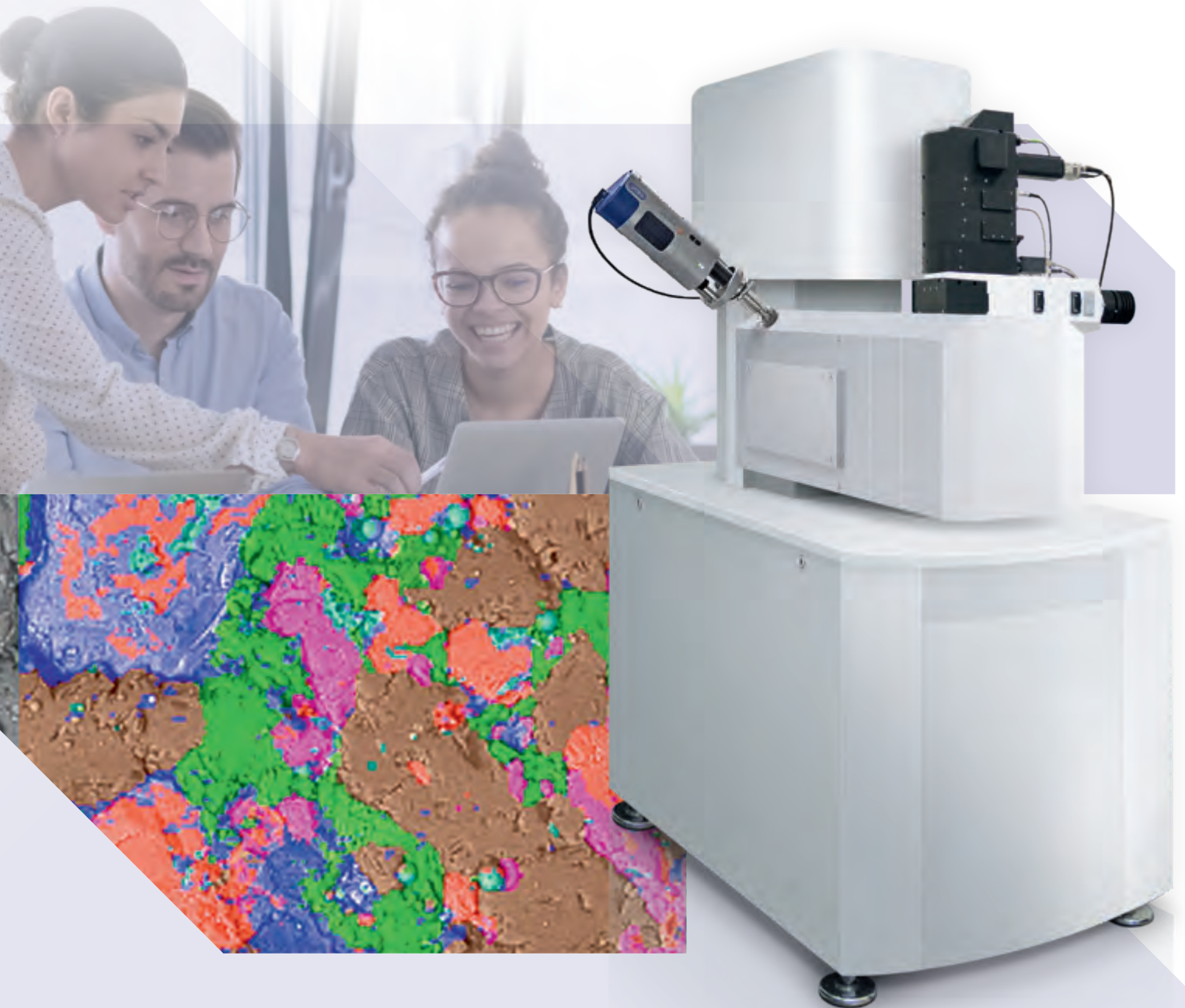


Molecular and Elemental
Material Characterisation

Correlative RISE/EDS Microscopy



Benefits

Raman Imaging and Scanning Electron (RISE[®]) 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

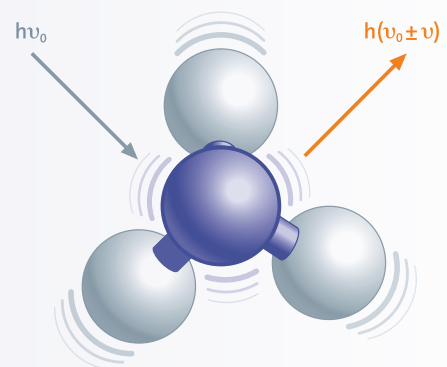
Multimode operation

Independent Raman operation, Raman-SEM image correlation

Simultaneous SEM and EDS data acquisition

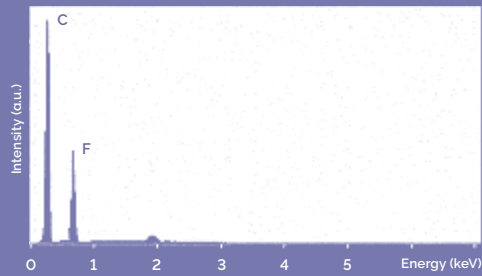
RISE Microscopy

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.



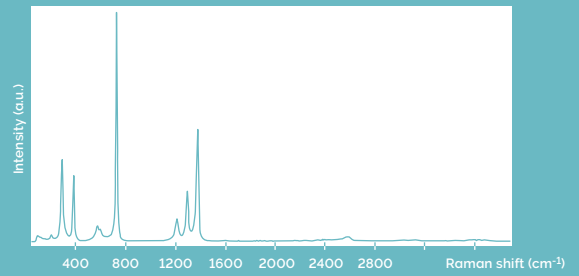
Inelastic scattering of light by a molecule

Technique



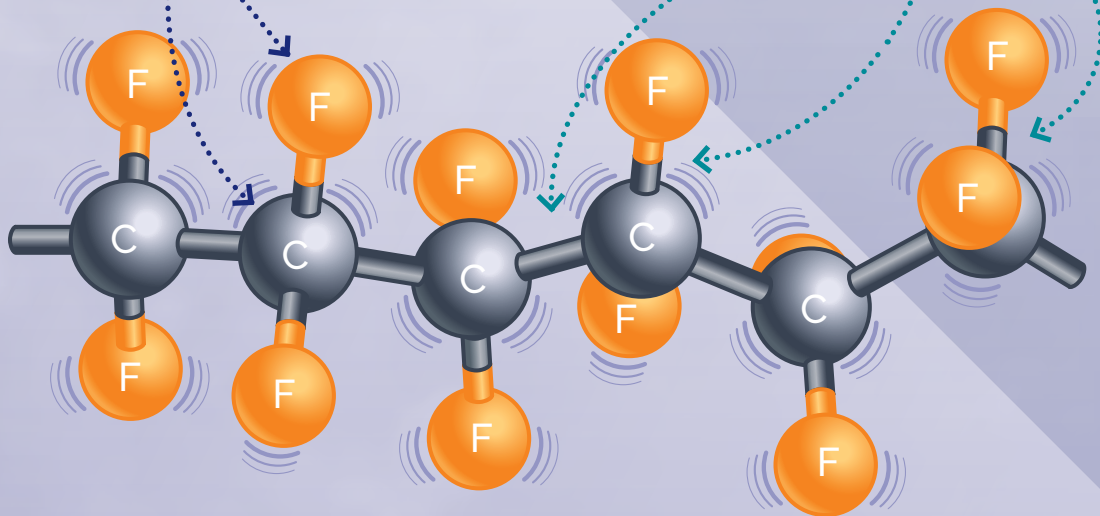
Target: Atoms – Determine elemental composition

EDS



Target: Bonds – Identify molecules and their bonding characteristics

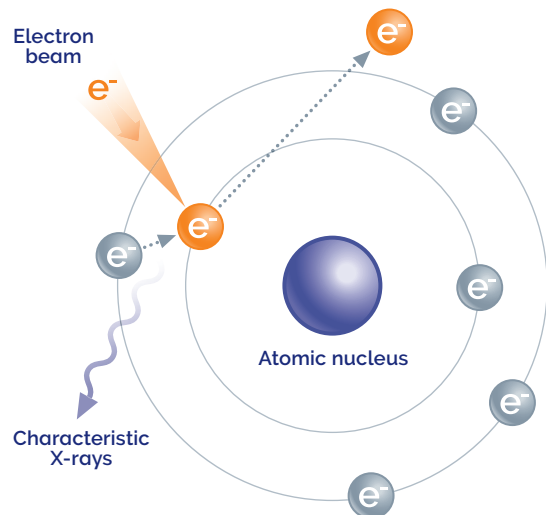
Raman



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.

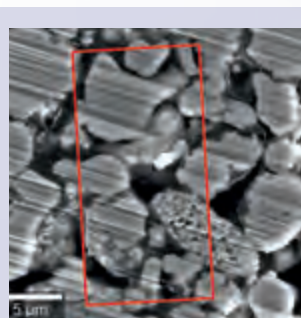


The principle of EDS

Applications: SEM, Raman & EDS imaging

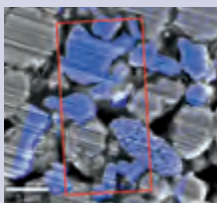


Battery materials

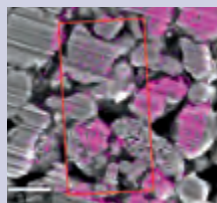


SEM

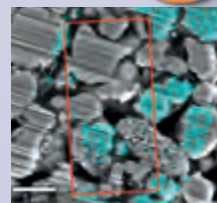
EDS



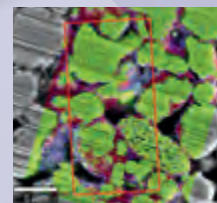
Co



Mn

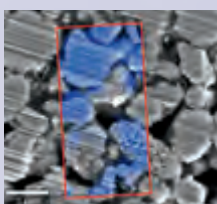


Ni

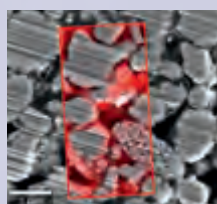


Metals & oxygen (green), carbon (red), fluorine (blue)

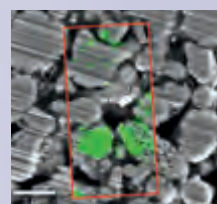
RISE



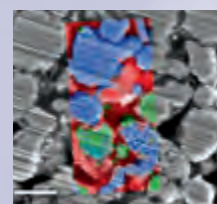
LiCoO₂



C (amorphous)



LiNi_xCo_yMn₂O₂

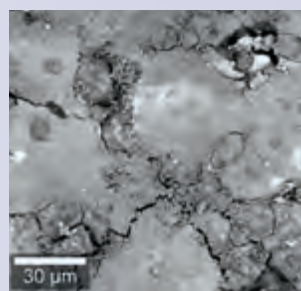


combined

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

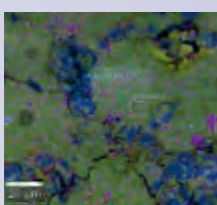
RISE



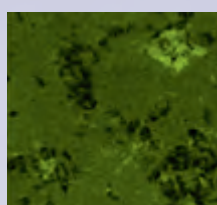
combined

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

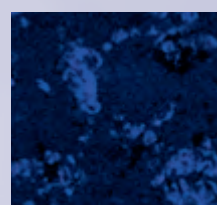
EDS



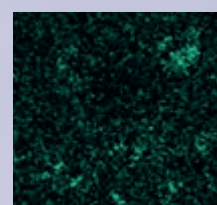
combined



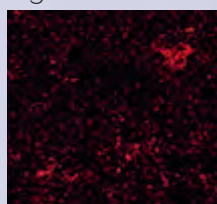
Mg



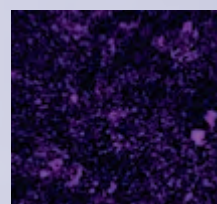
C



K



Ca



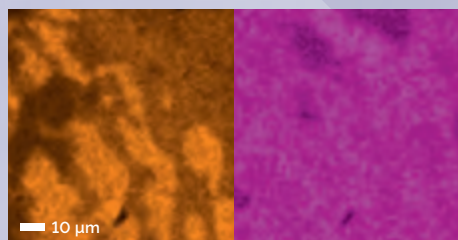
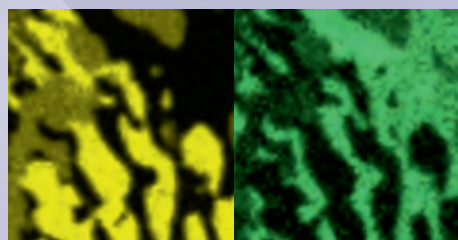
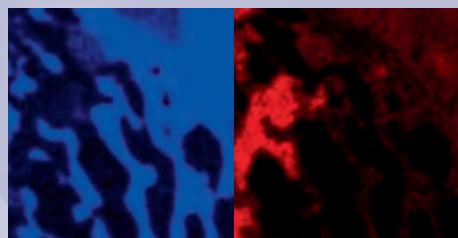
Si

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.

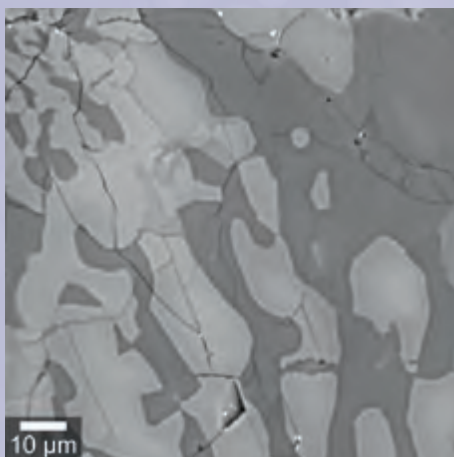


Geological sample

EDS



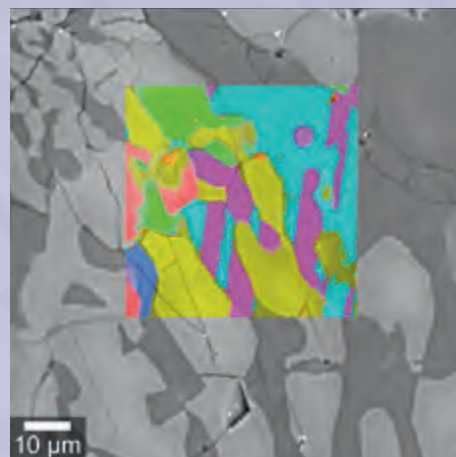
SEM



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 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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