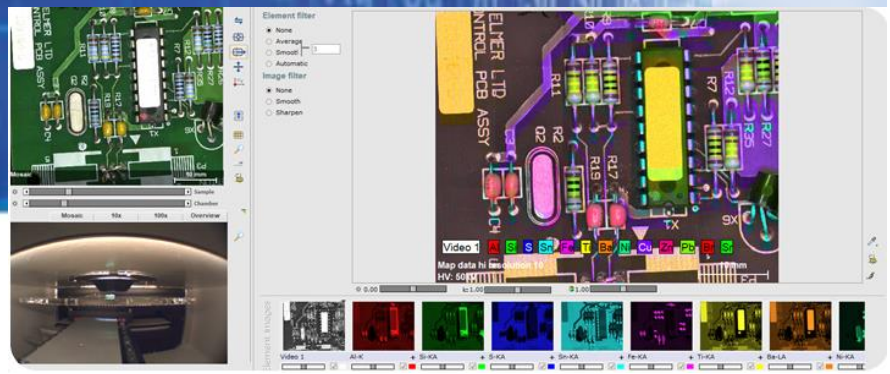
Elemental distribution analysis Using High Performance μ-XRF Spectrometer

Solid State Elemental Analysis Unit
Mark Wainwright Analytical Center



What can our XRF laboratory do?

What samples do we analyse?

- ✓ Geological samples: Rocks, soil, slags, clays, ores.
- ✓ Industrial samples: building materials, cosmetics, glass, ceramics, plastics
- ✓ Liquids: Oil, diesel fuel…

What elements do we analyse?

From B to U, from PPM to percentage level using XRF;

C, N, H, S, O analysis using elemental combustion technique.

Non-destructive analysis?

Energy dispersive XRF (Epsilon XRF, Olympus pXRF)

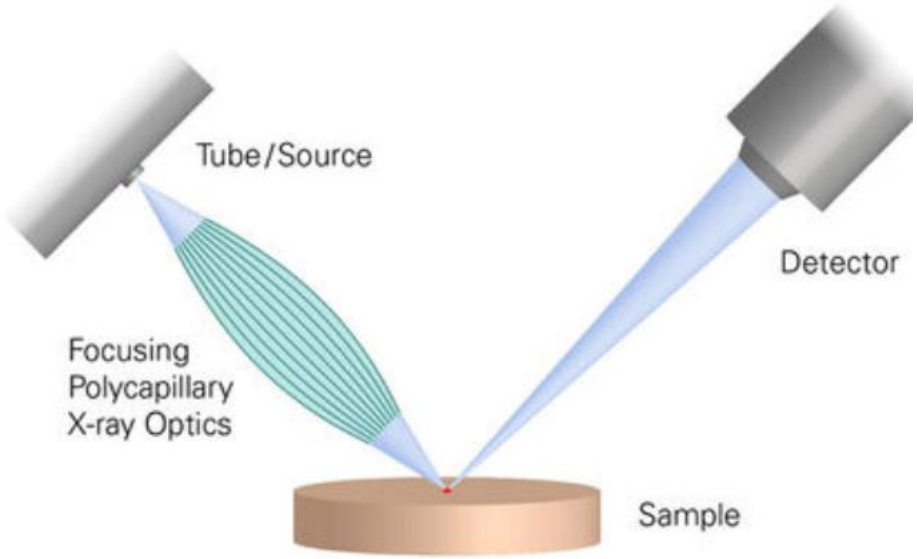
Elemental analysis for non-homogeneous sample?

Bruker M4 Tornado μ-XRF for elemental distribution analysis

XRF instrumentation in our laboratory

Energy Dispersive XRF			
	PANalytical Epsilon	Olympus Handheld XRF	Bruker M4 Tornado μ-XRF
Wavelength Dispersive XRF			
	PANalytical AXIOS	PANalytical PW2400	

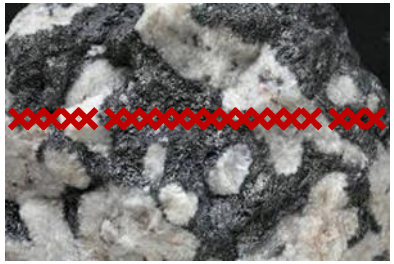
Bruker M4 TORNADO µ-XRF



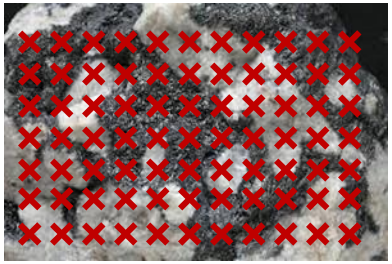
✓X-Ray optics for spot sizes of 20 µm and 150 µm;
✓Rapid surveying (60 s for a single point measurement; 20 min for a 100 mm line scan);
✓Two Silicon drift detectors for improved sensitivity;
✓Standardless quantification of bulk material and coating systems;
✓Option to measure under vacuum, helium or air.

Single point analysis

Multiple points analysis



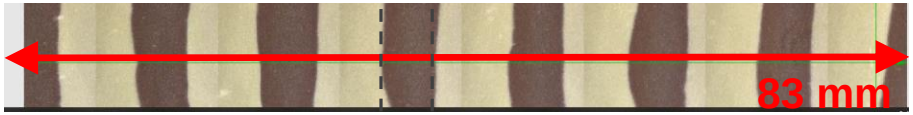
Line scan

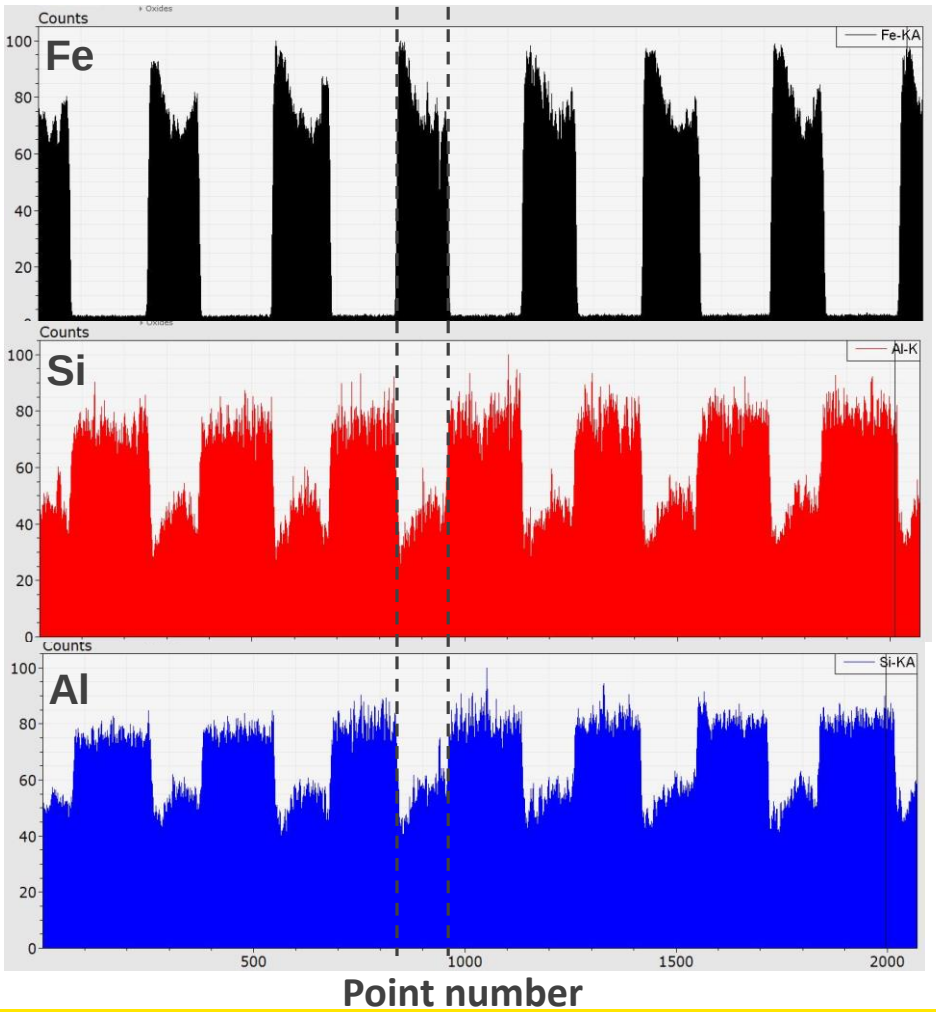


Area mapping

Line scan on a “Zebra” Rock

Mosaic image of the “Zebra” rock

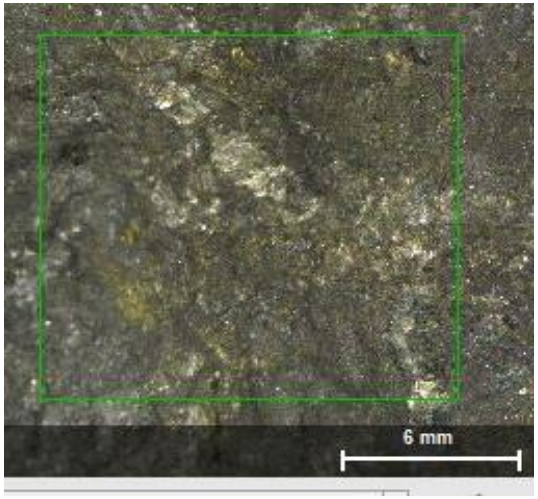


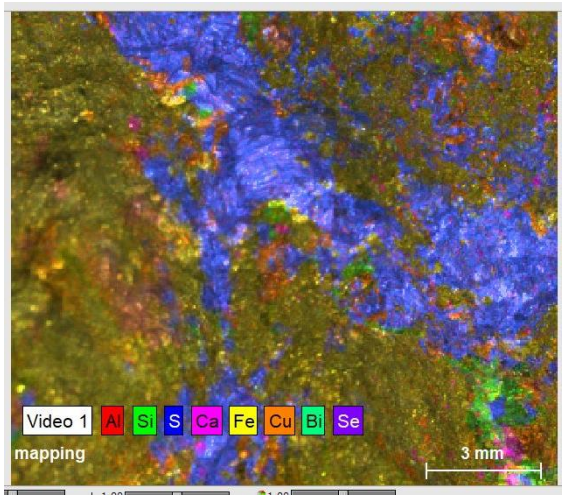


- **Test sample**: “Zebra Rock”
- **Source**: East Kimberley, WA
- **Composition**: quartz, sericite, other minerals
- **Origin**: Unknown

Tube voltage: 30 kV
Tube current: 600 µA
Time per pixel: 30 ms
Pixel distance: 40 µm (2071 points)
Cycle number: 3 cycles
Pressure: 20 mbar
Measure time: ≤ 4 min

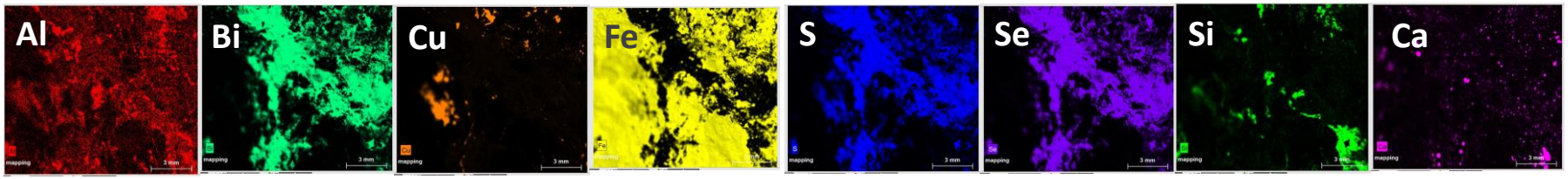
Mapping on a mining rock sample using μ-XRF





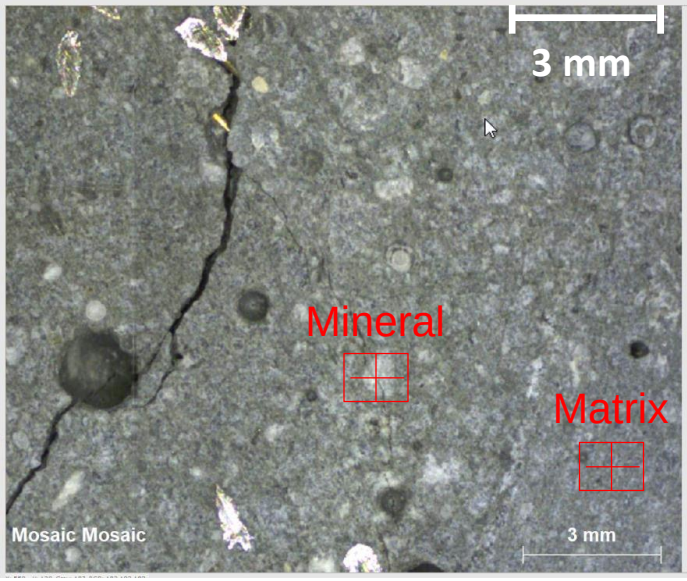
Elemental distribution data on a mining rock

Tube voltage: 40 kV;
Tube current: 500 μA;
Time per pixel: 10 ms
Pixel distance:
40 μm = 104,100 points
Pressure: 20 mbar
Measure time: 15 min

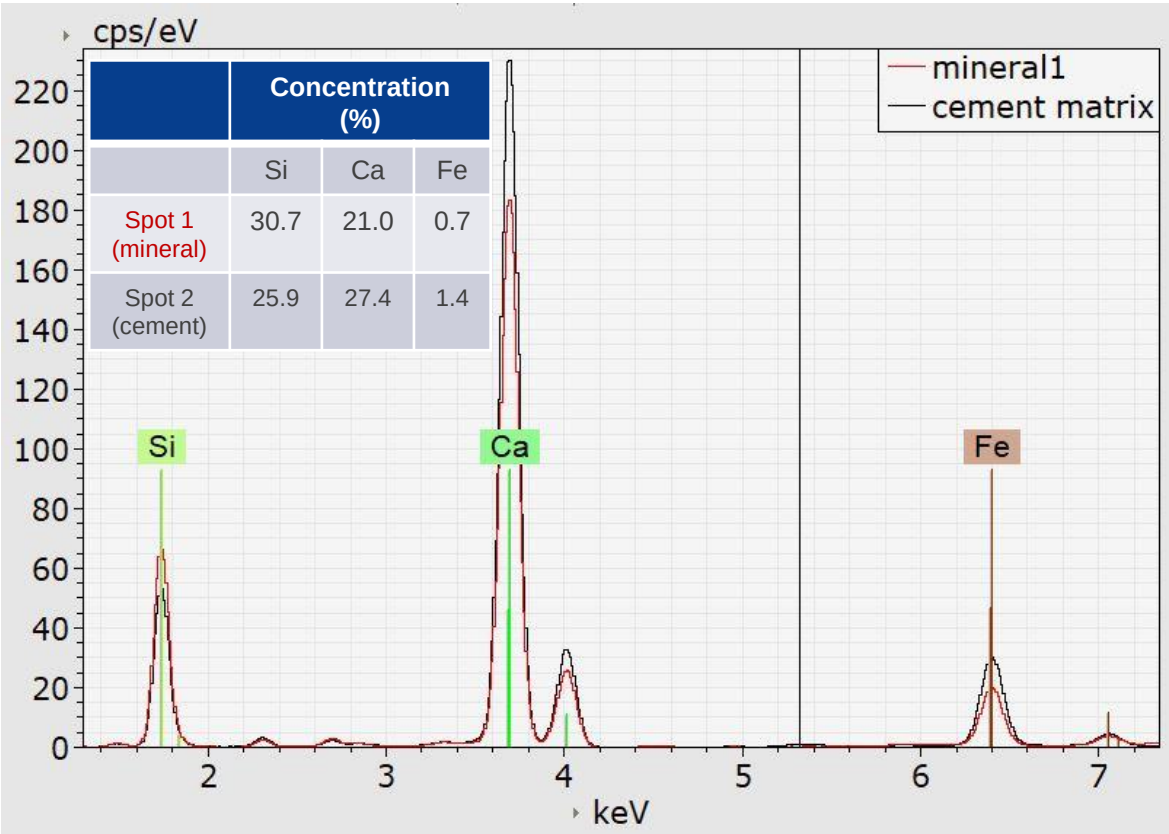


Mapping data on each element

μXRF analysis on a cement sample with steel fibre



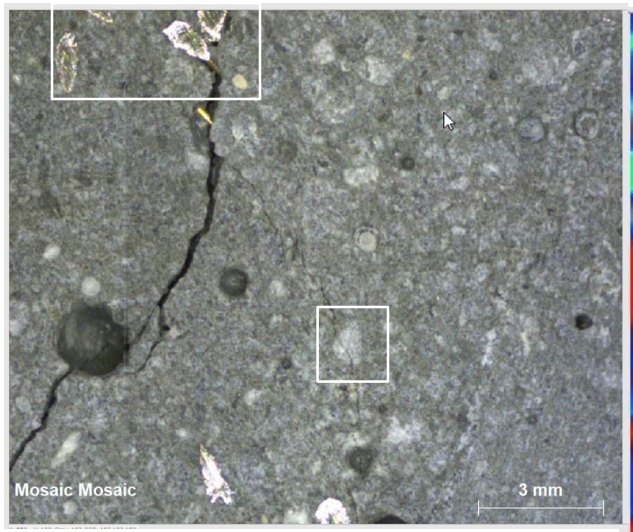
Tube Current: 600 μA
Tube Voltage: 50 kV
Pressure: 20 mbar
Measure time: 30 s

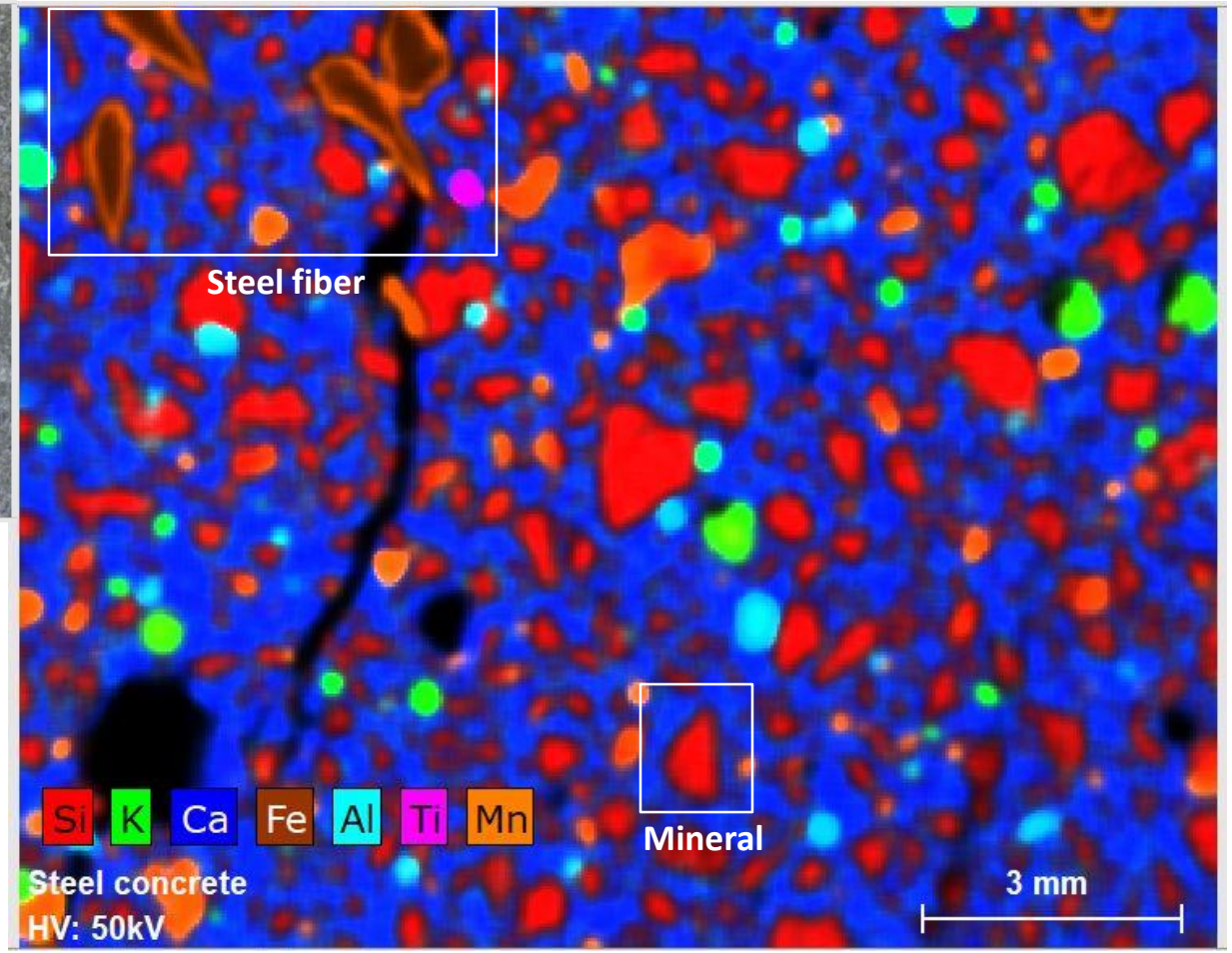


	Concentration (%)		
	Si	Ca	Fe
Spot 1 (mineral)	30.7	21.0	0.7
Spot 2 (cement)	25.9	27.4	1.4

The intensity of X-ray radiation from different spots can be directly compared.

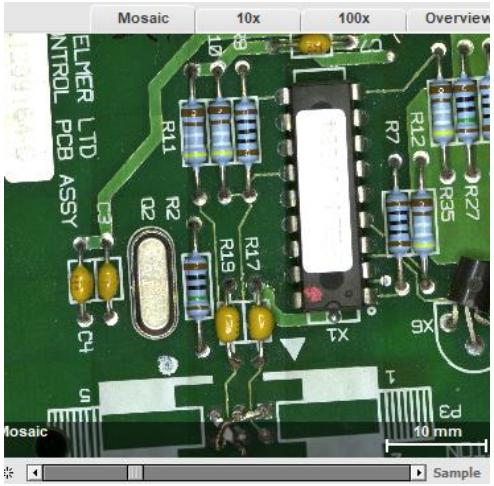
Mapping on a cement sample with steel fibre using μ-XRF

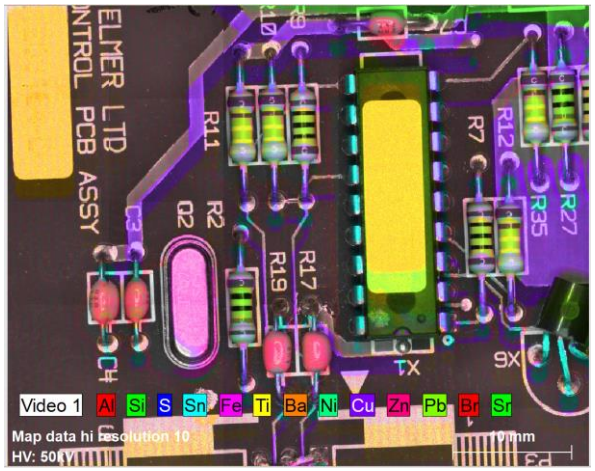




Tube voltage: 50 kV;
Tube current: 600 μA;
Time per pixel: 50 ms
Pixel distance:
40 μm = 140, 000 points
Pressure: 20 mbar
Measure time: 2 hours

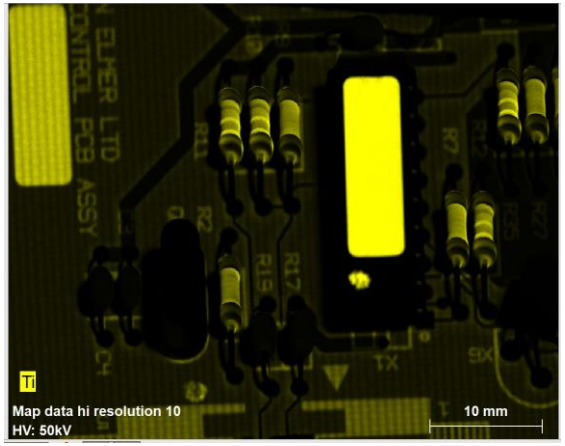
Mapping on a PCB Board



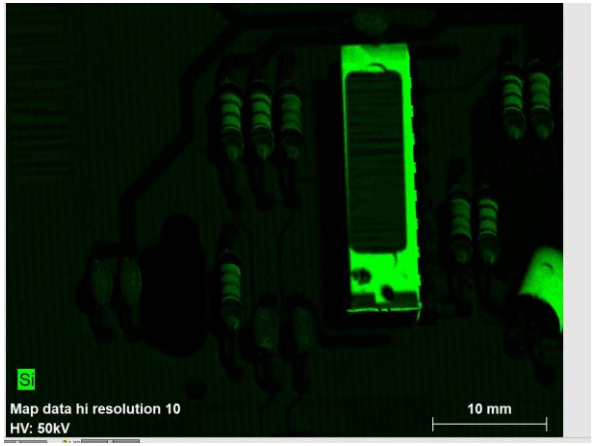


Test sample: PCB Board
Tube voltage: 50 kV
Current: 600 µA
Time per pixel: 10 ms
Pixel distance: 50 µm
Pressure: 20 mbar
Measure time: 3 h

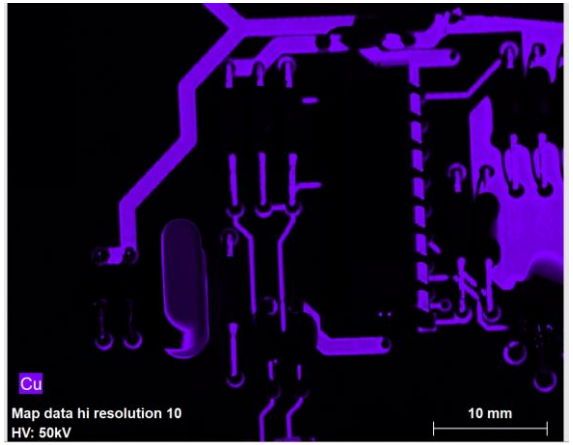
Elemental distribution on a PCB board



Map data of Ti

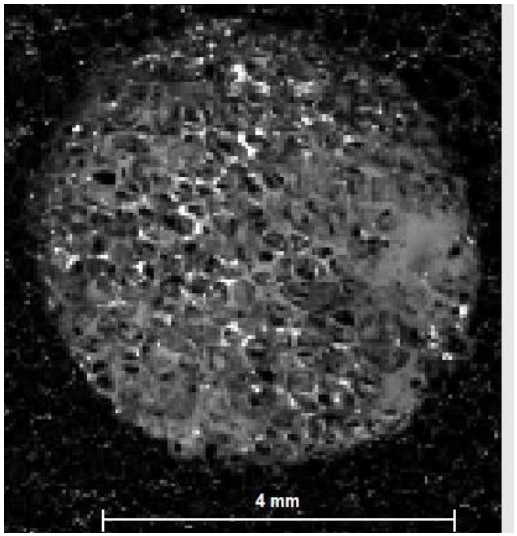


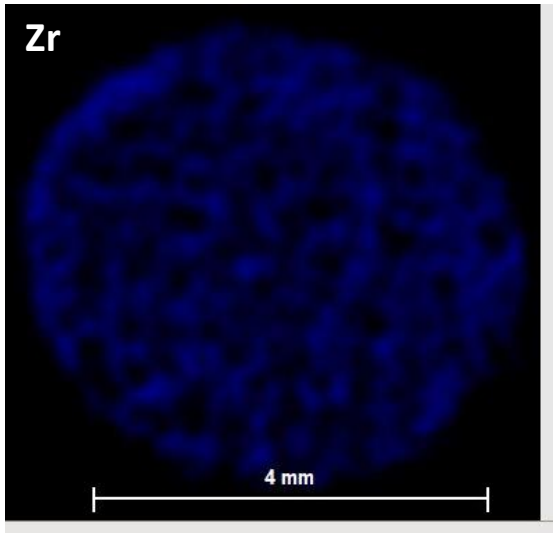
Map data of Si

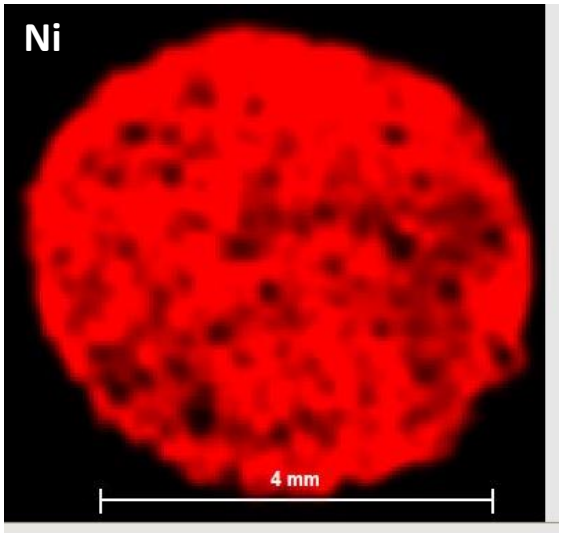


Map data of Cu

Mapping on a Metal organic framework (MOF) sample using μ-XRF







Test sample: zirconium MOF coated on a 4 mm size nickel foam.
Usage: MOF has extremely large surface area which can be utilized to capture volatile organic compounds and has high thermal stability.

Mapping parameters:
High voltage: 38 kV
Current: 600 μA
Time per pixel: 30 ms
Pixel distance: 40 μm
Pressure: 20 mbar

μ-XRF is useful for elemental distribution analysis for non-homogeneous samples with no sample preparation.