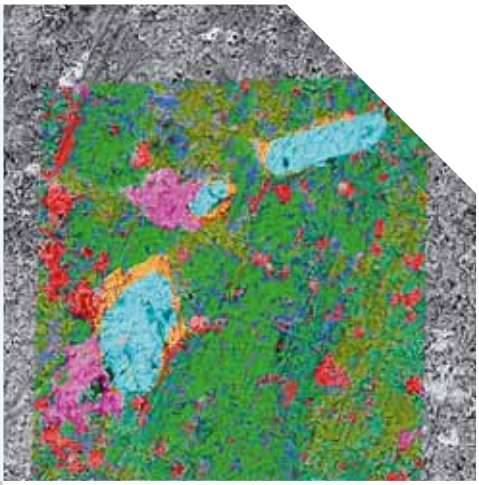
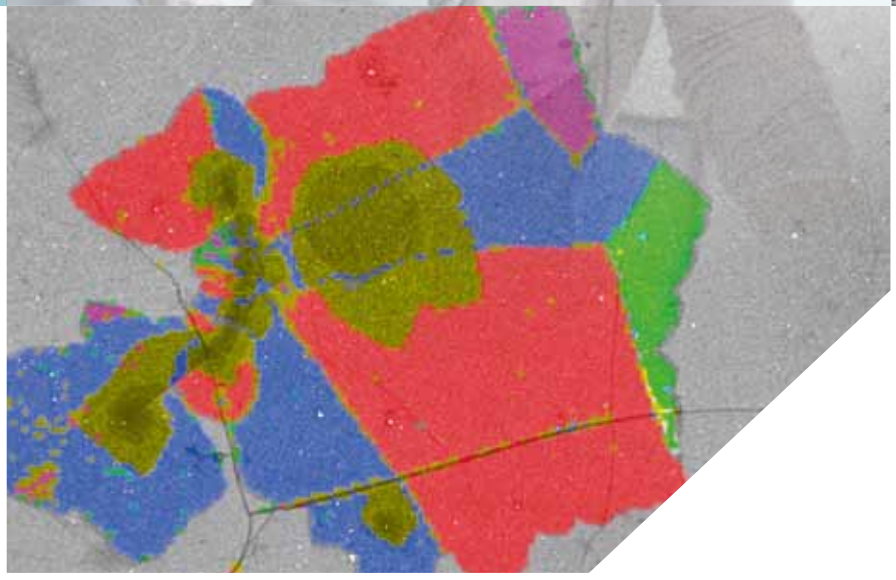
WITec
focus innovations

Raman Imaging and
Scanning Electron Microscopy

RISE Microscopy

Correlative Molecular and Ultrastructural Imaging





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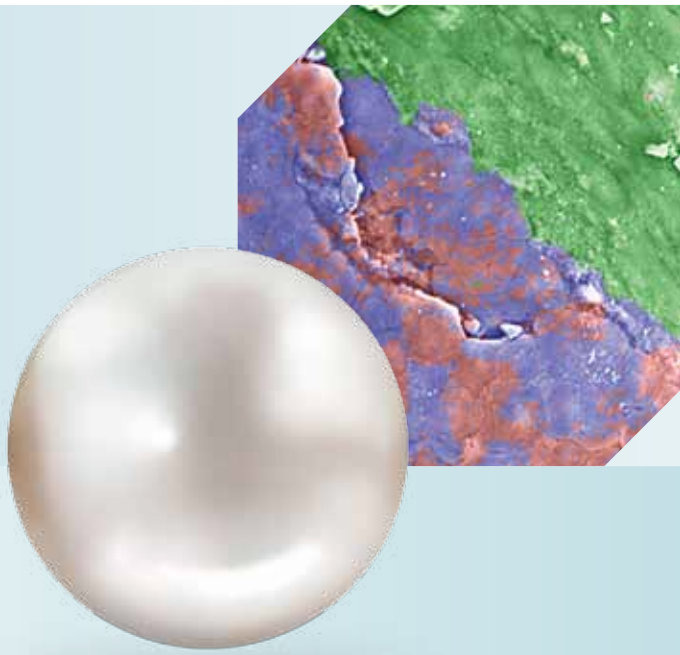
RISE Microscopy

Molecular and Ultrastructural Imaging



Correlative Raman imaging and scanning electron microscopy for comprehensive sample analysis.

A new dimension in imaging: see both the form and substance of your samples at the highest resolution.

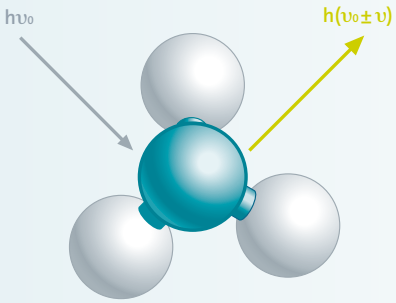
RISE microscopy measurement of a pearl's surface: Raman imaging attributes aragonite (blue, red) and vaterite (green), two polymorphs of calcium carbonate, to the structural features revealed by SEM.

RISE microscopy will benefit ...

... researchers looking for a deeper understanding of their samples through quick and straightforward measurements controlled with an intuitive user interface.

RISE microscopy is well suited to ...

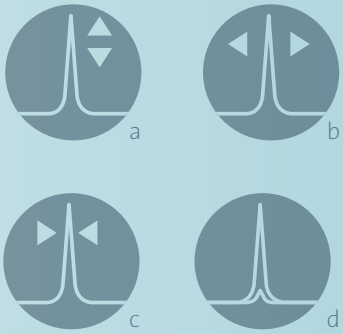
... investigations in materials science, nanotechnology, forensics, geosciences, life sciences, pharmaceutical research and many other fields of application.



Inelastic scattering of light by a molecule

The Raman Principle

- A Raman spectrum describes the energy shift of the excitation light (laser) as a result of inelastic scattering by the molecular bonds in a sample.
- Each molecule and chemical compound produces a particular Raman spectrum when excited and can be easily identified by this unique 'fingerprint'.
- Raman spectroscopy is a well-established and nondestructive method for analyzing the molecular composition of a sample.



Additional sample information from Raman spectra:

a. Peak intensity: Quantity of a specific compound
b. Peak shift: Identification of stress and strain states
c. Peak width: Degree of crystallinity
d. Polarization state: Crystal symmetry and orientation

Confocal Raman Imaging

WITec confocal Raman imaging systems combine Raman spectroscopy with confocal microscopy to offer:

- Complete Raman spectral acquisition at every image pixel with diffraction-limited resolution (~200 nm).
- Unprecedented performance in speed, sensitivity and resolution.
- Outstanding depth resolution ideally suited to 3D image generation and depth profiles.
- Ultrahigh-throughput spectroscopic capability for the highest sensitivity.
- Nondestructive imaging. No staining or other specialized sample preparation is required.

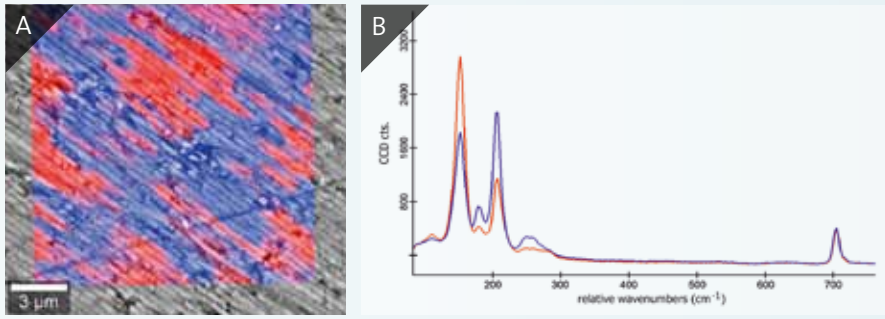
RISE Microscopy

RISE systems combine all features of a stand-alone SEM and a WITec research-grade confocal Raman imaging microscope within one instrument to provide:

- Quick and convenient switching between Raman and SEM modes.
- Automated sample transfer from one measuring position to the other within the vacuum chamber.
- An integrated software interface for user-friendly measurement control.
- Easy correlation of the experimental results and image overlay.
- SEM and Raman imaging capabilities without compromise.
- A truly confocal optical path.
- Research-grade optical imaging.

The sample remains inside the vacuum chamber during both the SEM and Raman measurements to ensure a streamlined workflow.

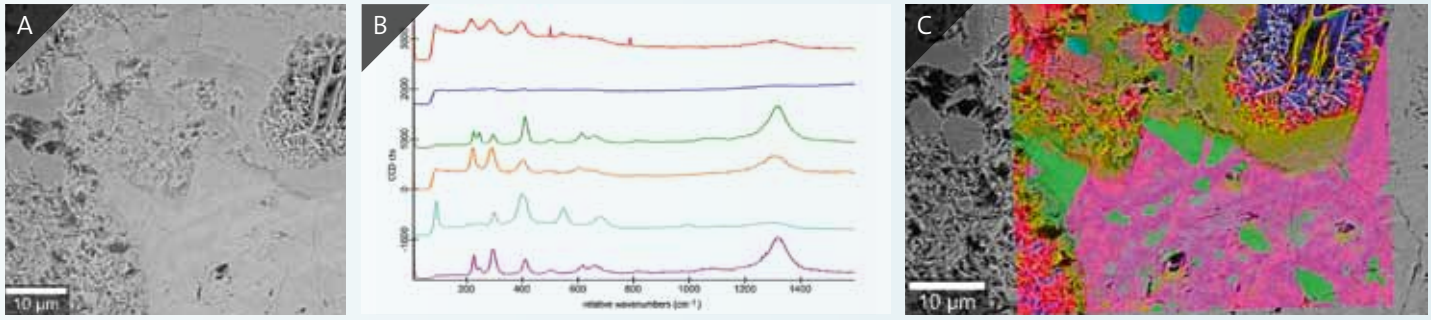
Applications



Abalone shell

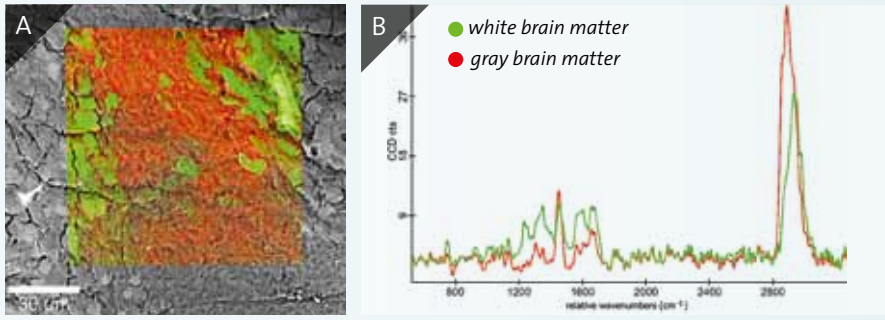
(A) RISE image of a polished cross-section reveals the layered structure of the nacre (mother-of-pearl). It consists of aragonite, a crystal form of calcium carbonate.

(B) Raman spectra can enable the differentiation of crystal orientations (blue, red), revealing the anisotropy of the aragonite phase.



Iron mineralogy

(A) In the SEM image a piece of hematite (Fe_2O_3) shows some structural characteristics. **(B)** Hematite and goethite (FeO(OH)) in several crystal orientations were identified from their Raman spectra. Crystal forms of hematite are depicted in red, blue, green, orange and pink, those of goethite in light blue and cyan. From the spectra, a Raman image was generated. **(C)** Correlation of Raman and SEM data resulted in the RISE image.



Brain tissue

(A) RISE image of a hamster brain tissue sample. In the color-coded Raman image the white brain matter is shown in green and the gray matter in red. **(B)** The corresponding Raman spectra reveal the different spectral characteristics of the white and gray brain matter.
Raman image parameters: 90,000 spectra, 50 ms integration time per spectrum.

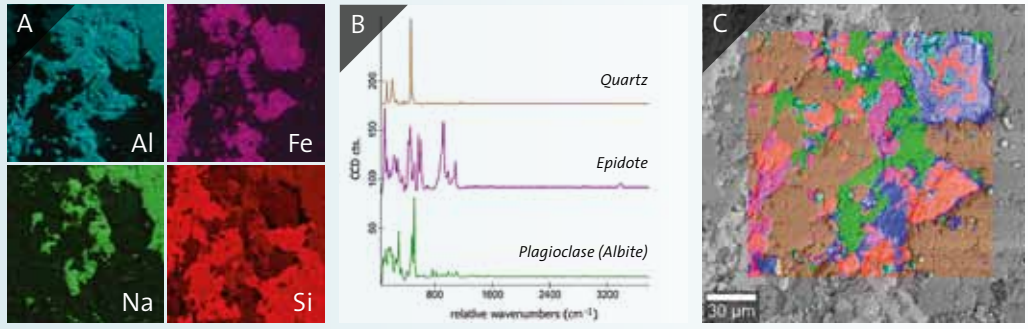
LT GaAs sample

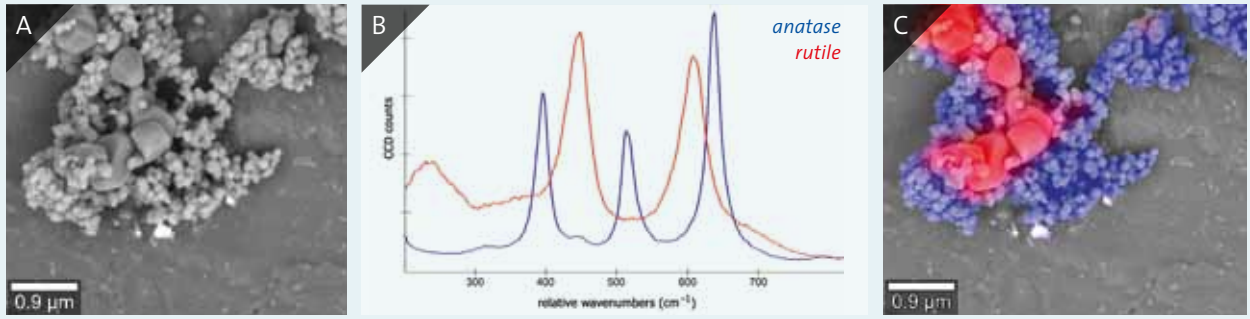
The color-coded Raman image, showing the gold substrate (yellow) that can be clearly distinguished from GaAs (red), is correlated with the ultrastructure of the sample.
Raman image parameters: 90,000 spectra, 34 ms integration time per spectrum.

Comparison between RISE microscopy and energy-dispersive X-ray spectroscopy (EDX)

Geological sample

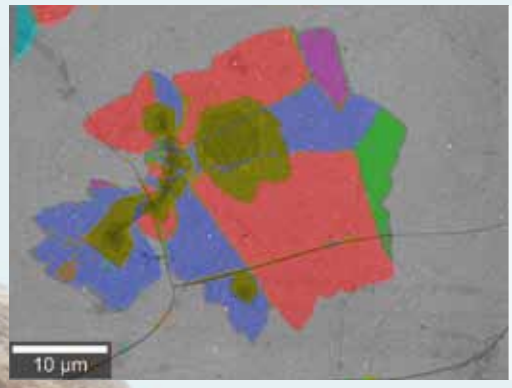
(A) Distribution of elements, measured in EDX mode of the SEM.
(B) Raman spectra of the same sample area: Quartz (brown), epidote (pink), plagioclase (green).
(C) RISE image showing the distribution of the molecular compounds in the sample.
Raman imaging parameters: 22,500 spectra, 80 ms integration time per spectrum





Titanium dioxide

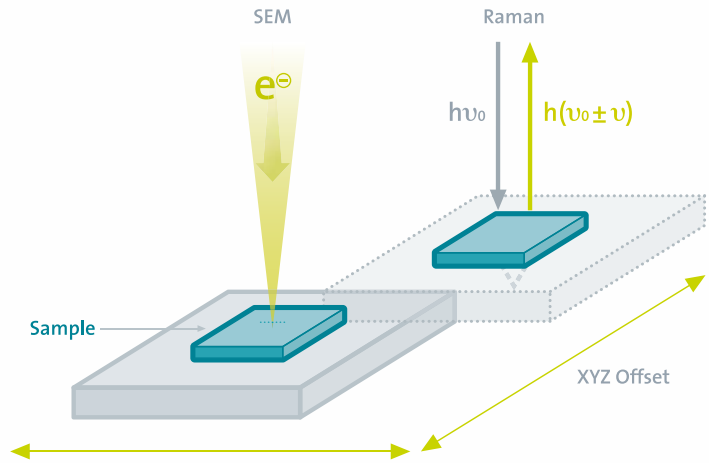
(A) Two modifications of titanium dioxide, anatase and rutile, were mixed and imaged with an SEM. **(B)** In the Raman spectrum anatase (blue) can be easily distinguished from rutile (red). **(C)** RISE image derived from Raman spectra and SEM data. Raman imaging parameters: 22,500 spectra, 37 ms integration time per spectrum.



Twisted bilayer graphene

CVD-grown, bilayer graphene (here on Si/SiO_2) is often twisted and folded. These structural properties cannot be differentiated by SEM or EDX. However, variation in peak intensities of graphene's Raman bands and changes in the FWHM (full width of half maximum) of the bands allow for the determination of the stacking order and the twist angles of the layers. These features can be correlated with the structural features by RISE microscopy.

Raman imaging parameters: 22,500 spectra, 50 ms integration time per spectrum.



Principle of RISE Microscopy

Samples are automatically transferred from one measuring position to the other within the vacuum chamber of the combined Raman-SEM instrument, streamlining the workflow and drastically improving ease of use.

WITec Microscopes

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Raman-AFM

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