Thermo Scientific als Kooperationspartner zur Analytischen Tribologie

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Netzwerktreffen Analytische Tribologie

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Thermo Scientific Analytik im Tribologie Netzwerk

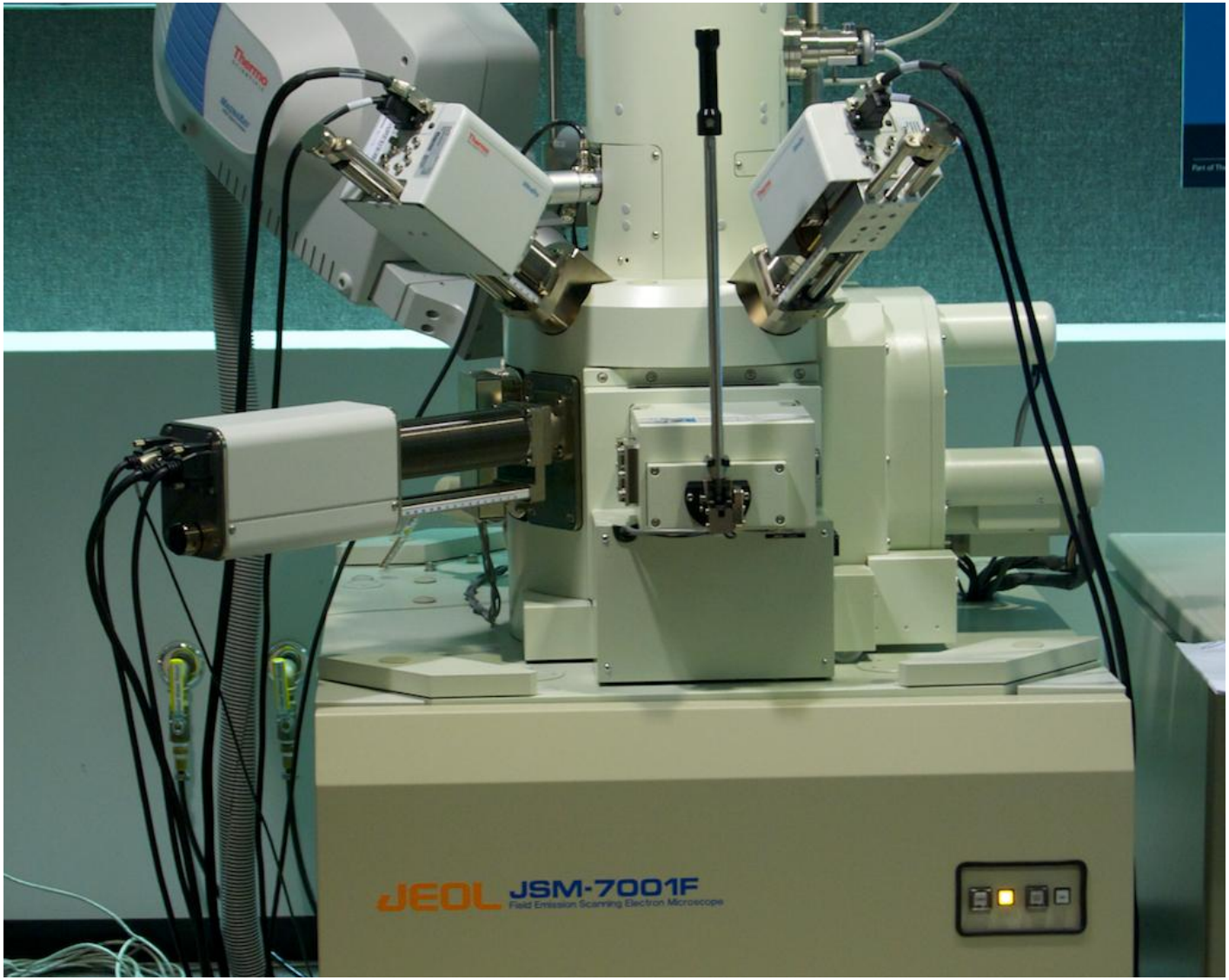
Thermo Fisher Scientific ist nicht nur ein Life Science Konzern, sondern auch ein Partner im Bereich Materialwissenschaften mit:

- Mikroanalytik mit EDS/WDS/EBSD
- Oberflächenanalytik mittels XPS
- Molekülspektroskopie mittels Raman Imaging System
- Rheometer
- Prozesstechnologie

…und viele Kombinationen wie

- Rheometer mit IR Kopplung
- XPS mit EDS und Raman Einheit
- Strahlungsmessung, Gas Analysatoren, Handheld

All Analytical Techniques with double EDS System



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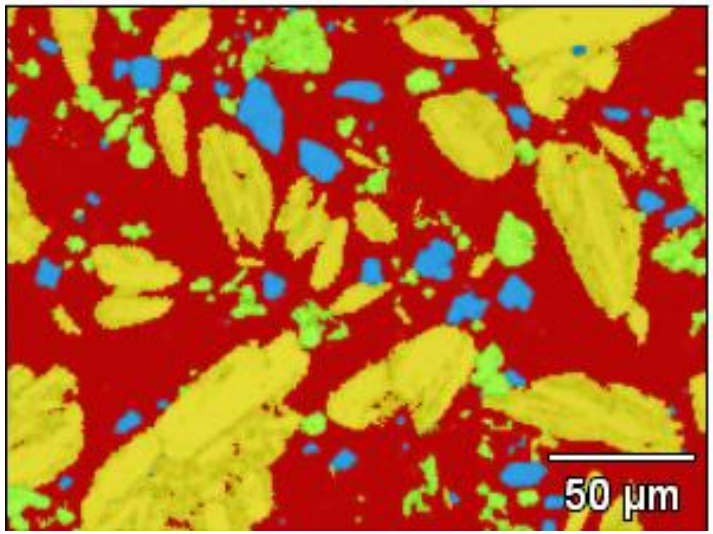
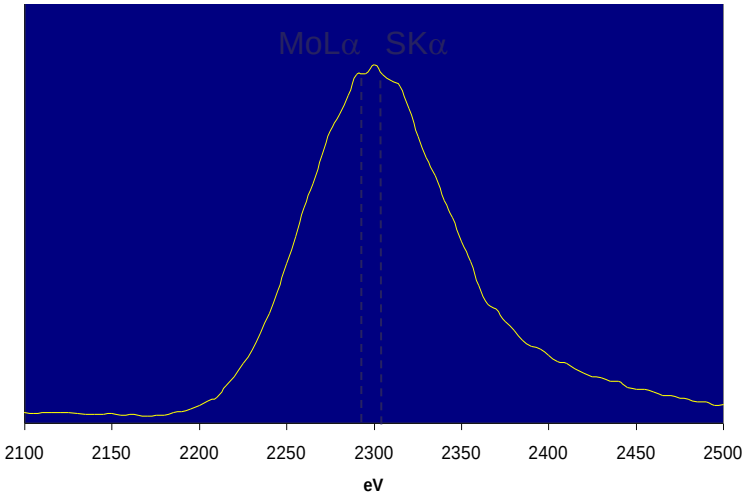
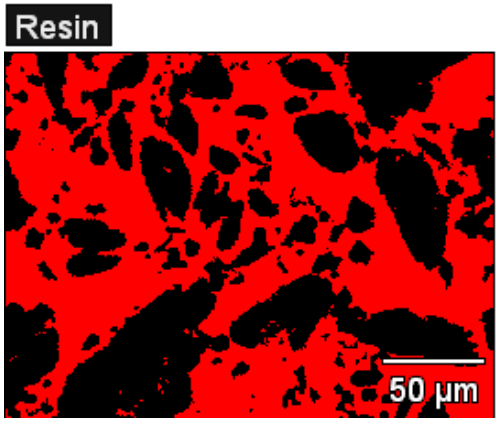
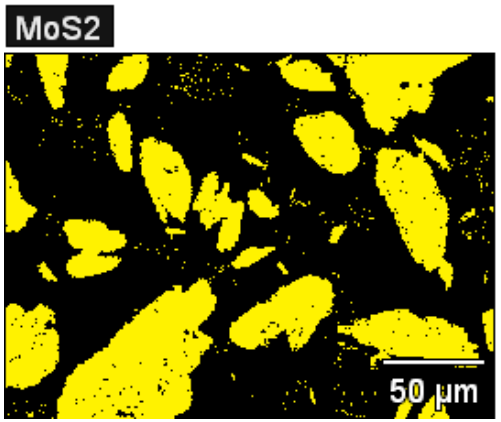
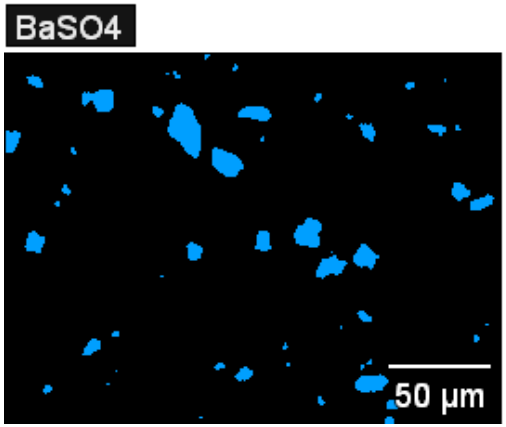
Example – Mo, S, Ba – COMPASS, Xphase, DTP

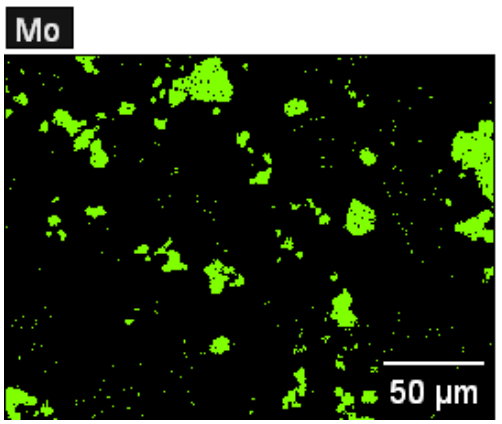








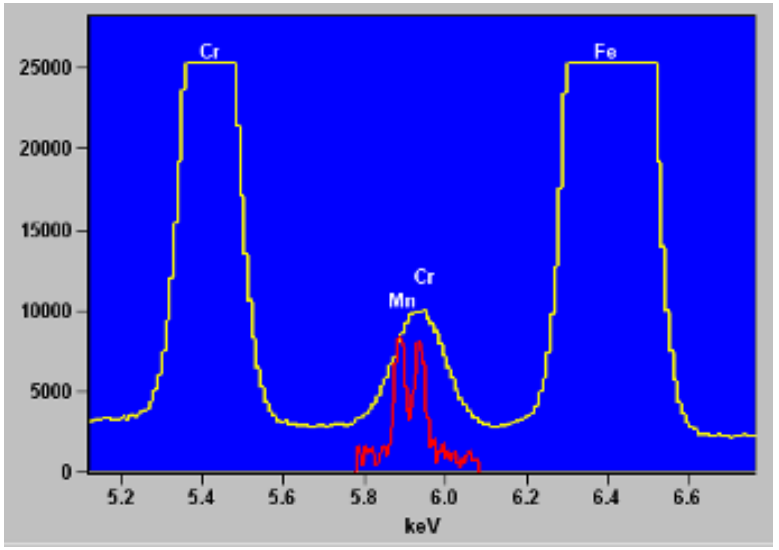




- Distinguishing the three main phases is not possible without robust peak deconvolution

WDS spectrometer „MagnaRay“ integrated in NORAN System 7

(*Wavelength Dispersive X-ray Spectroscopy)*



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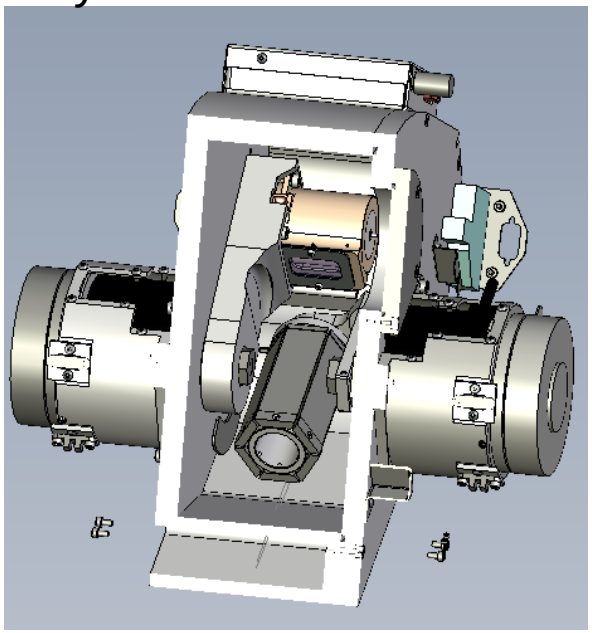
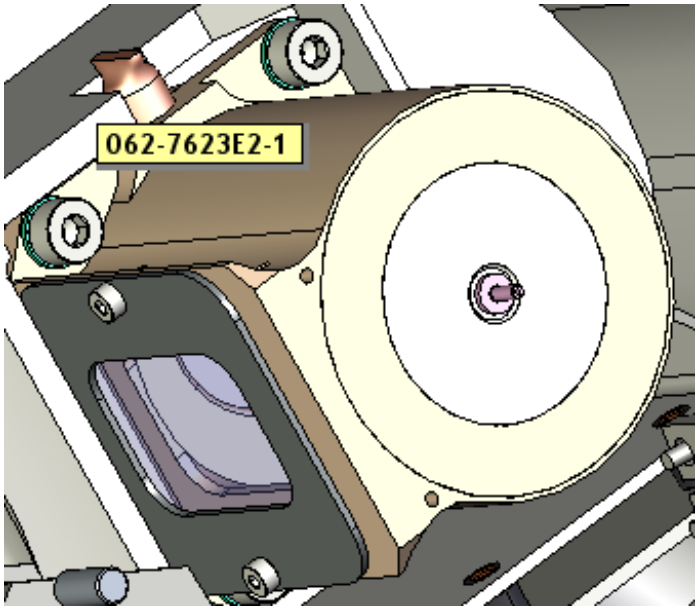
New developments for MagnaRay

very small volume



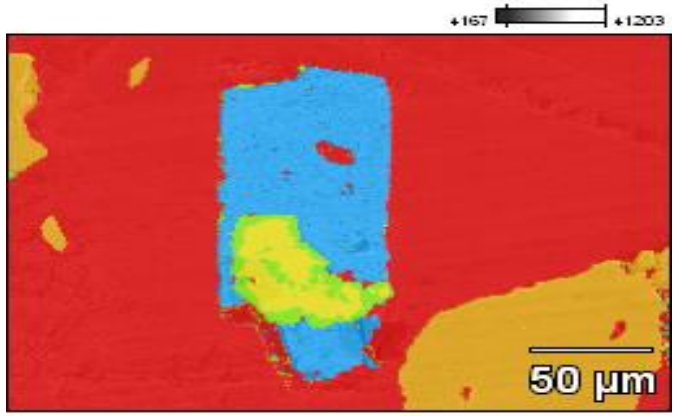


sealed Xenon counter –
no P10 gas needed

Combined X-ray lens to convert
divergent X-rays into parallel beam
- provides very good efficiency

Full-Standards Quantification – Geological

Complex multi-element geological sample



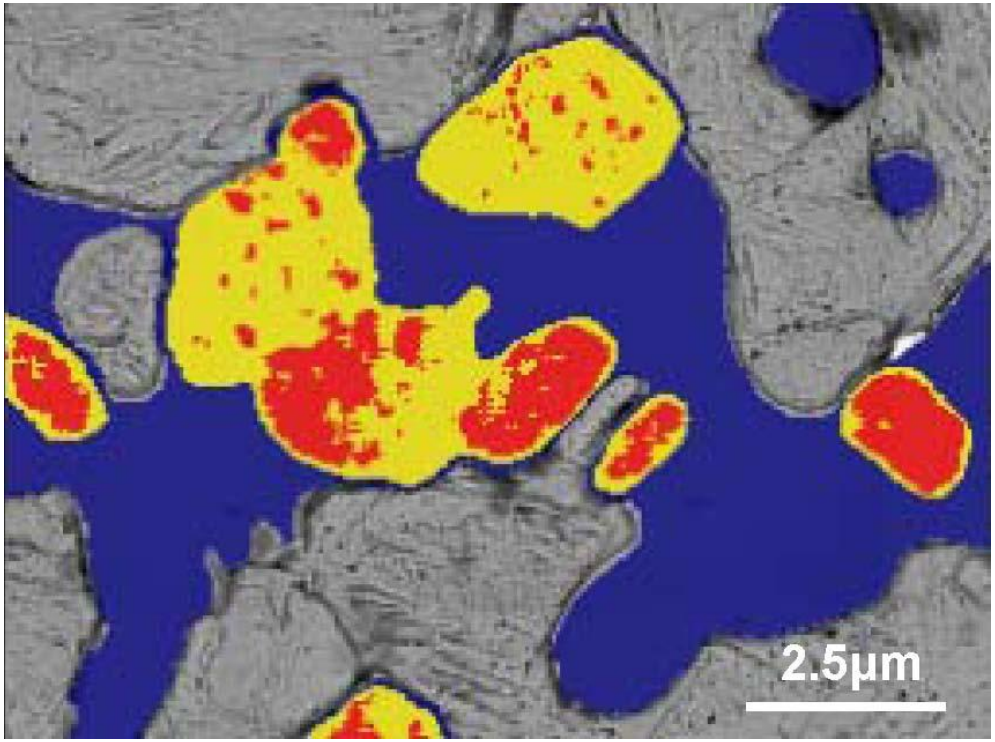
- Phlogopite
- Diopside
- Barite
- Pyrite
- Hematite

Wt%	Diopside	Diopside	Diopside	Diopside	Pyrite	Pyrite	Barite	Barite	Hematite
O	45.89	45.39	45.72	45.35	0.00	0.00	27.46	27.52	32.39
Mg	9.02	9.17	9.12	8.93	0.00	0.00	0.00	0.00	0.01
Al	3.46	3.68	3.33	3.73	0.00	0.00	0.00	0.00	0.01
Si	22.91	22.81	22.12	22.64	0.00	0.00	0.00	0.00	0
S	0.00	0.02	0.01	0.00	53.19	52.57	13.67	13.11	0.1
K	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Ca	18.25	18.31	17.78	18.37	0.00	0.00	0.00	0.00	0
Fe	0.93	1.01	0.88	1.36	48.91	49.28	0.00	0.00	66.58
Ba	0.15	0.11	0.14	0.22	0.00	0.00	58.75	58.23	0.01
Total	**100.61**	**100.50**	**99.10**	**100.60**	**102.10**	**101.85**	**99.88**	**98.86**	**99.11**

Microprobe Accuracy!

MagnaRay – Low Energy Sensitivity

WDS is used mostly at low energies where most peak overlaps occur



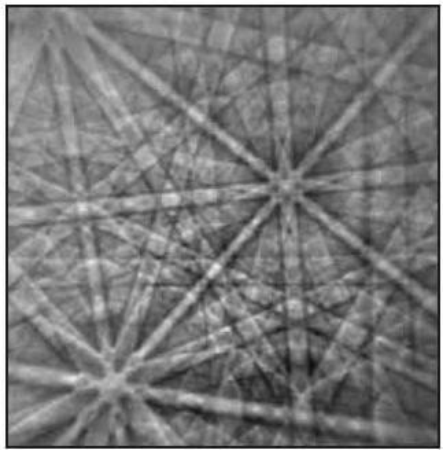
WDS mapping of **Boron** in a Fe-Cr-B alloy at 5kV and 3nA.

- Blue phase 0.5wt% B
- Yellow phase 0.9wt% B
- Red phase 1.4wt% B

- Low concentrations of light element in a heavy matrix

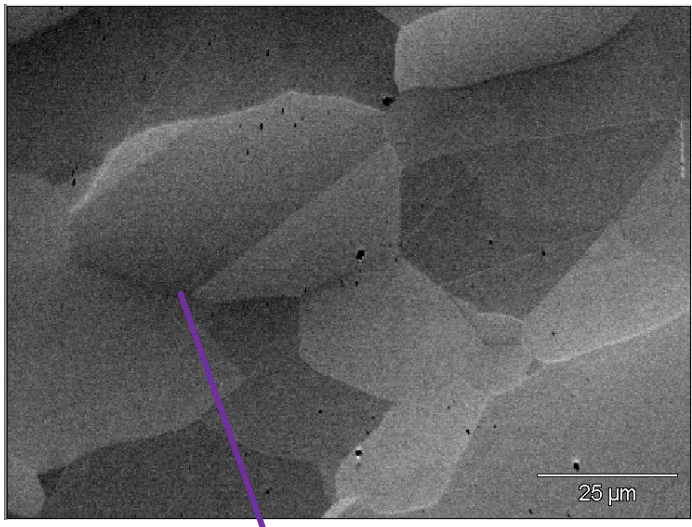
Low energy quantitative analysis

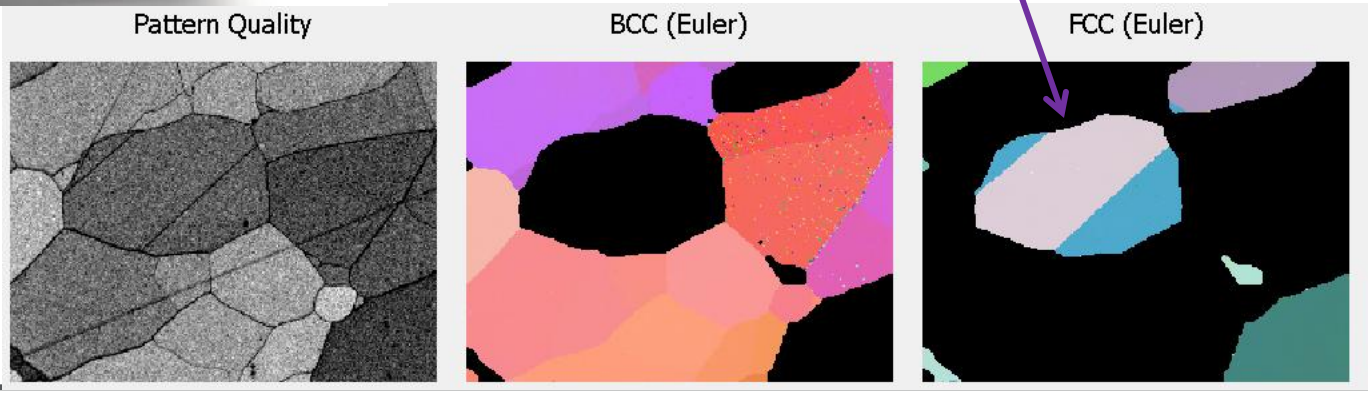
EBSD camera QuasOr in NORAN System 7
(*Electron Backscatter Diffraction*)



Kikuchi Pattern

QuasOr EBSD camera





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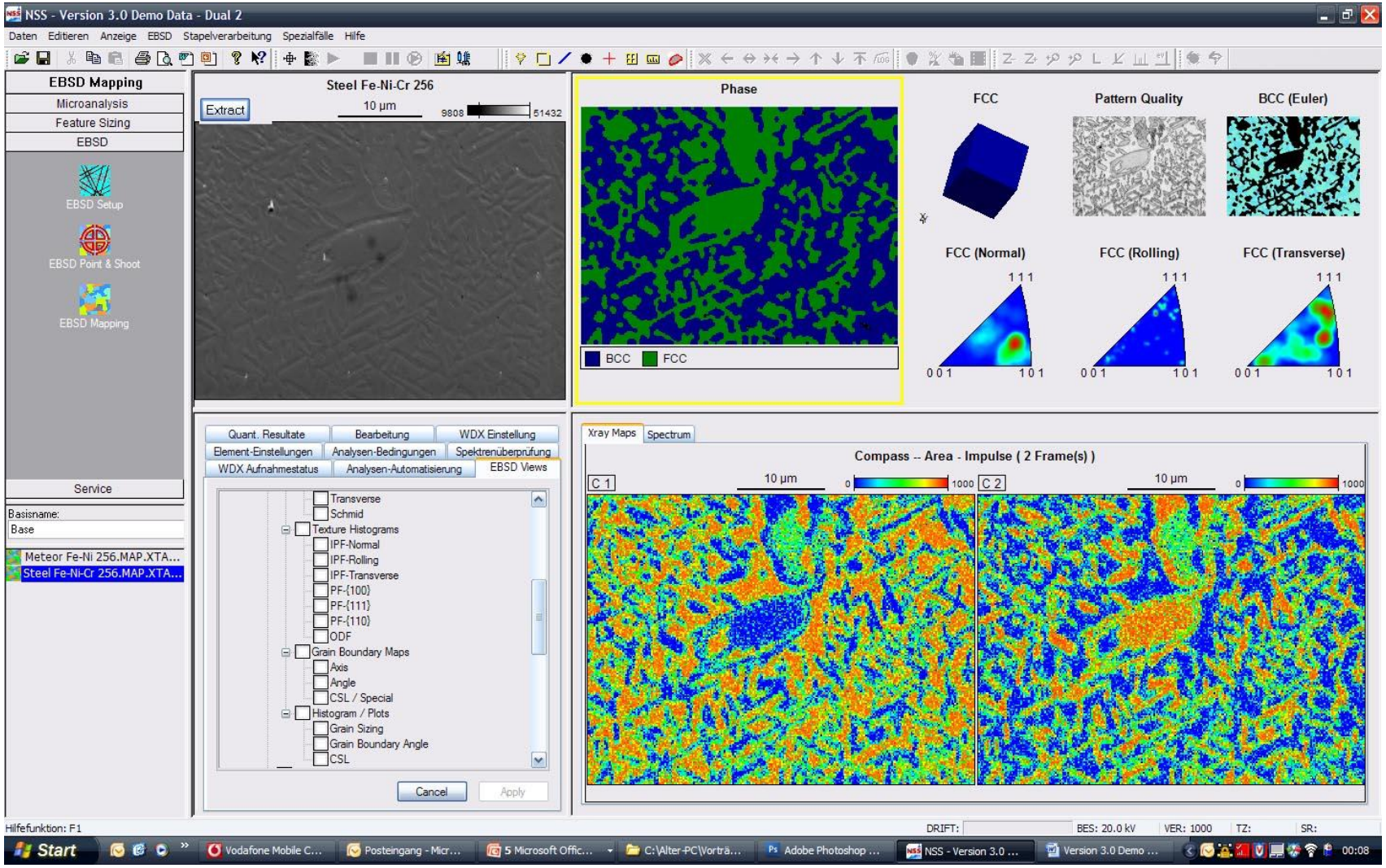
Steel sample



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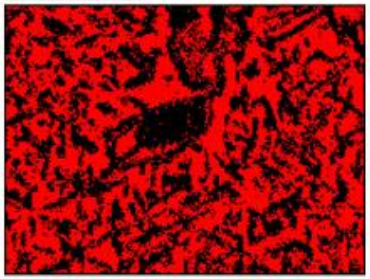
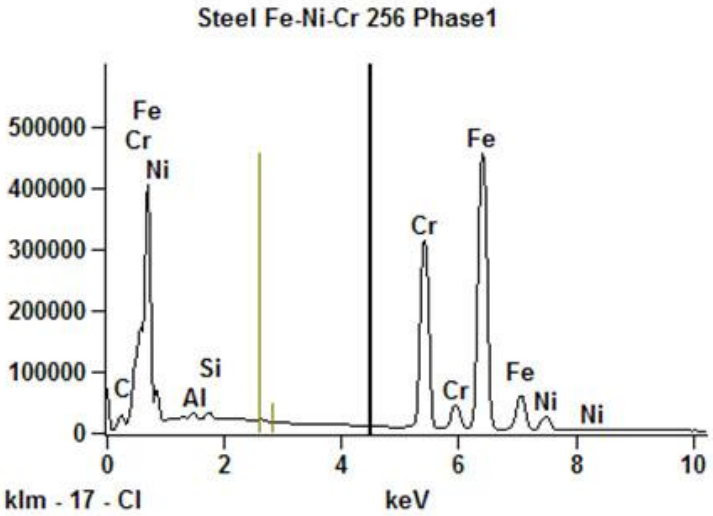
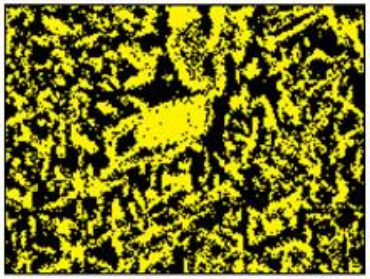
Steel sample – two phases

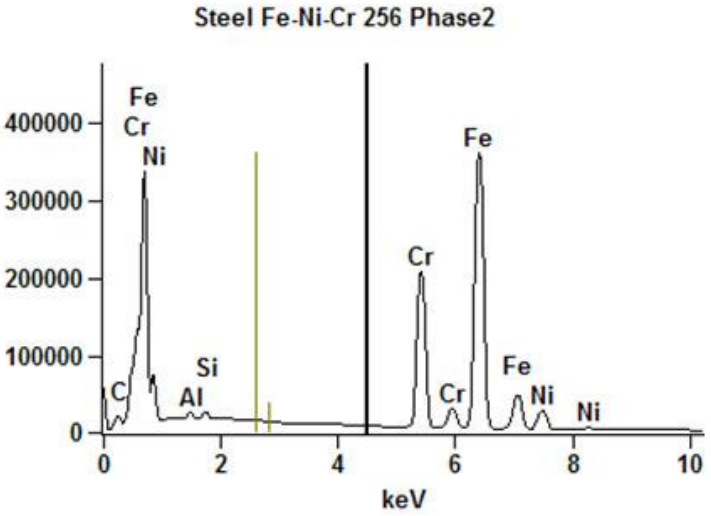
Phase1





Phase2





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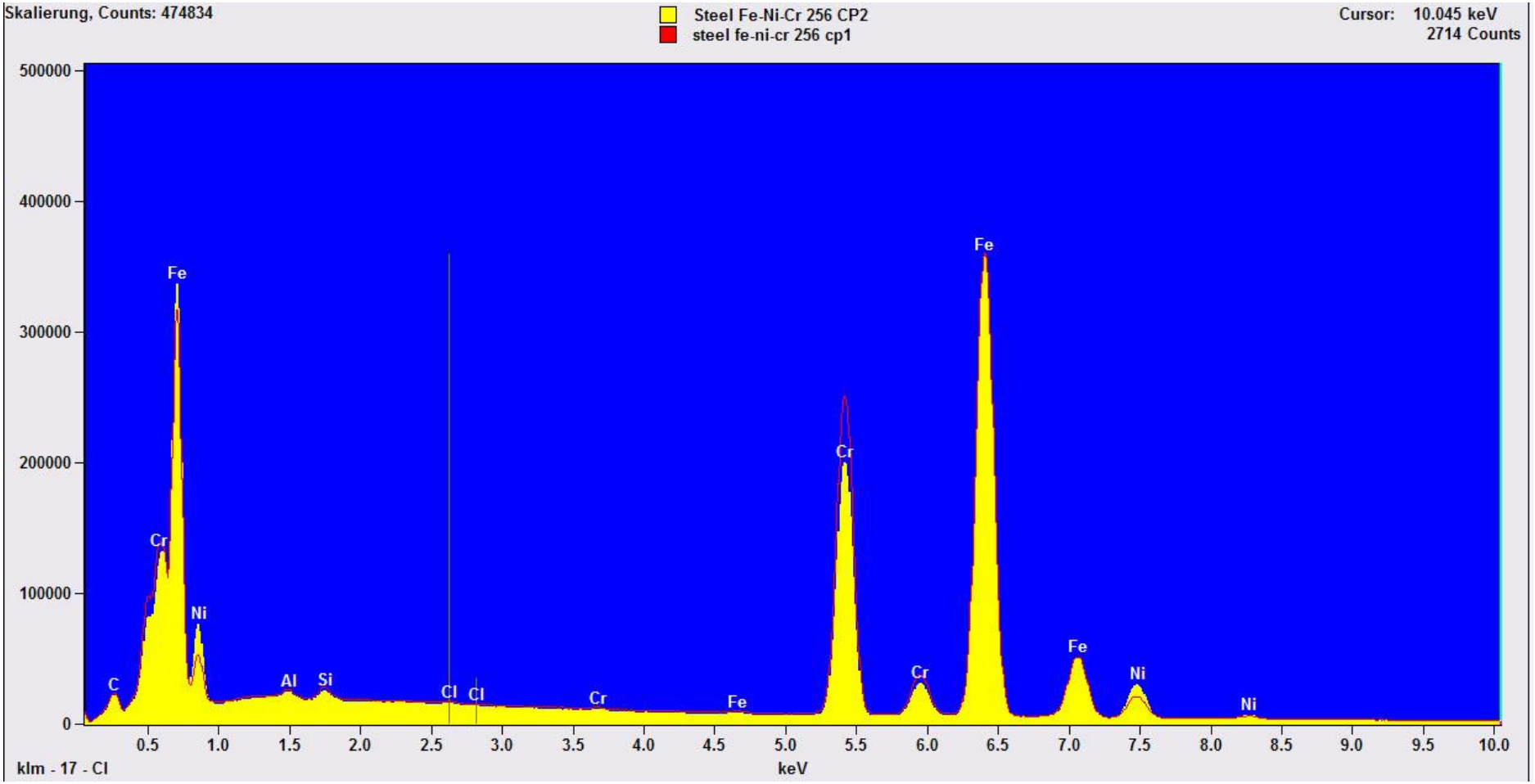
Steel sample – compare spectra



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Surface Analysis with XPS
(*X-ray Photoelectron Spectroscopy)*

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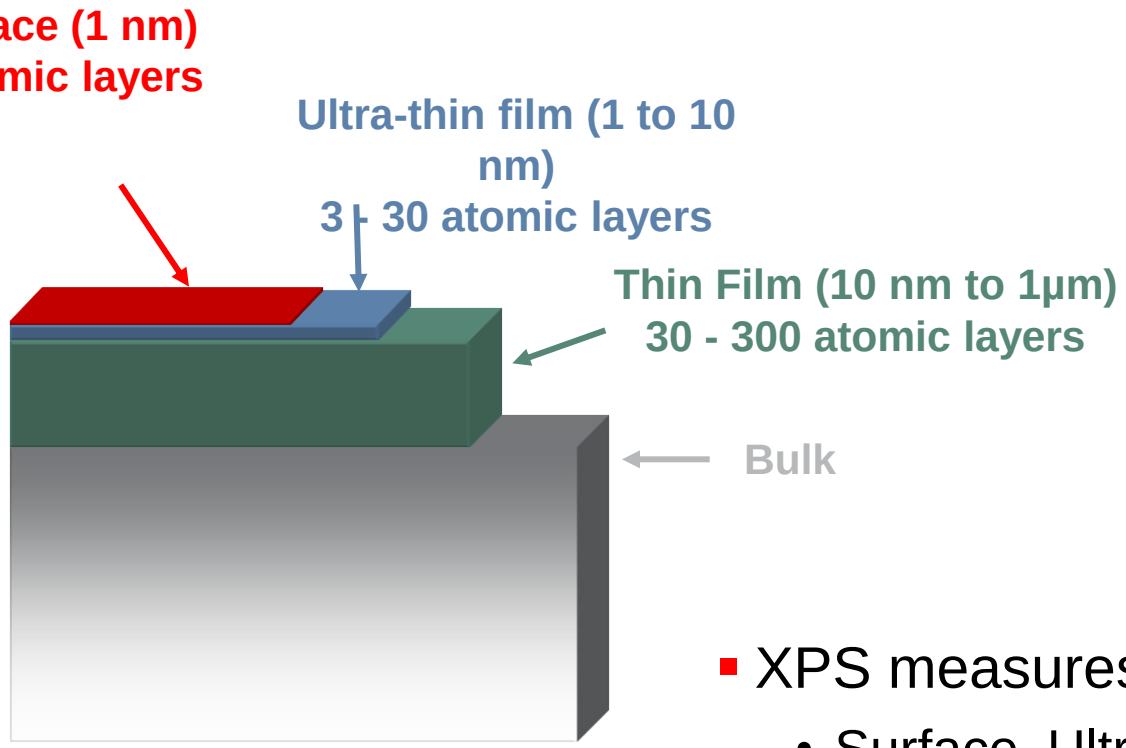
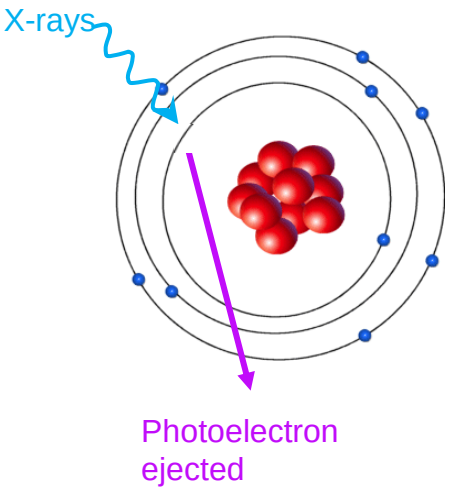
Surface Analysis



Note: Approximate figures only. Actual values depend upon materials

- XPS measures
  - Surface, Ultra-thin film using XPS
  - Ultra-thin film using ARXPS
  - Thin film using sputter profiling

XPS – the data

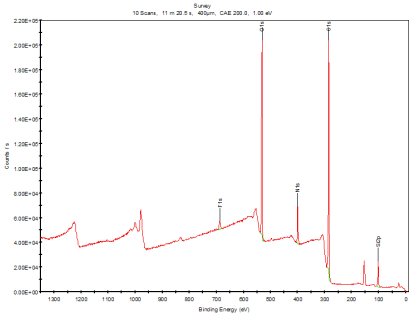


Binding energy tells

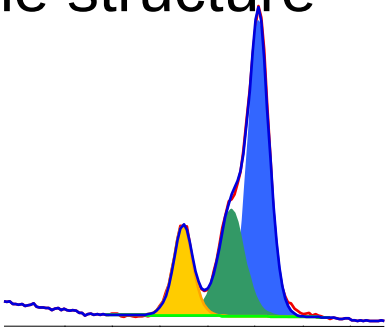
Element

Transition

Wide scan



Fine structure



Elemental identification and quantification

Chemical state identification and quantification

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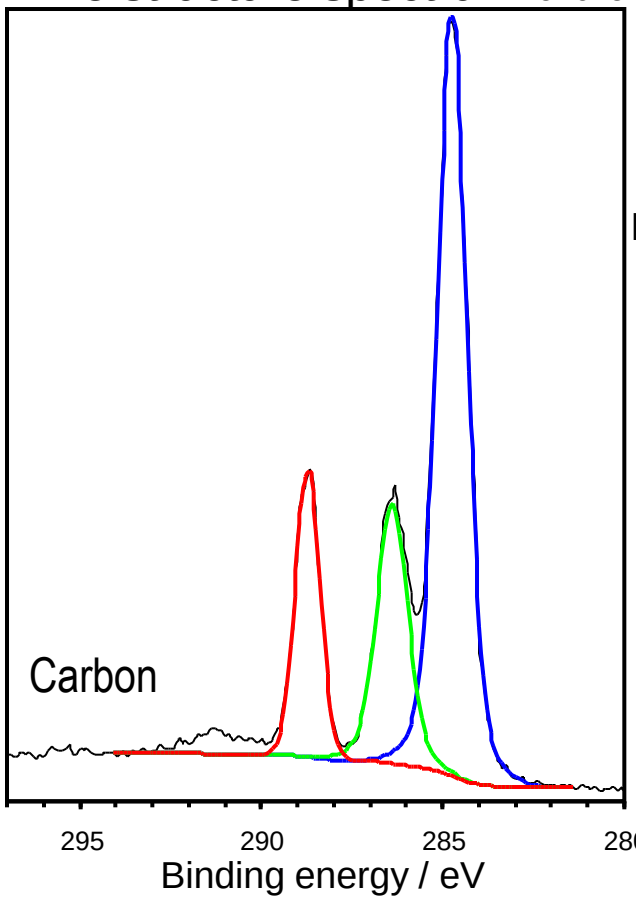
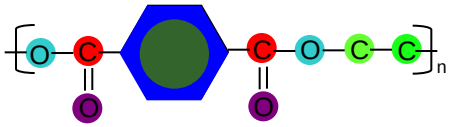
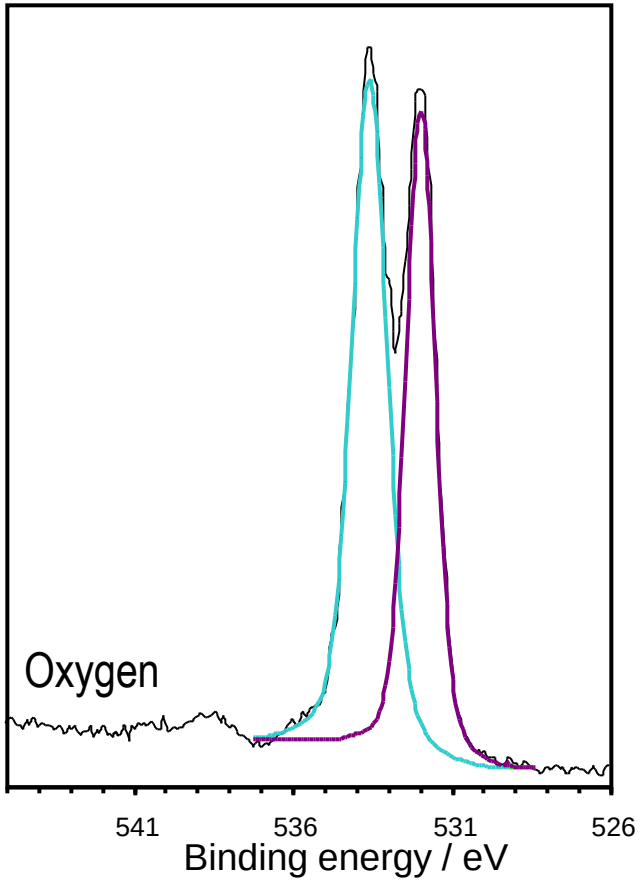
Fine structure spectrum comprises the chemical state information which makes XPS unique in surface analysis

Fine structure spectrum for chemical state information:

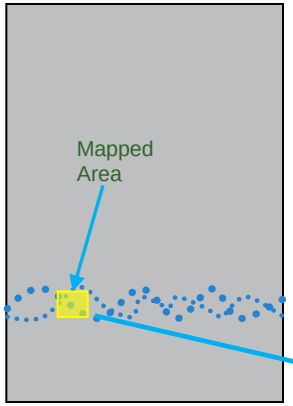


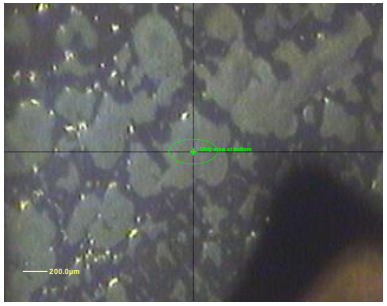
Poly(ethylene terephthalate), PET

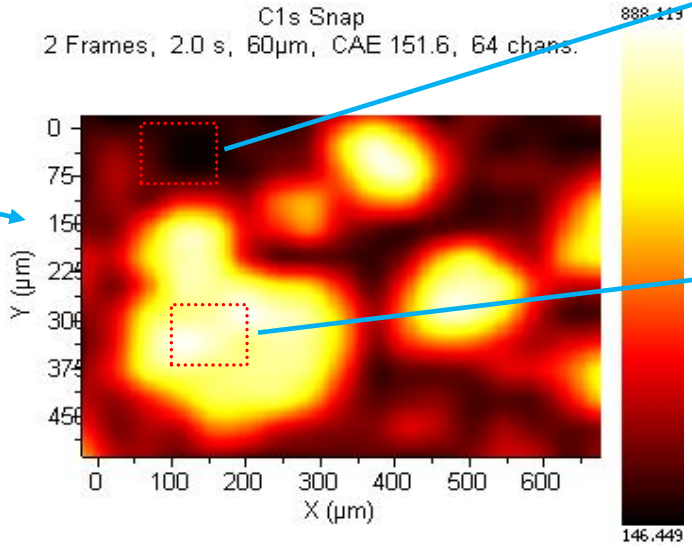


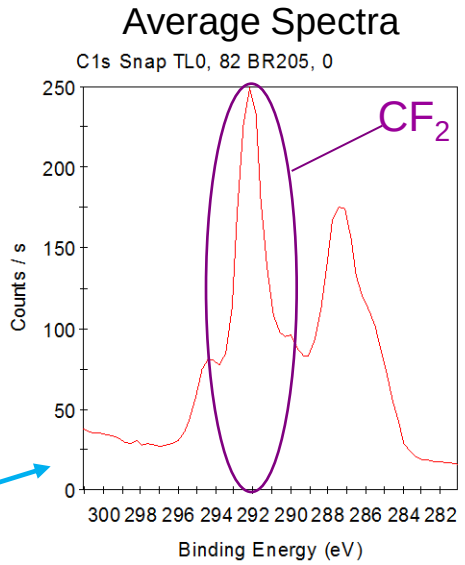


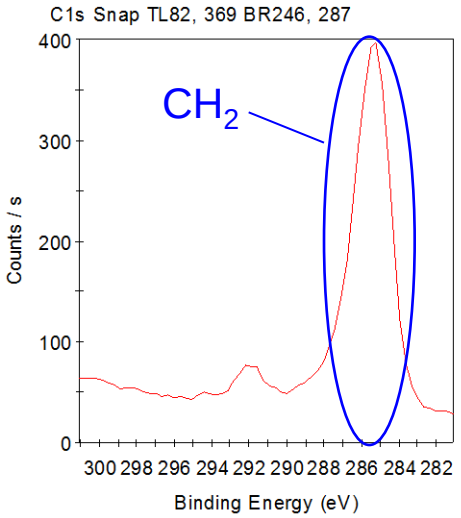
By moving the sample underneath the X-ray beam, and acquiring spectra at many points on the sample chemical maps can be formed.
Mapping and imaging techniques allow determination the spatial distribution of elemental and chemical states at the sample surface.











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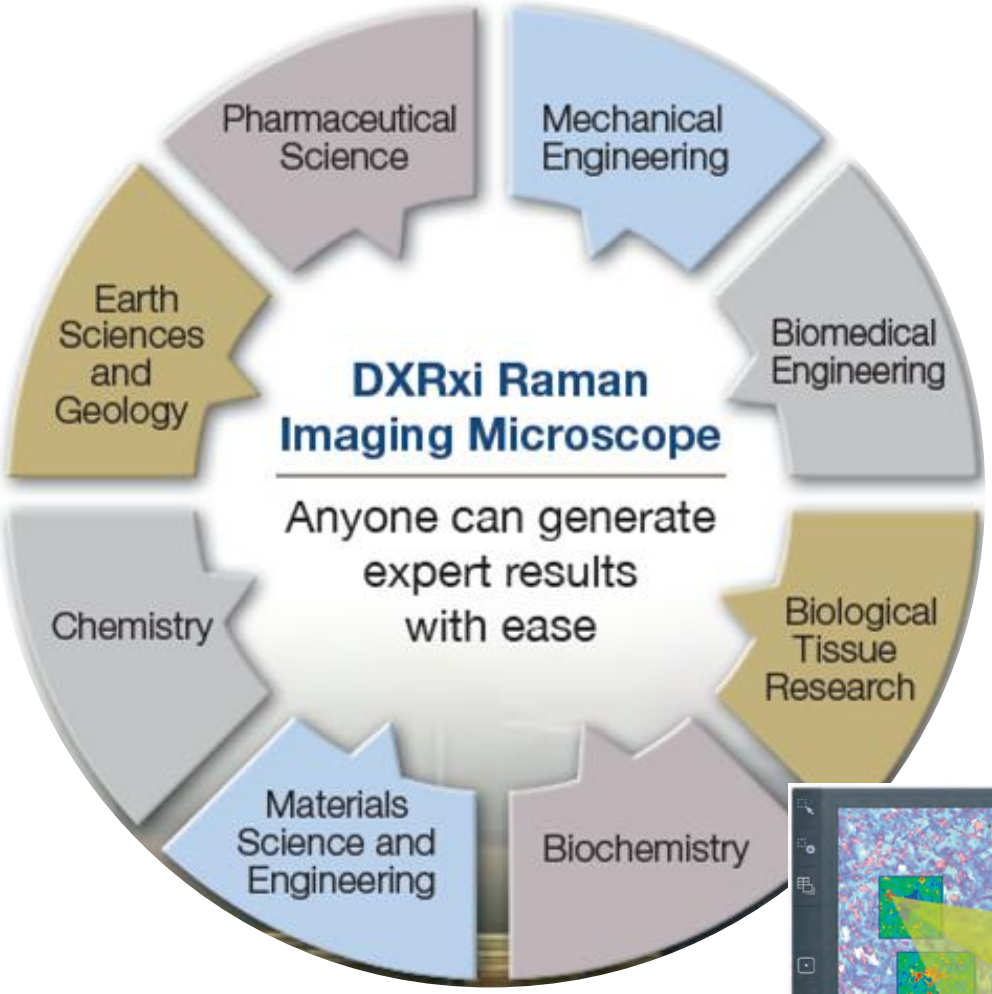
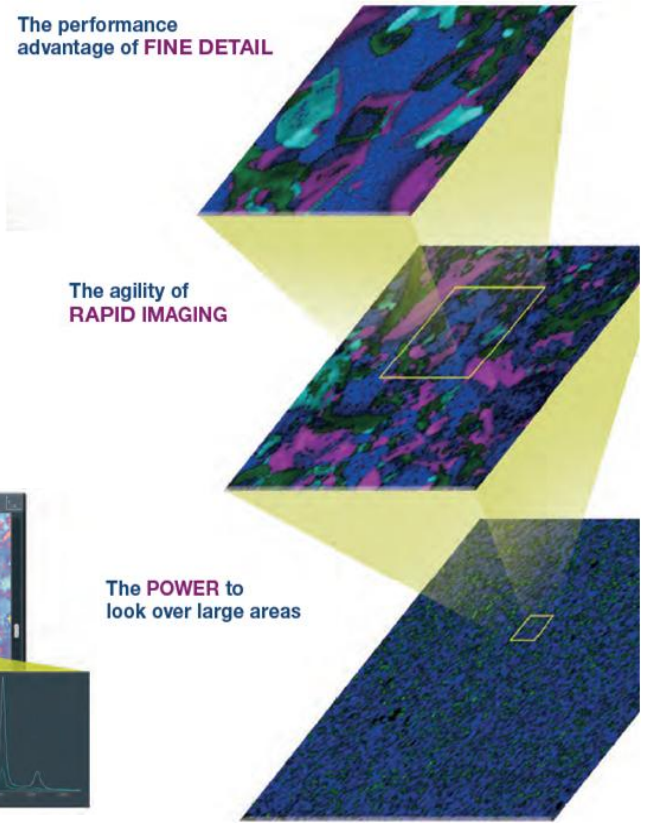
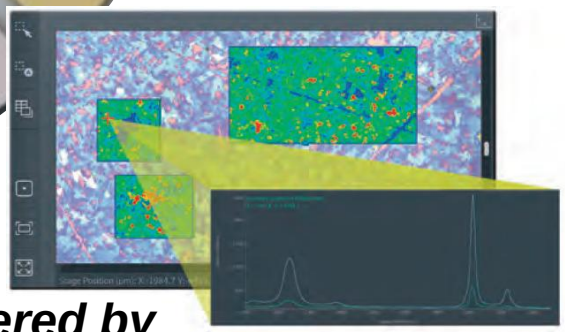
Raman Imaging System

The Raman Imaging Value Proposition



Advanced materials analysis benefits from an image-driven approach





Emphasis on microscopy, powered by spectroscopy keeps the answer in focus

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The Multiuser Laboratory Toolkit

- **Multiple techniques** are increasingly used with the same sample
- Strong emphasis on **image data** and **data visualization**
- ~70% of those polled use **SEM/TEM**, ~50% use **AFM**
- Work continues to become more **interdisciplinary,** requiring broad **proficiency with many different instruments**

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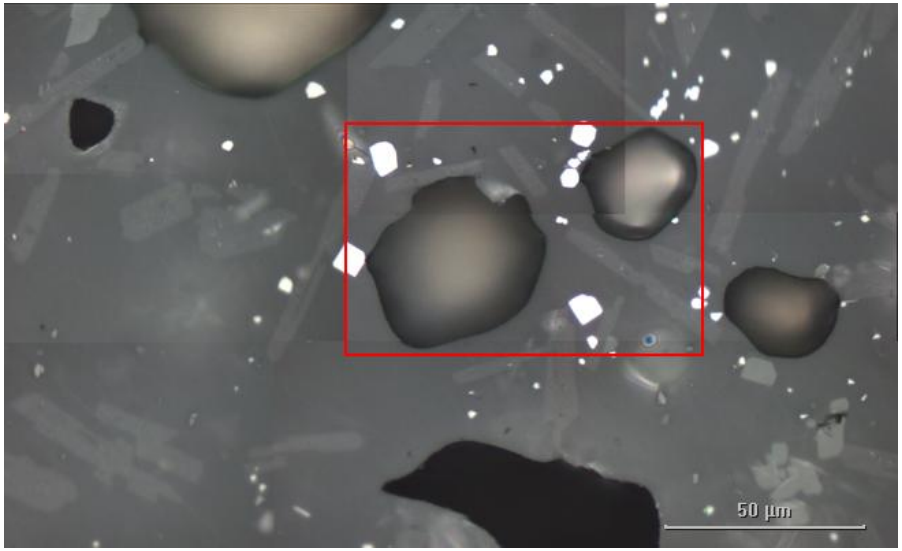
Introducing the DXRxi Raman Imaging Microscope

A total imaging system: hardware and software integration combines **powerful performance** with **image-centric** analysis and **ease of use**

*A completely **new approach** to Raman imaging!*

Inclusion in Minerals



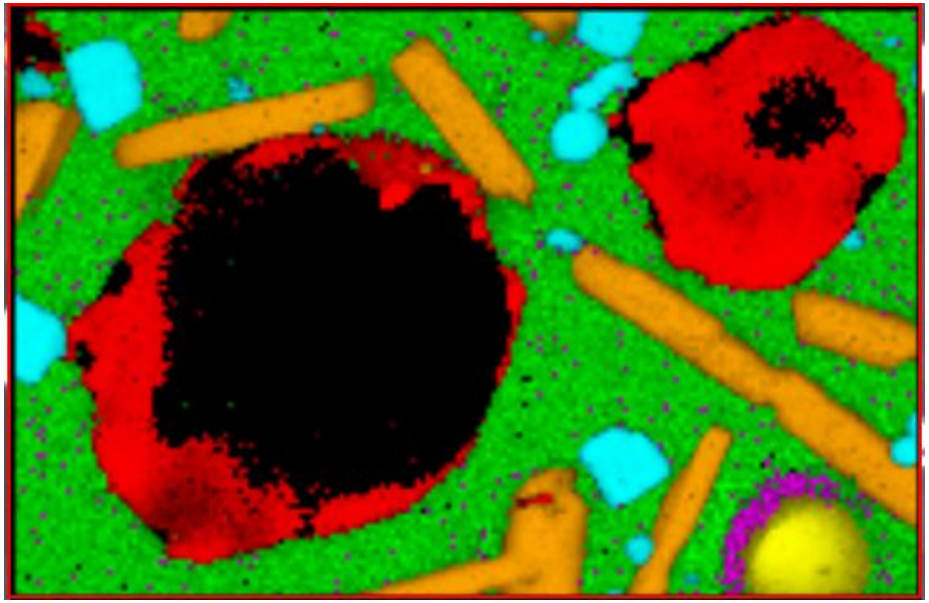
The DXRxi maintains the same confocal capability as the DXR

Quantifying the volatiles in the sample will provide clues about the nature of volcanoes.

455 nm laser, 5.9 mW, 100X objective

21,000 spectra

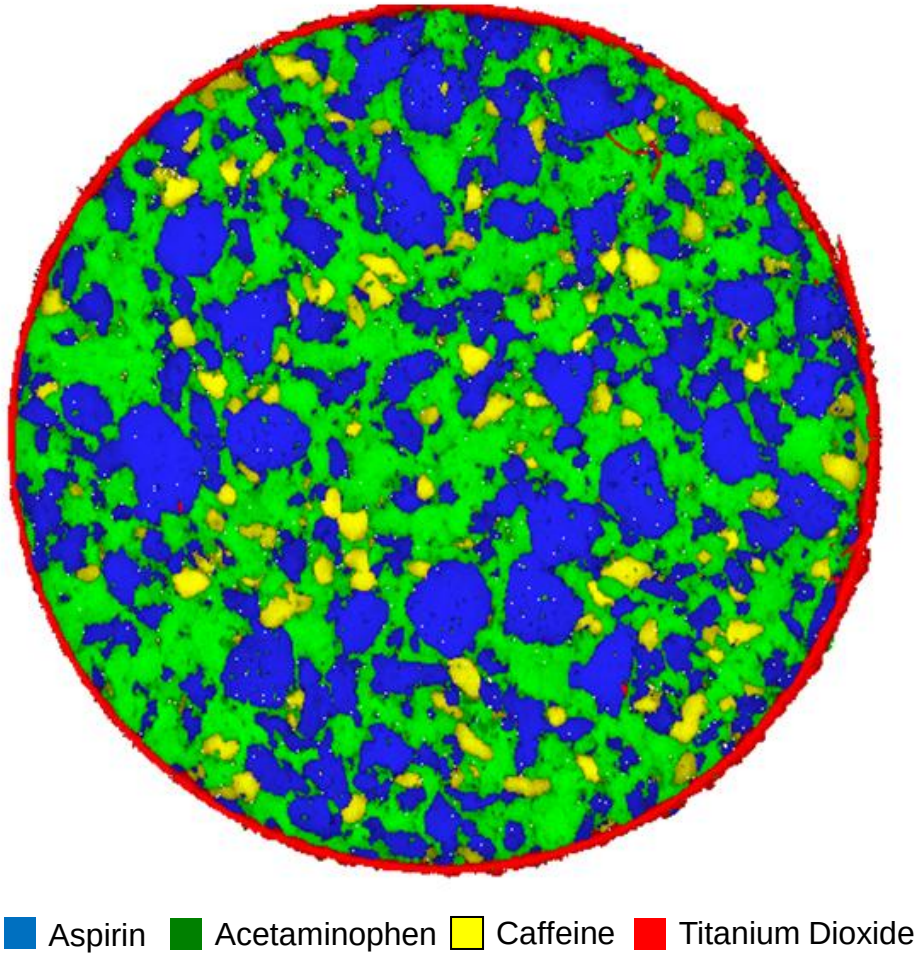
Acquisition parameters: 40 Hz (25 ms/spectrum), 100 scans, 0.5 µm pixel size



Sample provided by Jenny Riker, University of Bristol

Tablet analysis

MCR Analysis



Determine:
- Size of each domain
- Distribution of domains
- Overall composition of tablet

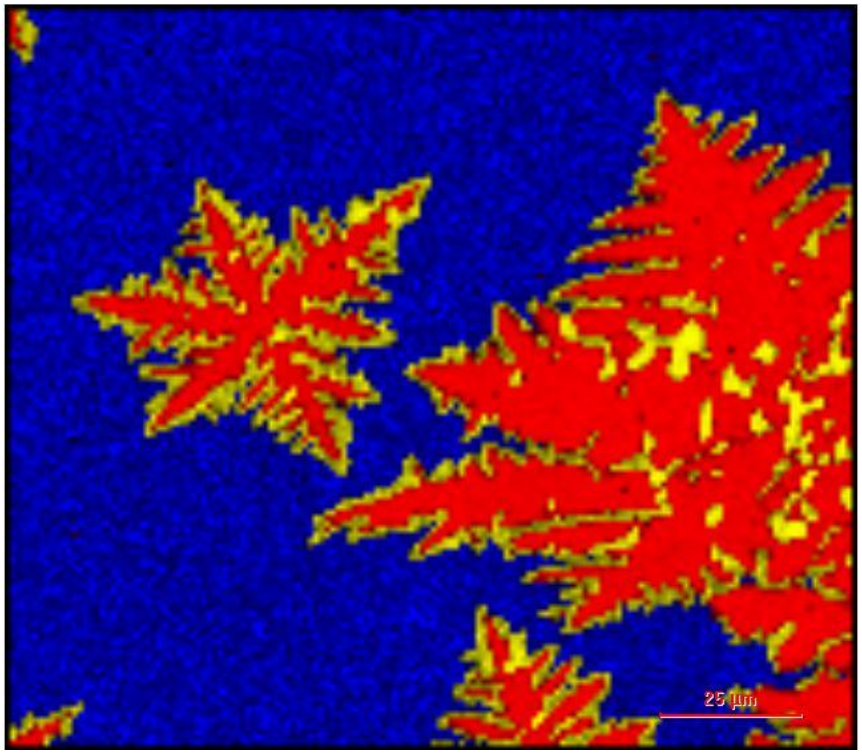
11 x 11 mm surface area
532 nm laser, 10X objective

226,000 spectra, 25 μm pixel size

Acquisition parameters: 550 Hz (1.8 ms/spectrum)

8 minute collect time!!

Graphene on Copper



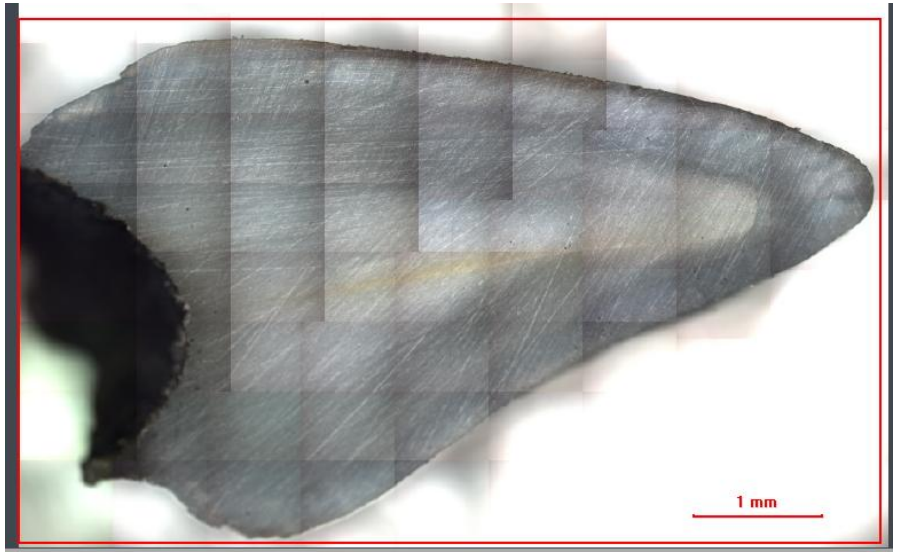
Graphene grown on copper and analyzed ***on the copper*** with the 455nm laser

$$I_{scatter} \propto \frac{1}{\lambda_{ex}^4}$$

455nm laser
150 x 150 µm surface area
90,000 spectra!!!
2.0 µm pixel size
Acquisition parameters: 100 Hz (10 ms/spectrum), 4 scans

Copper Substrate Oxidized Copper Single-layer graphene

Tooth analysis



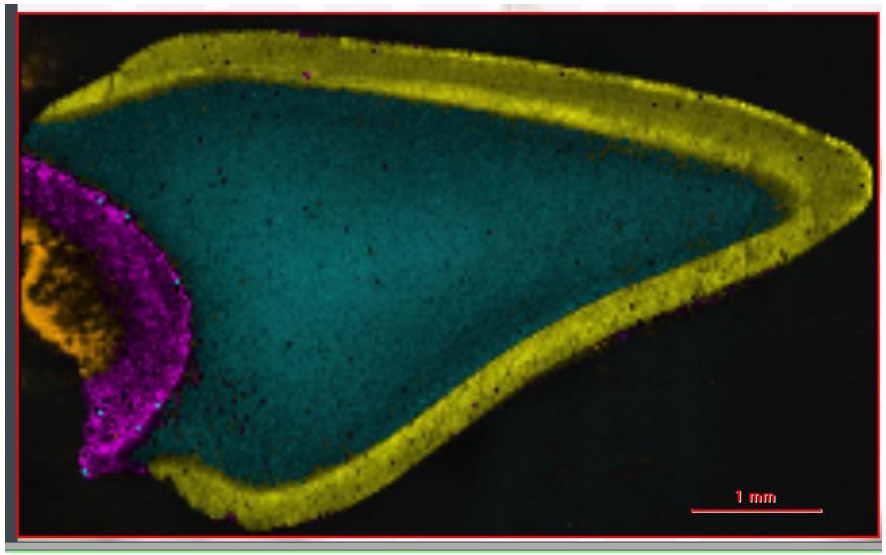
780nm laser, 5.9 mW, 10X objective

29,000 spectra!!!

Acquisition parameters 40 Hz (25 ms/spectrum), 100 scans, 30 μm pixel size

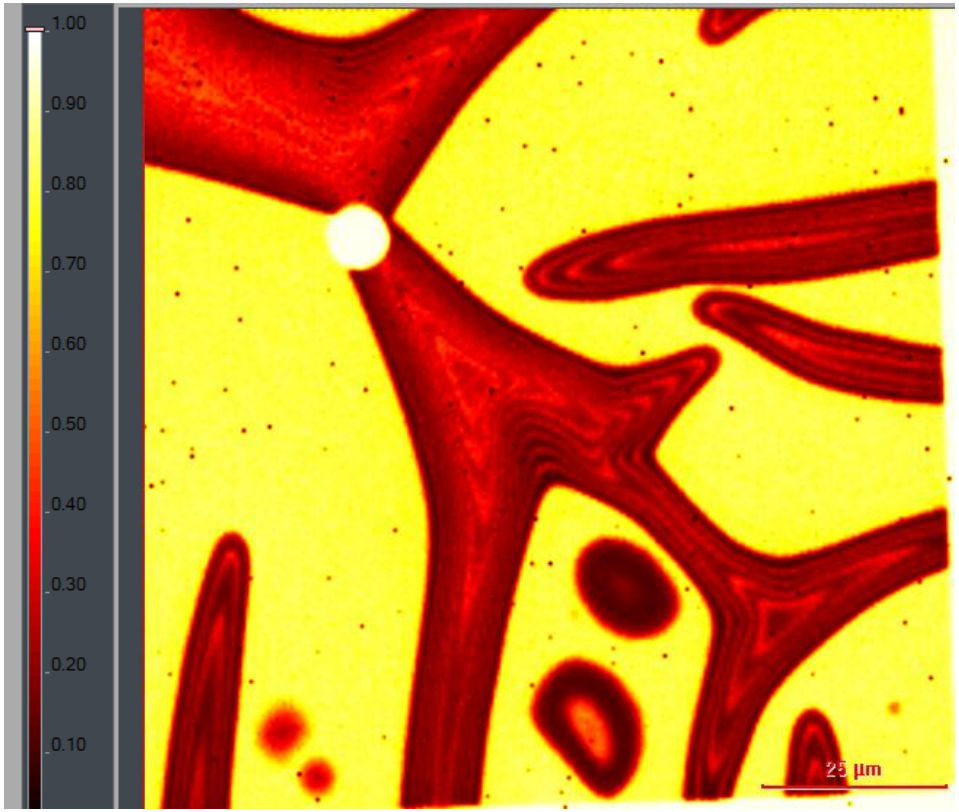
~22 hour collect time

Impossible on a traditional mapping instrument!



Pulp Circumpulpal Dentin Dentin Enamel

Silicon Stress



455 nm laser, 1.0 mW, 100X objective

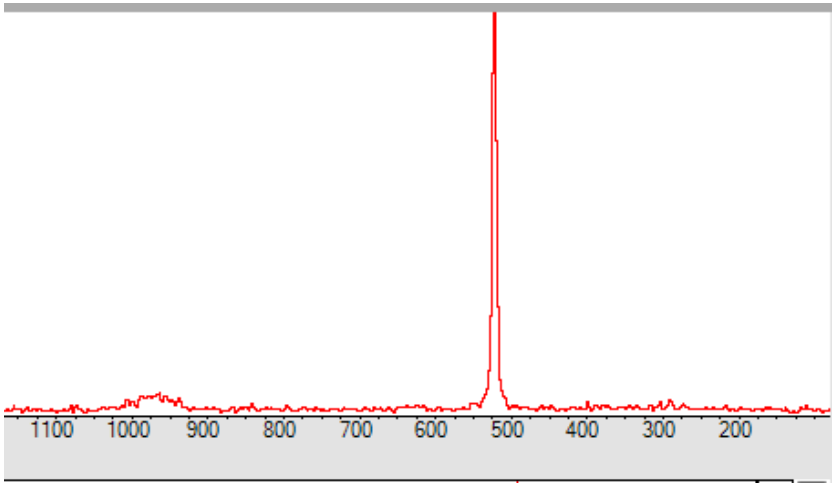
50,000 spectra

Acquisition parameters: 100 Hz (10 ms/spectrum), 25 scans, 0.5 µm pixel size

~4 hour collect time!!

Sample is a Si substrate with a layer of Si/Ge deposited followed by an additional layer of Si

The presence of the Ge causes stress in the second layer of Si, which is imaged



Analytical Opportunities with Thermo Scientific

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