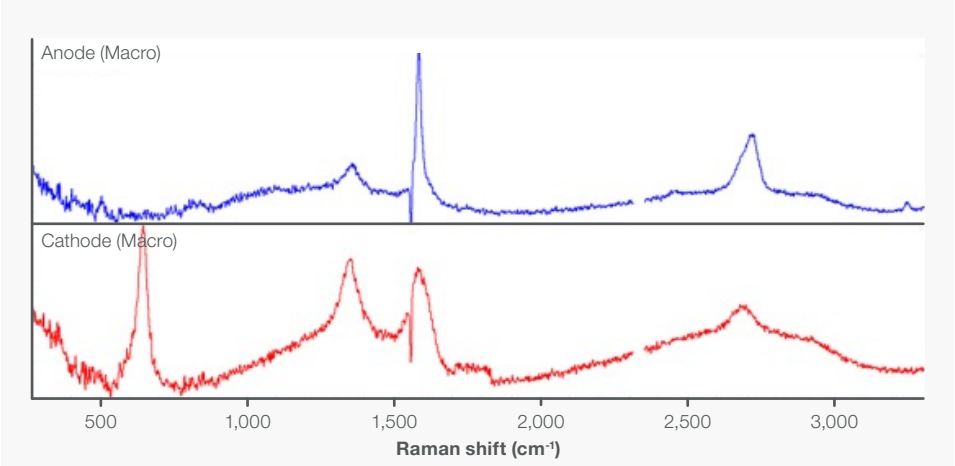
When the need arises for analysis of larger bulk samples or incoming raw materials, the DXR3 Flex Macro Compartment Sampling Accessory handles them with ease.

The macro measurement accessory gives the DXR3 Flex the capability to analyze bulk samples while still providing attributes needed for excellent data acquisition:

- Non-confocal, bulk measurement
- Free-space coupling for better signal-to-noise ratio
- Average spectra over a large sampling area



DXR3 Flex Bulk sampling accessory.



Example

These spectra shown here, in which both the anode and the cathode of a battery were analyzed, illustrate the high quality of the information that can be acquired using the macro compartment sampling accessory.

- Both the anode and cathode materials have the carbon G band at 1580 cm^{-1}, the D band at 1,350 cm^{-1}, and the 2D band at 2,712 cm^{-1}.
- The cathode has a unique peak from $LiMn_2O_4$ at 645 cm^{-1}.

*Spectra were collected with a 532 nm laser and baseline corrected.

Fiber Optic Coupling

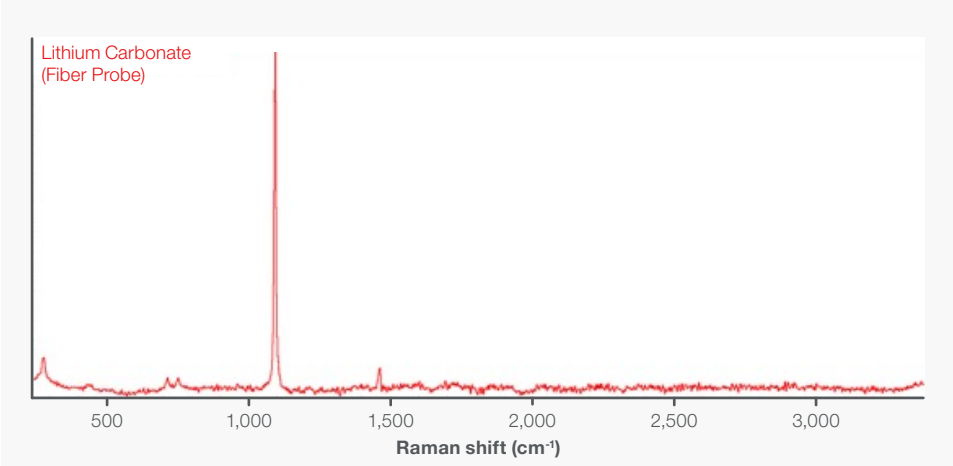
For those times when a sample is oddly shaped or needs to be contained in a vessel, a standard sample chamber might be inadequate. For such situations, the DXR3 Flex sports the ability to be coupled with a fiber optic probe. This brings versatility to the sampling process and allows the DXR3 Flex Raman Spectrometer to provide measurements where other standard Raman spectrometers may not.

Key capabilities are made possible by fiber optic coupling:

- Various probe head options can be used (reaction, immersion, and proximal) depending on what is most appropriate for the sample type.
- The probe tip can be brought to the sample, enabling multiple forms of sample analysis:
  - Measurements of irregularly shaped solid samples.
  - Measurements of air/moisture sensitive materials inside a dry box or glove box.
  - *In situ* measurements during manufacturing processes.

While the fiber optic probe options do allow for sample measurements that might not otherwise be possible, it should be noted that probes do have higher loss and lower efficiency than the free-space coupling, along with lower signal-to-noise ratios.

From left to right: Reaction, immersion, and proximal probes.



Example

Lithium carbonate, a common battery component, is an irritant and best kept contained so the fine powder does not cause health hazards. To analyze a sample, a fiber optic probe was used while the compound was stored inside a vial. The plot shows the result of such an analysis.

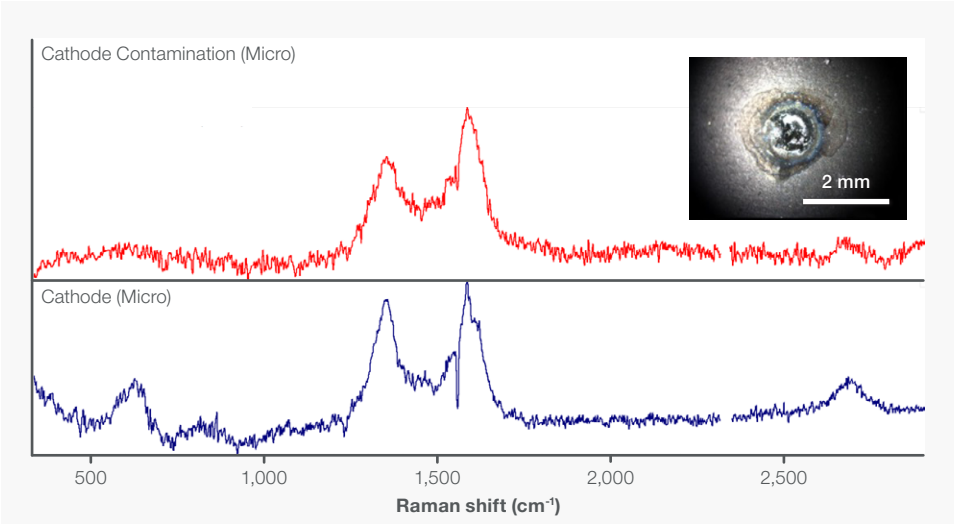
- Spectra were collected with a fiber optic probe and a 532 nm laser with power of 40 mW.
- Li_2CO_3 still has the prominent peak at 1,087 cm^{-1}.

DXR3 Flex Micro Stage Sampling Accessory

When your samples are exceedingly small, a specialized approach to analysis may be required. For such cases, the DXR3 Flex Micro Stage Sampling Accessory may be just what you need. The micro stage sampling accessory enables localized measurement of small areas or samples on the scale of mere microns.

The micro stage sampling accessory is a manual-stage single-point microscopic sampler that provides key benefits:

- Allows for spatially resolved analysis of specific sample regions
- Free-space coupling for better signal-to-noise ratio
- Ideal for defect and small feature analysis



Example

A small section of an electrode may appear to be irregular, but exactly what the cause of that visual difference is may be difficult to determine. Using the micro stage accessory allows the DXR3 Flex to perform Raman analysis on one small section of the sample, as is shown by these graphs.

- The Raman spectrum obtained from a visually distinct spot on the cathode shows the absence of the $LiMn_2O_4$ peak at 645 cm^{-1}, which was present in the base cathode material.
- By leveraging the high spatial resolution of the Raman micro measurements, small sample defects can be rapidly identified and analyzed.

Spectra were collected with a 532 nm laser and 10x microscope objective.

Whether the battery components you need to investigate are large or small, stable or sensitive, the Thermo Scientific DXR3 Flex Raman Spectrometer is the ideal instrument for your analysis. Please contact your local Thermo Fisher Scientific representative to learn more.