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Reasons to adopt Raman spectroscopy to complement electron microscopy

Using scanning electron microscopy (SEM) to view 2D and 3D structures at the micron to angstrom scale can help you understand material properties that you observe at a macroscale. Imagine taking that insight one step further using Raman microscopy to add chemical details that can help you…

- Identify and quantify unknown materials (contaminants, byproducts, oxidation)
- Understand molecular structure (crystallinity, polymorphism) and phase changes
- Study spatial relationships between sample components (failure/defect analysis, depth profiling)

Collect Raman chemical images to complement your electron microscopy and expand your sample knowledge to accelerate your product launch, root-cause investigation, thesis, patent or publication.

Use Raman spectroscopy in your lab to…

1 **Enhance SEM data with Raman microscopy**

Samples can be analyzed with Raman microscopy to reveal molecular details from 2D and 3D structures. Using proprietary Thermo Scientific™ MAPS Correlative Microscopy Software, overlay a chemical image of your SEM structures down to <1 micron using single-point measurements or rapid imaging of large areas.

2 **Characterize chemistry, including morphology and polymorphism**

The chemical backbone, polymorph structure, and degree of crystallinity can all be distinguished using Raman spectroscopy. Additionally, Raman polarization measurements can reveal crystal orientation, making Raman spectral analysis perfect for understanding a material's structure-function relationship.

3 **Elucidate organic materials**

The Raman spectrum can quickly reveal uniformity, purity, functionalization, thickness, and other properties of the symmetric bonding in 2D carbon materials such as graphene and carbon nanotubes. Raman data can also be used to speciate carbon-nitrogen-oxygen bonding to differentiate molecular structures providing complementary information to SEM and EDS data.

4 **Save time and preserve your sample**

Samples can be measured in their native form, eliminating the need for sample preparation. Raman microscopy is confocal, so depth profiles of multilayer or embedded samples can be acquired without damaging the sample.

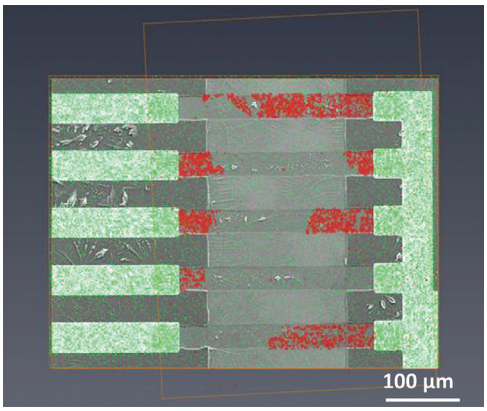


Easily characterize and compare unknown features using the Thermo Scientific™ DXR2xi Raman Imaging Microscope.

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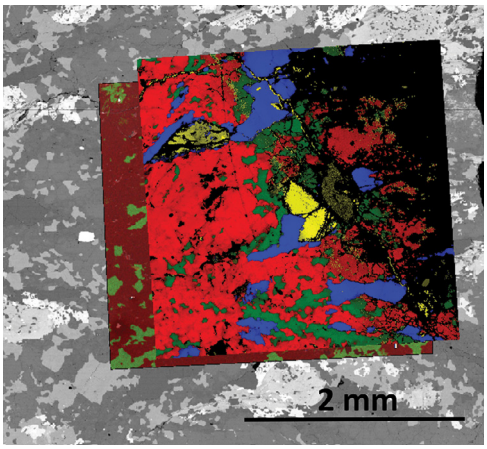
Stitch, Correlate and Analyze Raman and SEM Images

Overlay electron micrographs with Raman molecular information using our MAPS correlative microscopy software. Reveal rich information that can help you explain defects, develop new theories or verify new materials. Below are examples of Raman-SEM correlative microscopy using the Thermo Scientific™ DXR2xi Raman Imaging Microscope.



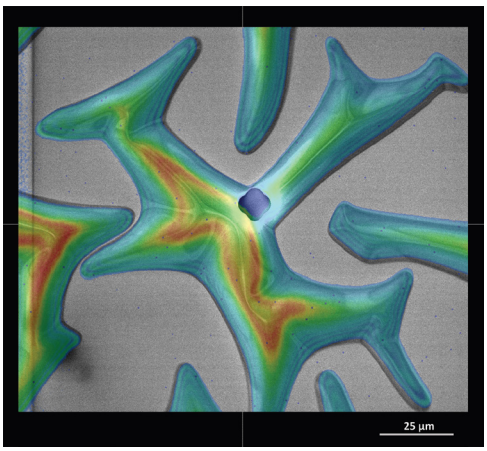
Graphene electrode

Difficulties in transferring 2D graphene electrodes from a copper substrate to the final semiconductor surface can be seen with this Raman image overlaid on the electron micrograph. A good quality image would show the graphene (red) as solid lines between the gold (green) contacts. The data show that the graphene is not continuous, indicating a need to improve the sample handling procedure. Raman spectroscopy can also quantify the number of layers of graphene transferred as well as differentiate between various carbon materials such as graphene and graphite.



Analysis of geological materials

Information on spatial relationships, mineral content, polymorphism, and chemical details can be generated by correlating SEM-EDS images with Raman microscopy images. The EDS shows the presence of titanium, aluminum, and silicon. The Raman image provides further information and shows the location of quartz (blue), orthoclase (green), amphibole (yellow), and abite (red). Raman has identified the silica polymorph present in this sample to be quartz. It also has identified the K-feldspar polymorph to be orthoclase.



Semiconductor stress

Strain in semiconductors has been shown to push the limits of electronic device performance and thermal properties. This Raman-SEM correlated image shows a mismatch of lattice constants between the SiGe and the top silicon epi-layer, causing stress on the semiconductor chip. The transition from red to blue color represents a shift in the Raman spectra, indicating more stress in the silicon.

Learn more about Raman-SEM correlative microscopy at
thermofisher.com/ramansem

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