



# *In-situ* and operando Raman spectroscopy for batteries

## Trusted for reliable results

Renishaw's inVia™ confocal Raman microscope and Virsa™ Raman analyser are trusted by leading researchers working on battery technology. The inVia microscope offers research-grade performance and ultimate flexibility. The Virsa analyser with its fibre probe functionality is easy-to-use and is readily transported between laboratory and manufacturing environments.

### Operando (triggered) measurement

You can synchronise Raman and electrochemical measurements using either hardware or software triggering. Hardware triggering can start a series of Raman measurements with an electronic signal e.g. from a potentiostat. Software triggering enables either LabVIEW™ or Python scripts to control Renishaw's WiRE™ software via a TCP/IP connection.

### Controlled laboratory environments

Renishaw's Raman spectrometers have been fitted in inert gas gloveboxes for Raman analysis of air-sensitive battery materials like LiCoO<sub>2</sub>. The inVia microscope and Virsa analyser are also used in clean rooms and humidity-controlled environments suitable for manufacturing batteries.

### LiveTrack™ focus-tracking technology

LiveTrack technology automatically keeps your Raman measurements in focus. Get topographical Raman images when analysing rough samples like activated carbon anodes, and uneven samples like electrode foils. If your sample swells during charge or discharge, LiveTrack technology keeps the Raman measurement in focus at the surface.

### Automation and remote access

Renishaw's WiRE software can automate your Raman measurements. You can queue many samples for Raman analysis and control your experiments remotely.

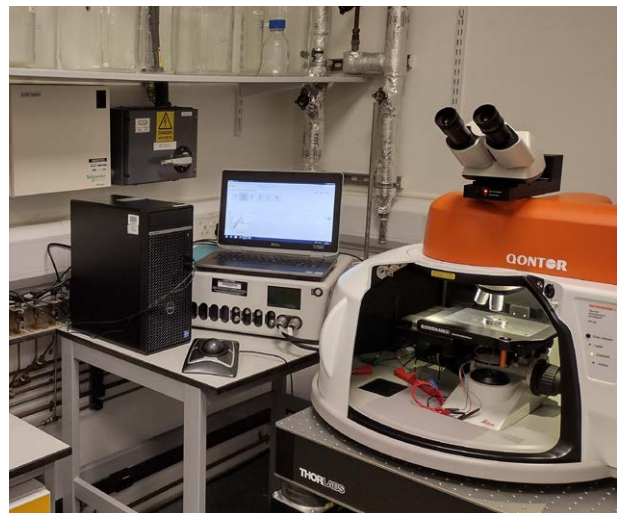


Combined Raman-AFM analysis of air-sensitive battery materials within an inert gas environment of a glovebox. (Image courtesy of Dr Collin Becker, US Army Research Laboratory (ARL), Maryland, USA)



**Electrolyte characterisation**

Operando Raman spectroscopy was performed using an inVia microscope to determine key electrolyte properties. Flexible sampling options are available for the required electrochemical cell orientation. (Characterising lithium-ion electrolytes via operando Raman microspectroscopy | Nature Communications, J. Fawdon, J. Ihli, F. La Mantia and M. Pasta, Nature Communications 12, 4053 (2021))




**Electrochemical cell and potentiostat**

Operando Raman spectroscopy performed using an inVia microscope and an EL-Cell Opto Std electrochemical cell. Hardware triggering was used to synchronise Raman acquisitions using electronic signals from a Metrohm Autolab potentiostat. (Image courtesy of Dr Rudra Samajdar and Dr Andy Wain, Electrochemistry Group, National Physical Laboratory, UK)

For more information on Raman spectroscopy for batteries, please visit [www.renishaw.com/batteries](http://www.renishaw.com/batteries)

[www.renishaw.com/raman](http://www.renishaw.com/raman)

 #renishaw

+44 (0) 1453 524524  [raman@renishaw.com](mailto:raman@renishaw.com)

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