University of Nottingham
Nanoscale and Microscale Research Centre

Raman spectroscopy

Raman spectroscopy is a powerful vibrational spectroscopy technique that can operate in ambient and non-invasive conditions to achieve chemical identification and 2D/3D mapping.

It measures the inelastic scattering of laser light by a sample, to produce spectra of distinct Raman shifts that enable the assignment of sample chemistry and physical state.

Capabilities

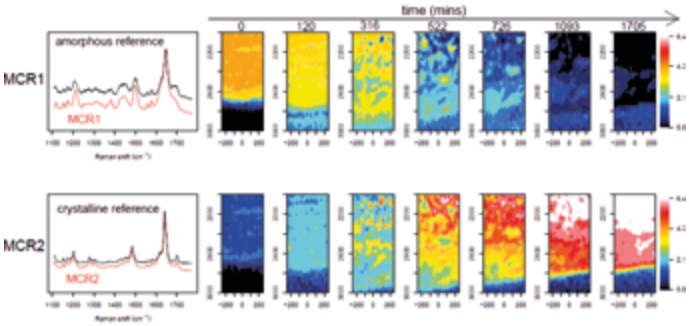
- Ambient chemical and physical state analysis.
- Real-time material transitions.
- Confocal analysis for 3D mapping.
- UV-Visible-IR excitation analysis.
- Temperature and time dependent chemical and physical state change identification.

Typical applications

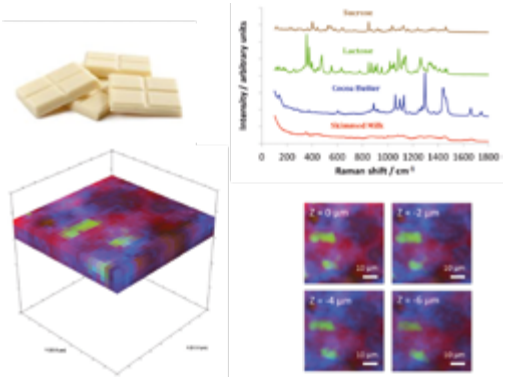
- Polymorph and ingredient analysis.
- Organic and inorganic material forensics.
- Microstructural composition (such as semiconductors, microparticles and others)
- Real time chemical event characterisation, for example swelling and dissolution.
- Mineralogical identification.

Real time 'in-situ' mapping of the re-crystallisation of a poorly soluble drug during dissolution

Raman has the capacity to perform real time, ambient, 'in-situ' analysis and mapping of the genesis or degradation of very subtle chemical signatures. One such example is of the amorphous or crystalline forms of the same drug. This figure details a re-crystallisation process over time by the intensity of the distinct Raman spectra of the two forms. As the amorphous signal decreases with time, the crystalline signal increases concurrently as seen by mapping. The capacity for such delicate distinction in ambient conditions makes Raman a powerful tool for chemical system analytics.



F Tres, K Treacher, J Booth, LP, Hughes, SAC Wren, JW Aylott, JC Burley. *Journal of Controlled Release* 188 (2014), 53-60.



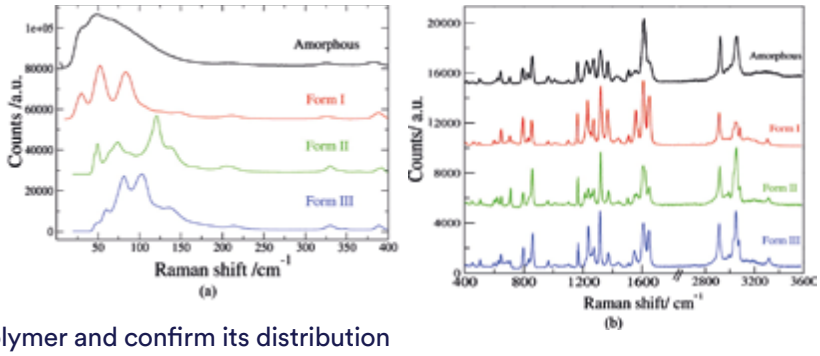
3D phase distribution of chocolate

Confocal Raman spectroscopy enables the characterisation of the local distribution of different sample components in 3D. This can be achieved with a z-resolution approaching the optical diffraction limit. The analysis can be performed at ambient conditions, without special sample preparation or doping of marker molecules. This figure shows the phase distribution of cocoa butter (blue), sucrose (brown) milk powder (red) and lactose (green) at and below the surface of a chocolate product. Such analysis is used to assess the homogeneity of dispersion of small domain-sized components that generate attractive textural properties.

Point spectra used with permission from Dr Qi He and Dr Bettina Wolf, School of Biosciences, University of Nottingham (2016).

Mapping the distribution of components of ionic liquids

Ionic liquids are being explored for a range of applications. They consist of a cationic and anionic component and exist as a liquid at room temperature and under vacuum. Here researchers used confocal Raman microscopy to map the spatial distribution of polymeric ionic liquids in a gel-polymer electrolyte. They map the intensity of ionic liquid functional group vibrational modes as a function of depth in the polymer and confirm its distribution throughout. 2-dimensional mapping also shows its distribution across the surface. The high sensitivity of the technique can be used as a diagnostic tool for testing new polymeric electrolyte membranes and methods of their manufacture, such as with 3D printing.



S Sen, SE Goodwin, PV Barbará, GA Rance, D Wales, JM Cameron, V Sans, M Mamlouk, K Scott, DA Walsh. *ACS Applied Polymer Materials* 3 (2021), 200–208.

Our facilities

Horiba LabRAM HR

- A powerful Raman spectrometer with four excitation wavelengths from UV through to Near Infra-Red (325nm, 532nm, 660nm, 785nm).
- Automated sample stage rastering for spectroscopic imaging.
- Olympus microscope stage with x10, x40, x50 and x100 objective lenses.
- Confocal capability allows z-axis sample slicing to produce 3D images.
- Thermal stage capabilities allow analysis of samples between -196 and 350˚C.
- SWIFT® and DuoScan® modes offer bespoke Raman analysis and/or mapping.
- Choice of gratings for standard or high-resolution spectroscopies.

Horiba XploRA INV Raman Microscope

- Inverted microscope geometry, suitable for 'in-situ' analysis and biological samples.
- Excitation wavelength available: 785nm.
- Gratings available: 600, 1200, 1800 and 2400 lines/mm (depending on configuration.)
- Objectives available: 10x, 20x and 100x.

Find out how Raman spectroscopy could help with your applications, designs or solutions:

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