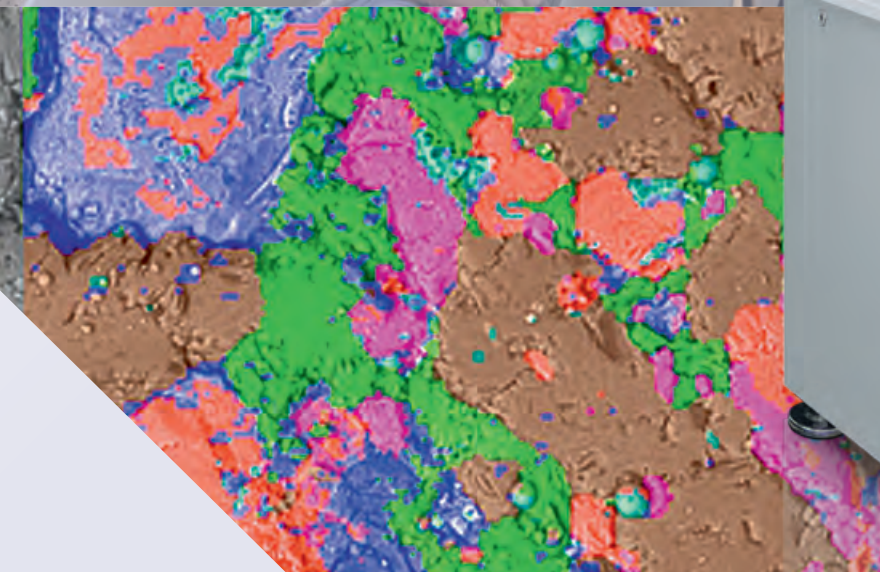


Molecular and Elemental  
Material Characterisation

# Correlative RISE/EDS Microscopy



# Benefits

Raman Imaging and Scanning Electron (RISE<sup>®</sup>) microscopy combined with energy-dispersive X-ray spectroscopy (EDS) offers comprehensive sample characterisation at the nanoscale.

## RISE

## EDS

### Detailed insight

Molecular and bonding information, crystallinity, material stress and strain, crystal orientation

Elemental quantitation and distribution, microstructure and crystal structure

### Wide-ranging analysis

Sub-micron and large-area molecular information, 3D chemical imaging

Point analysis, large area mapping, particle analysis

### Dynamic vision

Analysis of chemical processes possible

Live Chemical Imaging in real time with AZtecLive

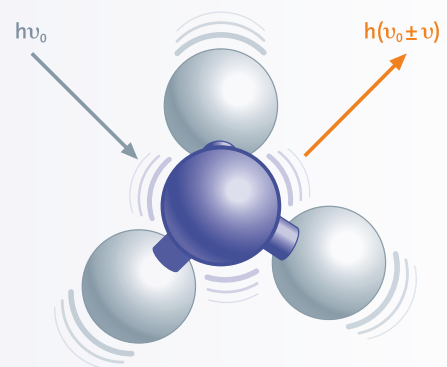
### Multimode operation

Independent Raman operation, Raman-SEM image correlation

Simultaneous SEM and EDS data acquisition

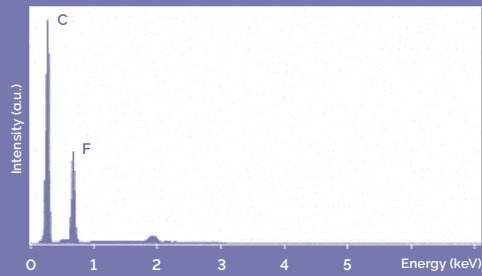
## RISE Microscopy

RISE instruments seamlessly integrate confocal Raman imaging and scanning electron microscopy (SEM). They incorporate the sensitivity and non-destructive nature of Raman spectroscopy with the atomic resolution of electron microscopy. Raman imaging enables the identification of molecules, their allotropes and polymorphs, the determination of their orientation, purity and crystallinity, and the detection of strain states. SEM allows for the imaging of surface structures on the nanometer scale.



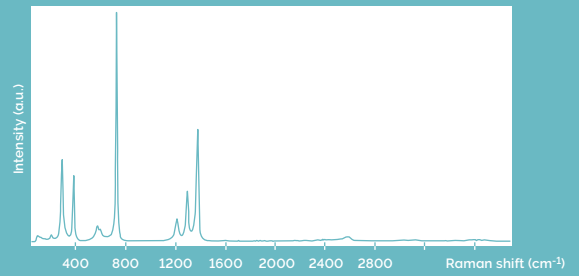
Inelastic scattering of light by a molecule

# Technique



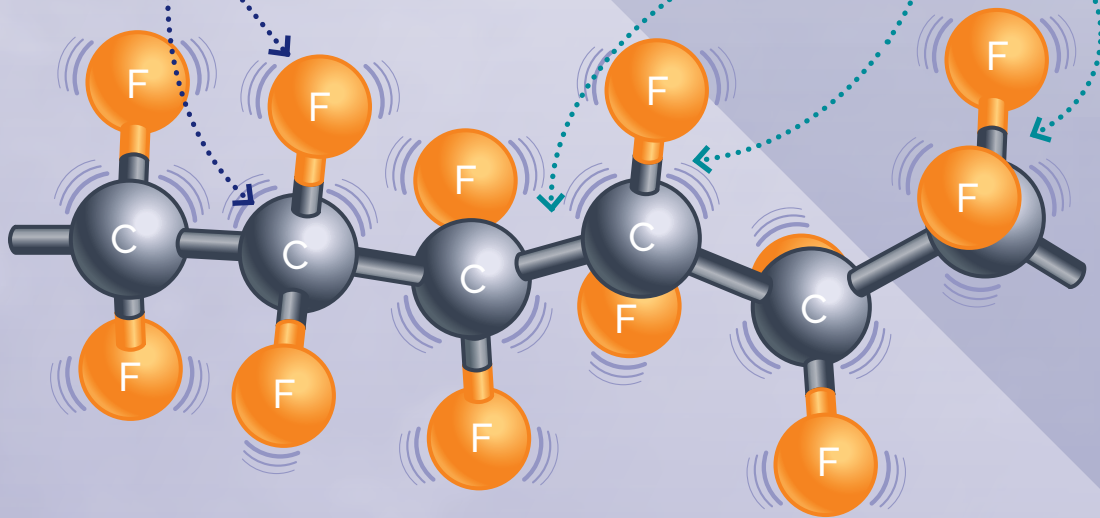
**Target: Atoms** – Determine elemental composition

**EDS**



**Target: Bonds** – Identify molecules and their bonding characteristics

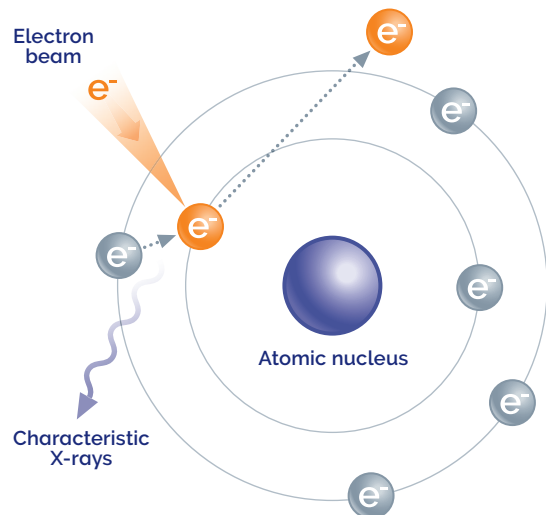
**Raman**



Teflon (Polytetrafluoroethylene, PTFE)

## EDS Analysis

EDS (Energy Dispersive X-ray Spectroscopy) is a technique for elemental and compositional analysis based on the detection and analysis of X-rays produced by electron irradiation of a sample. Ionisation causes an inner-shell electron of constituent atoms to be ejected. This creates a vacancy in the electron orbital. An electron from an outer shell, with a higher energy level, transfers to the inner shell to stabilise it, and an X-ray is emitted during this process. This so-called characteristic X-ray has a specific energy value for each element. From such signals, it is possible to determine microstructure, composition and crystal structure.

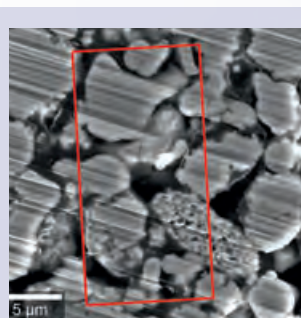


The principle of EDS

# Applications: SEM, Raman & EDS imaging

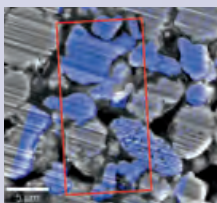


## Battery materials

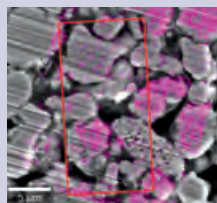


SEM

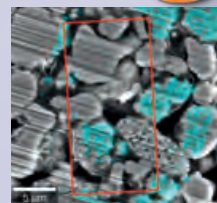
### EDS



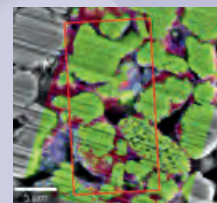
Co



Mn

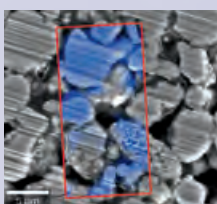


Ni

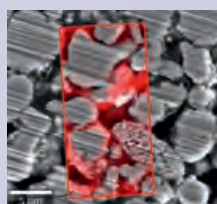


Metals & oxygen (green), carbon (red), fluorine (blue)

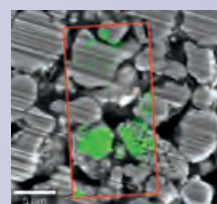
### RISE



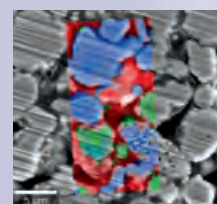
LiCoO<sub>2</sub>



C (amorphous)



LiNi<sub>x</sub>Co<sub>y</sub>Mn<sub>z</sub>O<sub>2</sub>

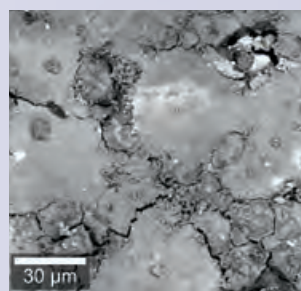


combined

Investigation of battery cathode materials. EDS (top row) reveals the distribution of the individual metallic elements. RISE delivers complementary information on microstructure and the distribution of chemical components along with the carbon matrix.

Sample courtesy: University of Southampton

## Nutritional supplement tablet



SEM

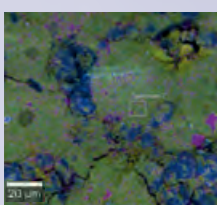
### RISE



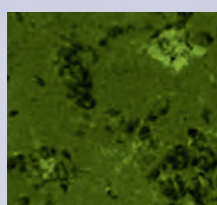
combined

- Maltoheptaose
- 1-O-Hexadecyl-2-Palmitoyl-sn-Glycero-3-Phospho-(n-Palmitoyl)-Ethanolamide sodium salt
- Hydromagnesite
- Calcite

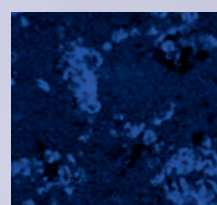
### EDS



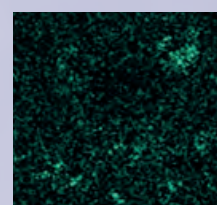
combined



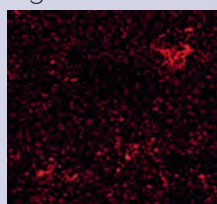
Mg



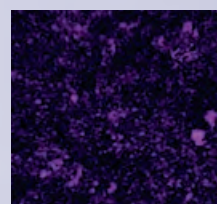
C



K



Ca



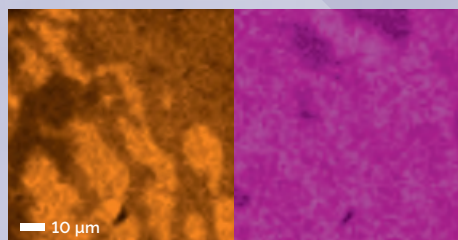
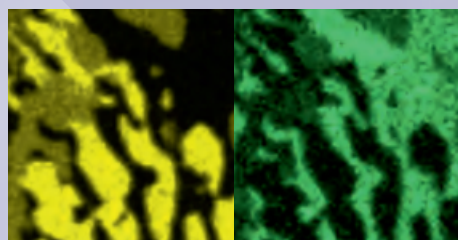
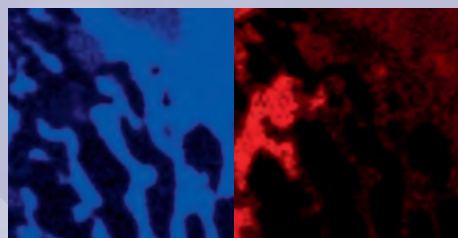
Si

Components of a nutritional supplement tablet. The RISE image visualises the distribution of the ingredients on the surface and the EDS data shows its contained elements.

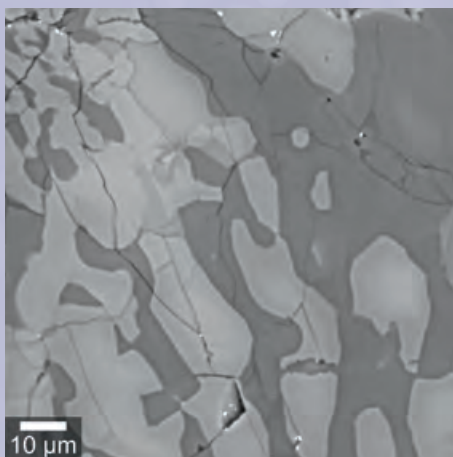


# Geological sample

## EDS



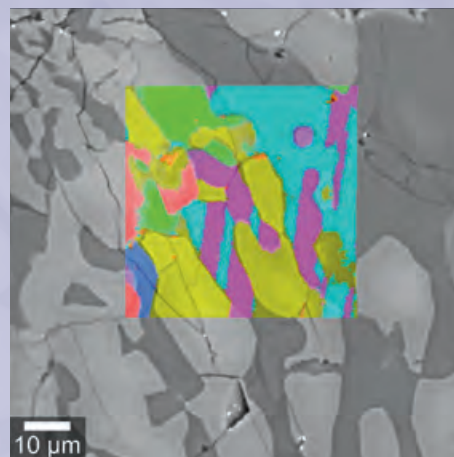
## SEM



Backscattered electron (BSE) image

- Al
- Ca
- Mg
- Na
- O
- Si

## RISE (Raman + SEM)



- Plagioclase in two different crystalline phases  $(Ca,Na)(Al,Si)AlSi_2O_8$
- Diopside  $CaMgSi_2O_6$
- Enstatite  $Mg_2Si_2O_6$
- Pargasite  $NaCa_2(Mg_4Al)(Si_6Al_2)O_{22}(OH)_2$
- Augite  $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$

Analysing a geological sample with EDS and RISE reveals the distribution of the elements and minerals along with the microstructure through SEM.





Oxford Instruments NanoAnalysis detectors used in electron microscopes for materials characterisation.

**Unity:** The world's first Backscattered Electron and X-ray (BEX) Imaging detector

**RISE:** Raman Imaging and Scanning Electron microscopes

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**Explore the possibilities of RISE/EDS**

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