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Environmental cells and sample stages

Combine Renishaw's Raman systems with a range of sample stages for *in-situ* measurements

You can equip the inVia™ confocal Raman microscope or Virsa™ Raman analyser with a variety of environmental cells and sample stages to study physical changes and chemical reactions.

Use Renishaw's Raman systems to follow the chemical and structural changes that occur due to varying conditions like temperature, pressure, humidity or electrochemistry. The unrivalled sensitivity of Renishaw's Raman systems means that even very subtle changes can be monitored with ease, making them ideal for measuring challenging samples and conducting cutting-edge research.

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Temperature stages

Temperature control stages are widely used for the study of phase transitions such as polymer melting, crystallisation, conformational changes in proteins and annealing. They are also used by materials scientists for studies of photoluminescence in semiconductors and other materials.

Renishaw's WiRE™ software includes integrated Raman acquisition and temperature control with stages from Linkam Scientific Instruments, including:

- **Linkam Scientific Instruments THMS600** for heating up to 600 °C and freezing down to -195 °C
- **Linkam Scientific Instruments TS1500** for heating to 1500 °C

You can now fully synchronise your Raman analysis with a programmable heating and cooling profile. Renishaw's LiveTrack™ focus-tracking technology keeps your sample in focus throughout the experiment, even when the sample surface moves due to thermal contraction or expansion.

Linkam Scientific Instruments THMS600.

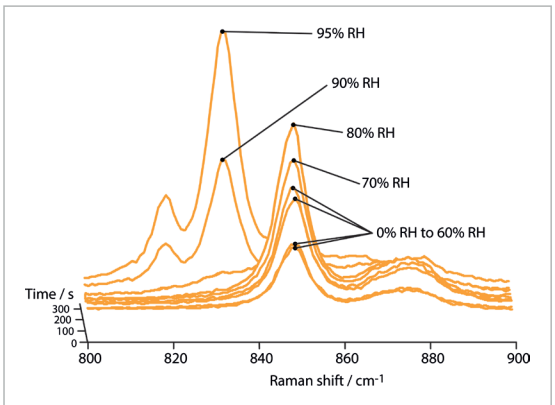
Linkam Scientific Instruments TS1500.

Humidity control

Changes in humidity can affect the structure and properties of many materials, from catalysts and semiconductors to microbiological cells and pharmaceuticals. Chemical and physical structure, as well as reaction rates and degradation processes, can all be influenced by changes in humidity.

You can use Linkam Scientific Instruments THMS600 stage with RHGen Relative Humidity Controller to precisely control the humidity environment of a sample between 5% to 90% relative humidity (RH). For example, you can study the influence of humidity on polymorph stability in pharmaceutical formulations or on the stability of drug delivery systems such as tablet coatings.

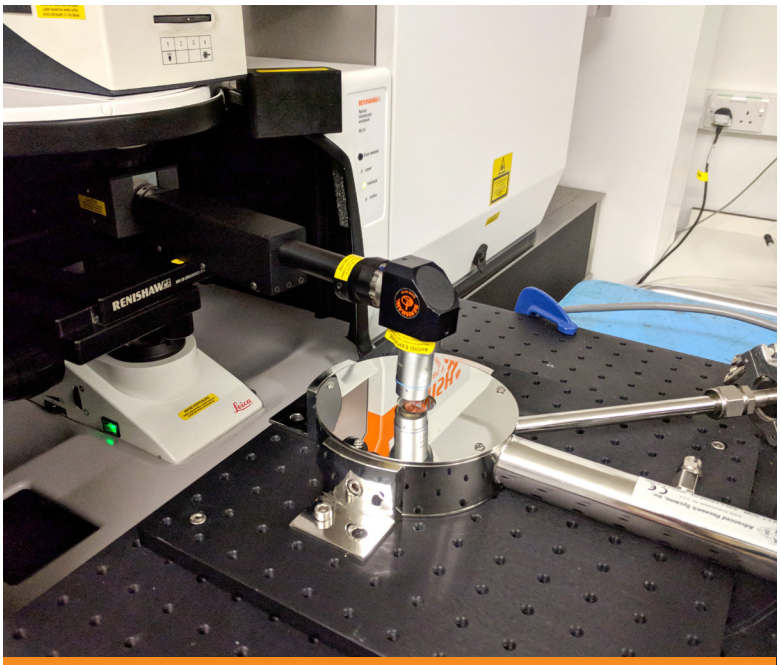
Linkam Scientific Instruments RHGen Relative Humidity Controller.



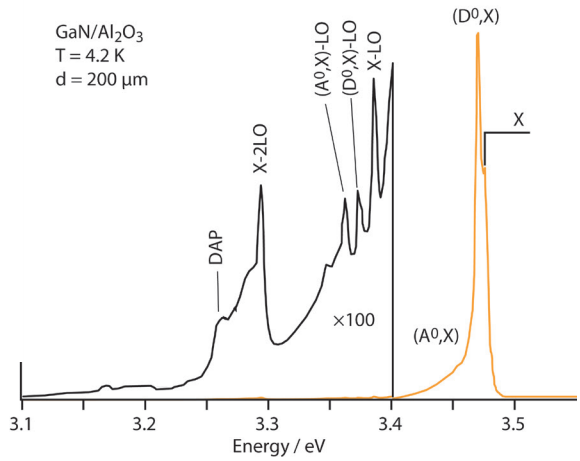
Effect of humidity on the crystallinity of a pharmaceutical tablet (Nurofen Meltlet). Dramatic structural changes occur at 80% RH as the sucrose component deliquesces.

Cryostat integrations

Raman spectroscopy can help to advance your research into quantum optics and mesoscopic devices at low temperatures. Renishaw can supply closed-cycle cryostats with ultra-low vibrations down to 5 nm. We have solutions for interfacing with liquid nitrogen (down to 77 K) or liquid helium cryostats (down to 2.2 K) from leading third-party cryogenics vendors.



Renishaw's flexible sampling arm can be used to collect Raman spectra and images from samples in cryostats.



325 nm excitation photoluminescence spectrum of a 200 µm GaN layer on sapphire, collected at 4.2 K using a liquid helium cryostat. Data courtesy of H. Siegle *et al.*, Technical University, Berlin, Germany.

Catalyst cell reactor

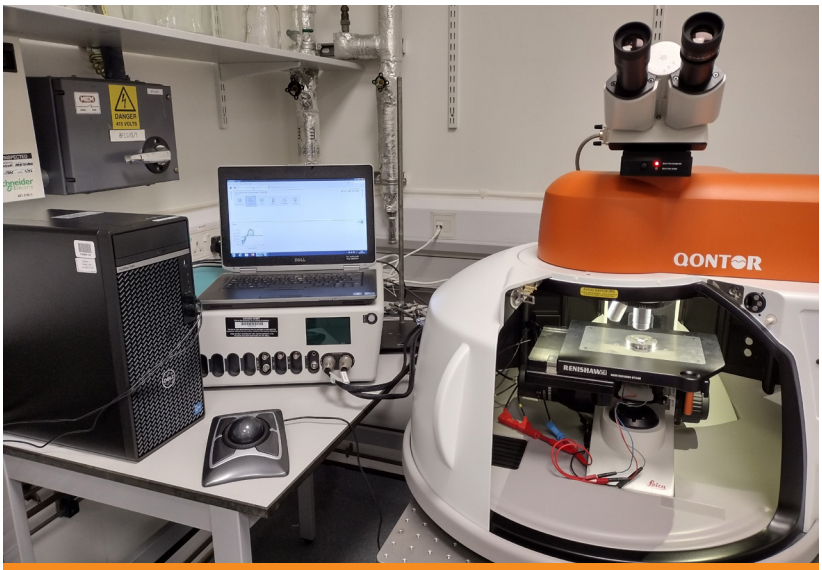
You can also use Raman spectroscopy for operando studies of catalysts and reaction kinetics. Renishaw's Raman spectrometers can be equipped with a Linkam Scientific Instruments CCR1000 Catalyst Cell Reactor. The CCR1000 is designed for small-scale test on catalyst formulations at temperatures up to 1273 K (1000°C) and gas pressures up to 500 kPa (5Bar).

Linkam Scientific Instruments CCR1000.

Electrochemical battery test cell

Raman spectroscopy can be used for the chemical and structural characterisation of novel electrode and electrolyte materials. Operando Raman measurements can be performed during battery charge and discharge cycles using an EL-Cell ECC-Opto-10. The electrochemical cell is suitable for Raman analysis of the electrodes in a face-to-face or side-by-side arrangement.

EL-Cell electrochemical cell for operando Raman analysis of battery devices.



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.

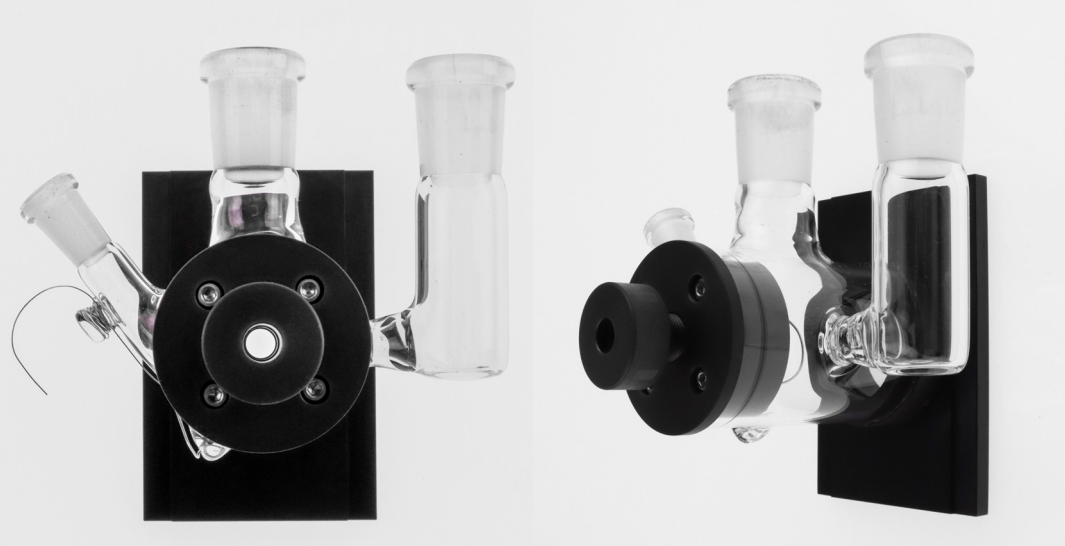
Electrochemistry cell

With a glass electrochemistry cell, you can use Raman spectroscopy to detect the chemical changes that occur during cyclic voltammetry for in-situ corrosion studies, the identification of electrochemically produced intermediates or the investigation of catalysts.

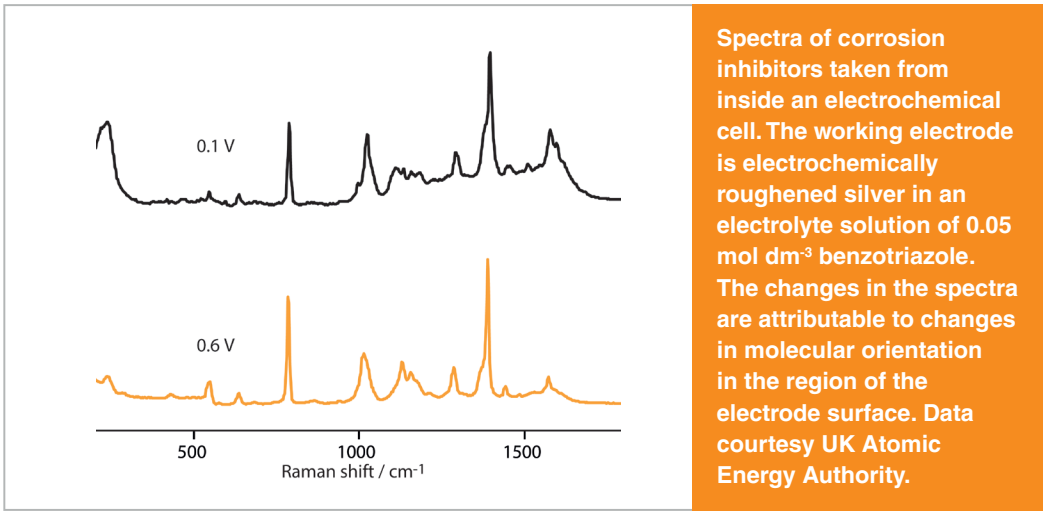
The glass electrochemistry cell can be used to synthesise electrochemically roughened surfaces. These roughened surfaces can be engineered as surface enhanced Raman scattering (SERS) substrates to produce greatly enhanced Raman signals.

The cell features ports for easy filling of the cell with electrolyte or reaction mixtures, and for venting gaseous reaction products. A side arm contains the standard electrode (a saturated calomel mercury/mercury (I) chloride electrode is supplied). The working electrode face is held vertically to allow gaseous reaction products to bubble away.

The glass electrochemistry cell is designed to fit onto Renishaw's macro sampling kit. The user can easily focus the Raman laser into the cell using the standard microscope stage controls.



Front and oblique views of the glass electrochemistry cell. The Raman measurement is performed through the round glass window.



Spectra of corrosion inhibitors taken from inside an electrochemical cell. The working electrode is electrochemically roughened silver in an electrolyte solution of 0.05 mol dm^{-3} benzotriazole. The changes in the spectra are attributable to changes in molecular orientation in the region of the electrode surface. Data courtesy UK Atomic Energy Authority.

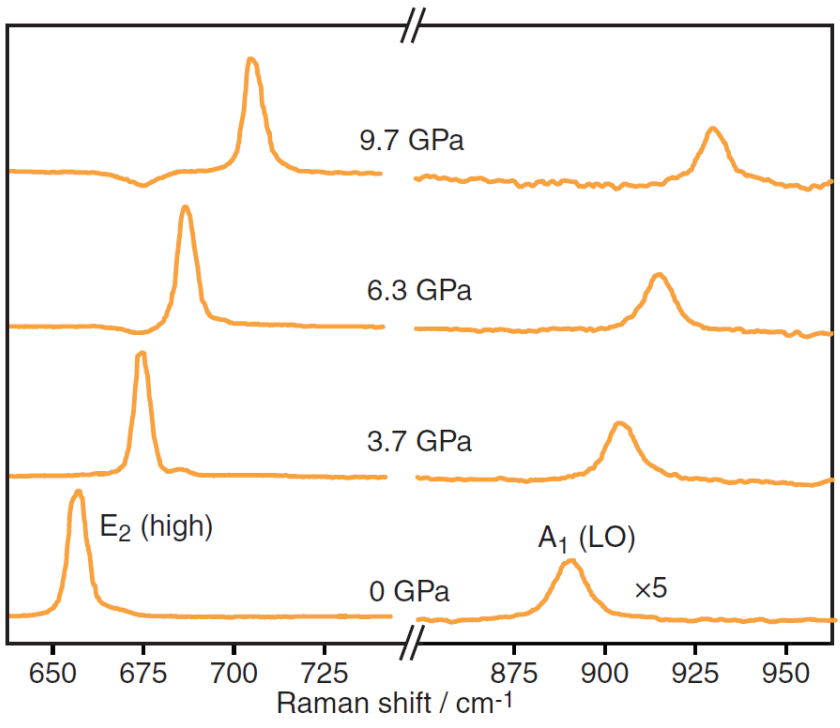
High-pressure cells

Raman spectra are sensitive to molecular arrangement and can differentiate different structures at varying pressures. Renishaw's spectrometers can also acquire photoluminescence (PL) spectra that reveal detailed information about defects, and the effect of changing pressure and temperature on them. These data are especially useful in for semiconductor and materials science applications.

The Diacell® LeverDAC-Maxi high-pressure cell can support pressures up to 50 GPa (500 kBar). The high-pressure cell operates on a leverage mechanism forcing two diamond anvils together. The cell has a numerical aperture of 0.44 for analysis via optical methods. It normally operates at ambient temperatures, but the addition of an internal resistive heater allows use at temperatures up to 500˚C.

The anvils can be adjusted for tilt to ensure anvil faces are parallel. For convenience, all adjustments necessary for alignment can be made under the microscope.

Almax easyLab Diacell® LeverDAC-Maxi is a diamond anvil cell for high pressure Raman measurements up to 50 GPa.



Raman spectra of the (0001) face of AlN, as a function of hydrostatic pressure. Data courtesy M. Kuball, University of Bristol, and D.J. Dunstan, Queen Mary, University of London.

Biological live cell incubator

One of the advantages of Raman spectroscopy for life sciences is its applicability to live cells. For prolonged live cell measurements (>30 minutes) of mammalian cells, the use of a live cell incubator is recommended. Live cell incubators provide temperature, CO_2 and humidity control, which are required for keeping cells alive and healthy.

Okolab provides stage incubators without a top glass, which are suitable for upright microscopes. Okolab's H301 Bold Line Top Stage Incubator comes with a lid with an aperture so that the objective can access the sample. As cells are in a cell medium or buffer, the use of a water immersion objective is highly recommended.

The Okolab stage top incubator system is suitable for Raman imaging of live cells on an upright microscope. The Okolab system controls the temperature, gas and humidity environment of the biological sample.

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Contact us

If you need more information or need any advice on configuring the right sample stage, please get in touch. Renishaw Spectroscopy understands the diverse range of sampling requirements for many applications.

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

Further details and specifications

1. Linkam Scientific Instruments
https://www.linkam.co.uk/

2. Almax easyLab
https://www.almax-easylab.com/

3. EL-Cell electrochemical test cell
https://el-cell.com/

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