Element Imaging with MultiMax

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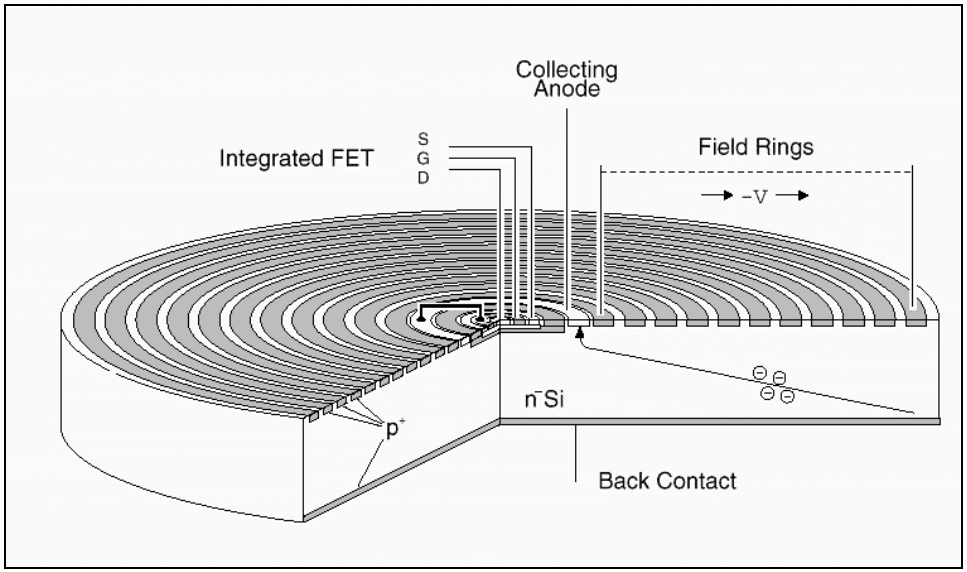
The problem:
Why all signal sources of a Electron Microscope (SE, BSE, specimen current, EBIC, ...) produce images, but X-rays do not supply pictures which paraphrased with MAP's **?**
Why we do not take element images with the EDX - SEM combination **?**

- Several orders of magnitude lower spatial resolution
  ⇒ *limited by physics, but this disadvantage disappears with lower magnification*

- Detectors with very low signal intensity in comparison to common electron detectors
  ⇒ ***energy dispersive X-ray detectors are 'quantum counters'***
  Semiconductor detectors are able to process only a limited number of X-rays quantums (10.000 ... 50.000 quantums per second as a maximum)

New Kind of Detectors for X-rays



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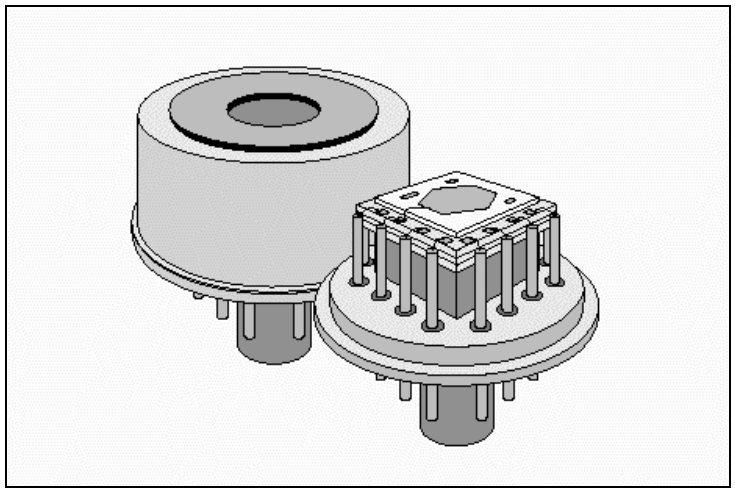


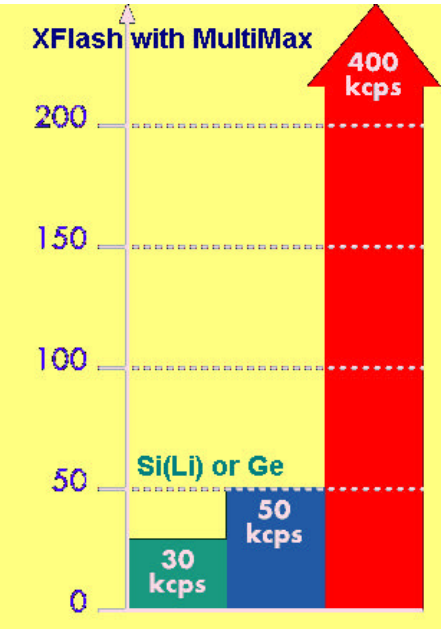
The problem:

- higher pulse processing ability in a given time
  -> shorter pulse shaping
- shorter shaping times
  -> lower detector capacity
  (but without lower sensitive area)

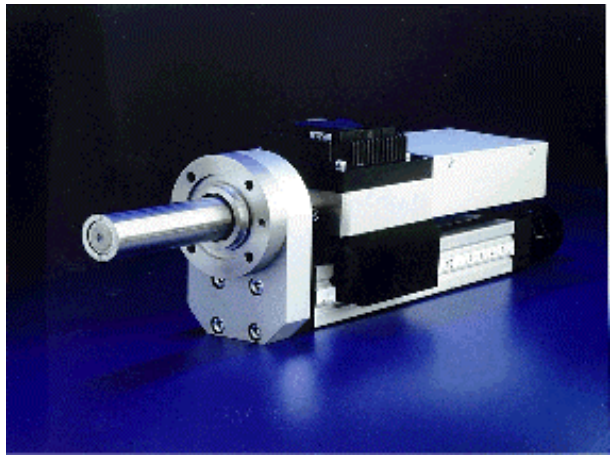
The solution:

- Si Drift Detector with inhomogeneous electrical field
  -> high sensitive area, low effective capacity with FET integrated

The MultiMax System



Comparison:
conventional detector -
digital pulse processor -
XFlash® with MultiMax

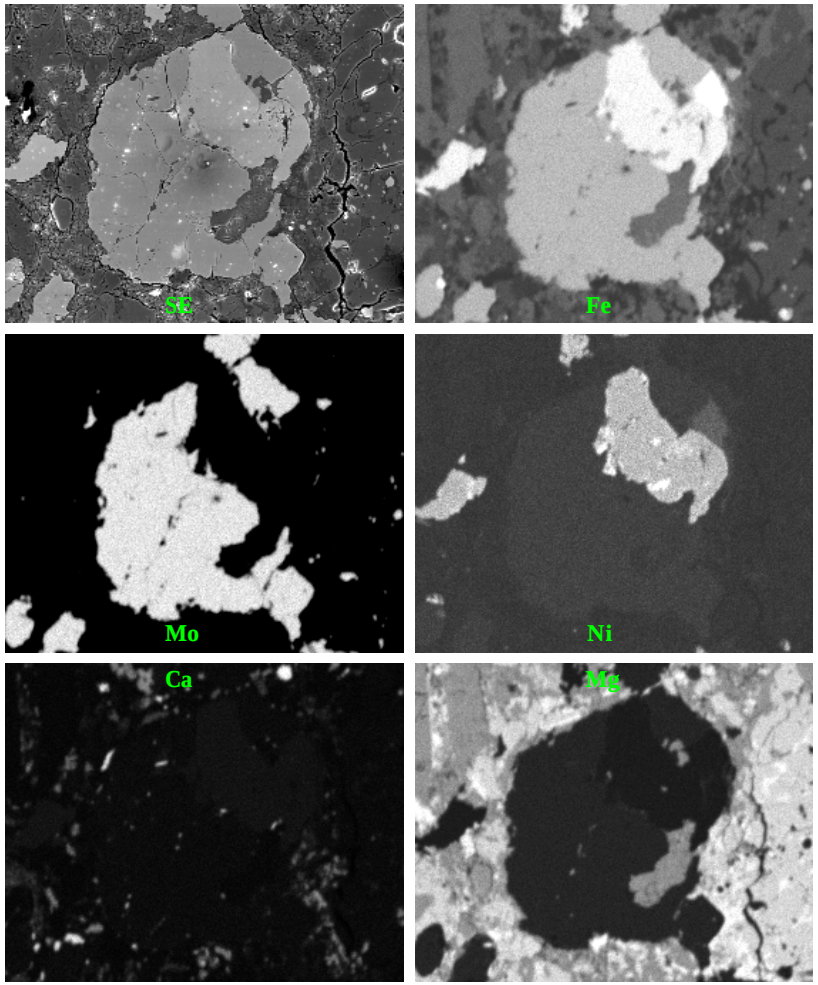


XFlash® detector **+**
MultiMax electronic unit for very fast pulse processing

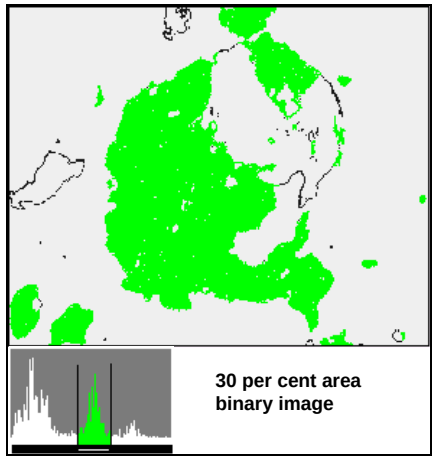
- maximum of pulse processing: **400.000 cps**
- dead time for **250.000 cps**: app. **30 %** only!

Examples for Application

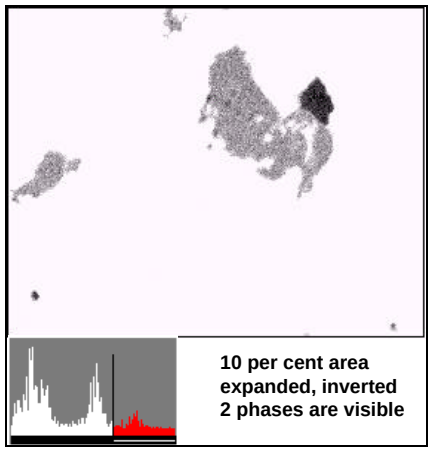
Analysis of materials with changing element composition:

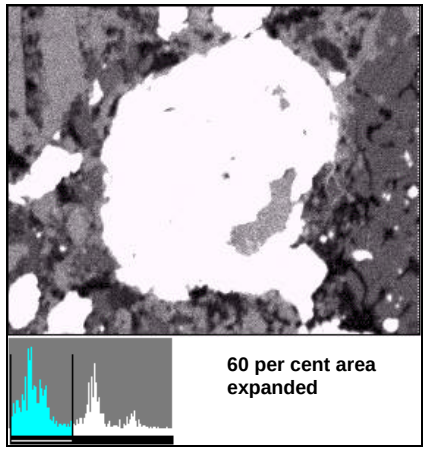


Grinded rock

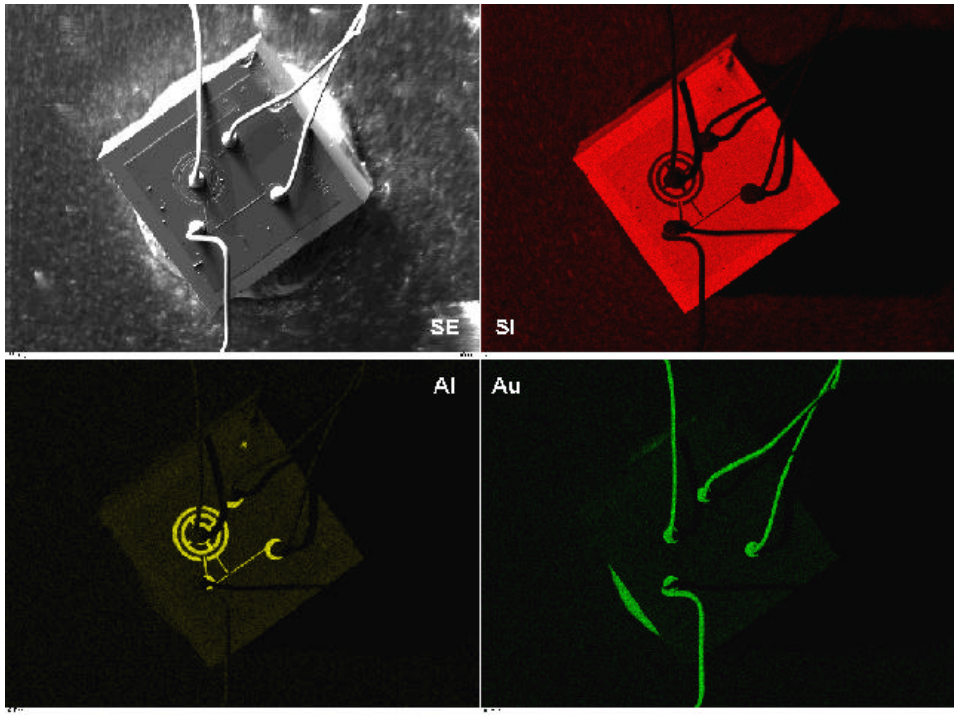


The iron image, taken with XFlash® (app. 5 minutes acquisition time), shows 4 different element concentration areas. Common image evaluation is usable and in respect to data depth appropriate.





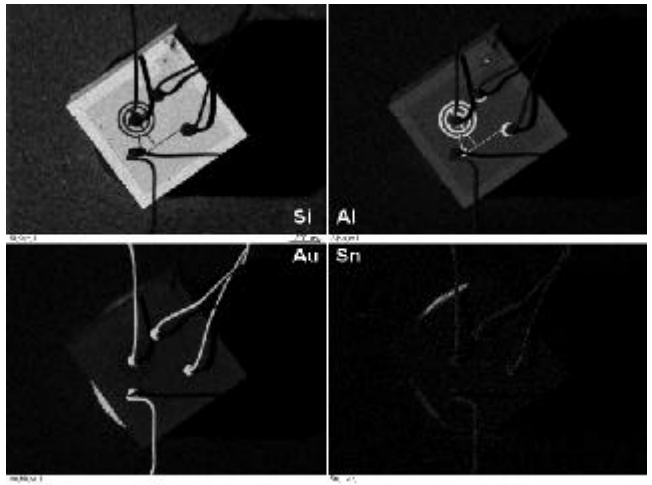
Ultra Fast Mapping / Element Imaging

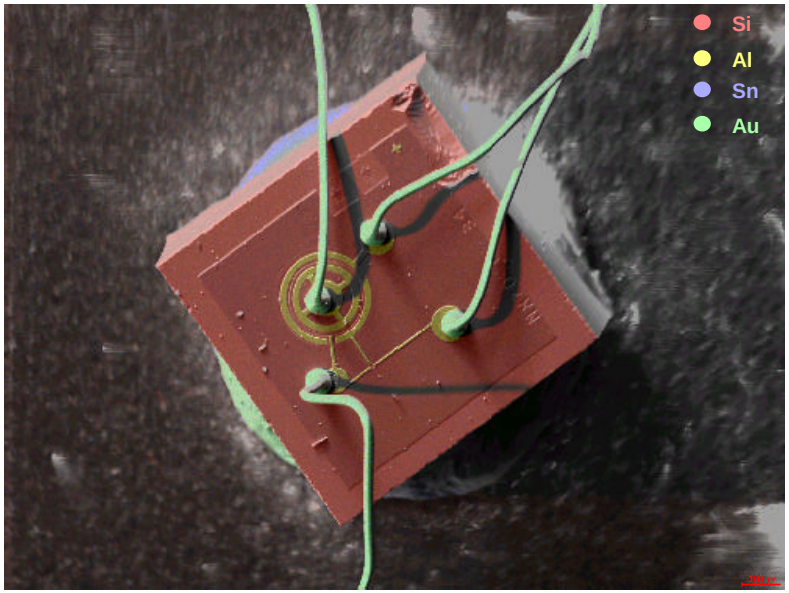


high resolution colour element images with high data depth (colour steps)

Mixed image:
SE image + 3 elements (true colour)
-> coloured SE image

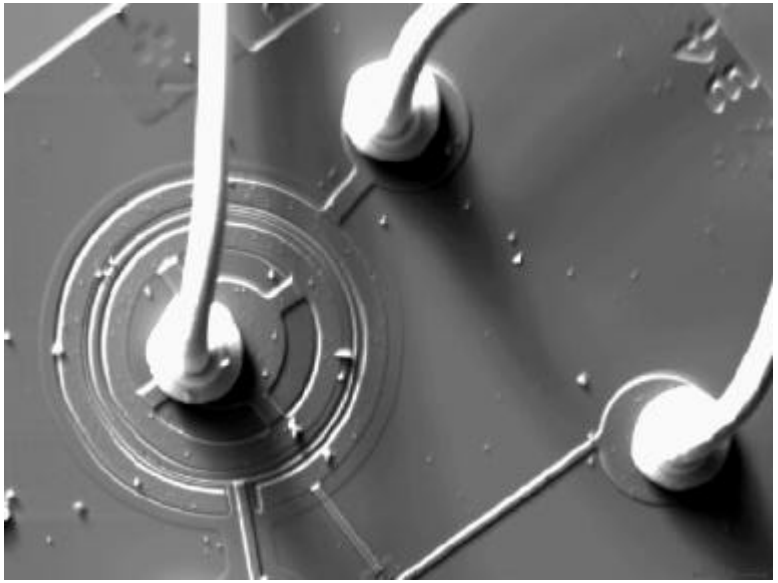
Element images (5 minutes)



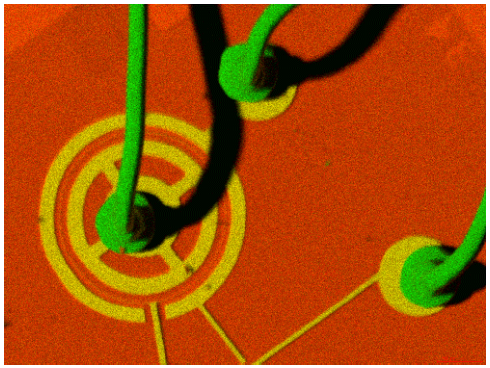


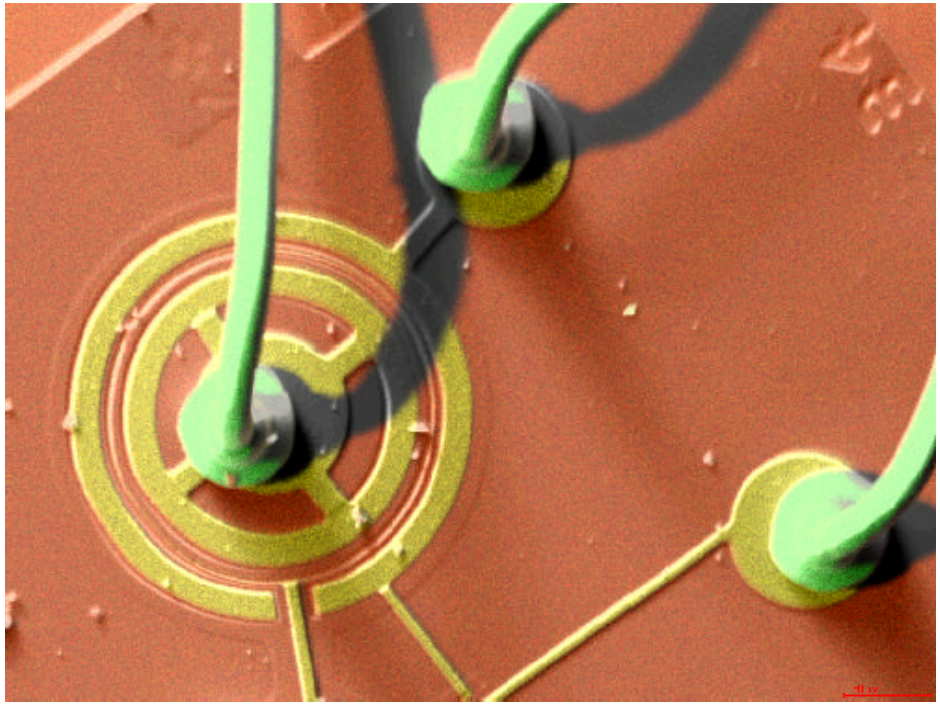
Examples for Application

Visualization of micro-structures:



Transistor

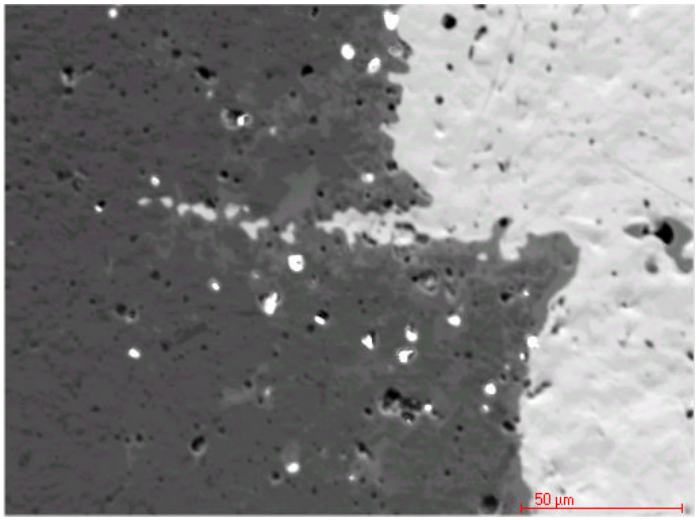




The shadow of X-ray detector
is clear visible.
The SE image has no colour in this region.

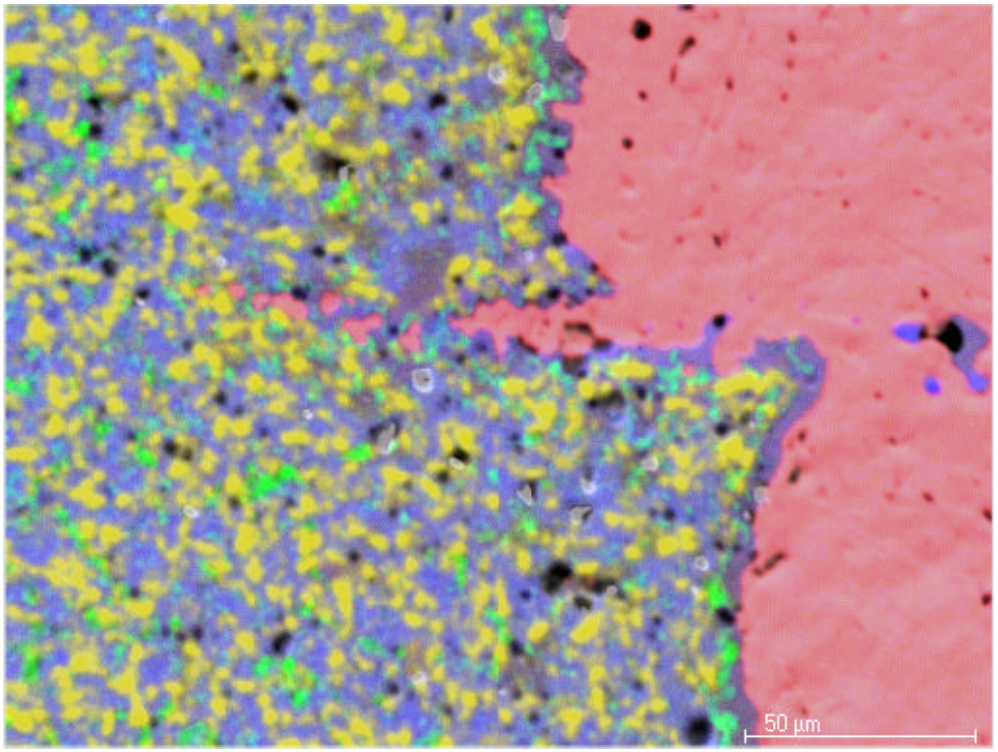
Examples for Application

Multilayer



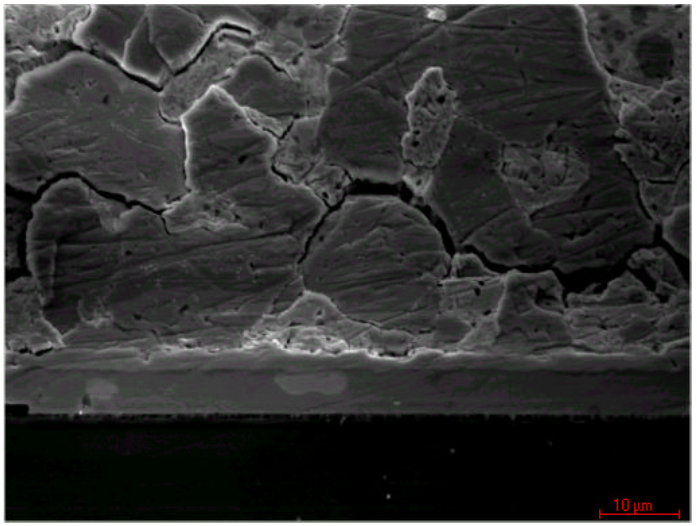
The illustration showed the cut of a piece of multilayer ceramics

In the electron image the dark zone on the left contrasts clearly with the bright one on the right. Additional structure can be identified relatively indistinctly in the dark zone. That we are dealing here with a constantly varying material composition and not just surface roughness as in the bright area can be seen only in the coloured image.



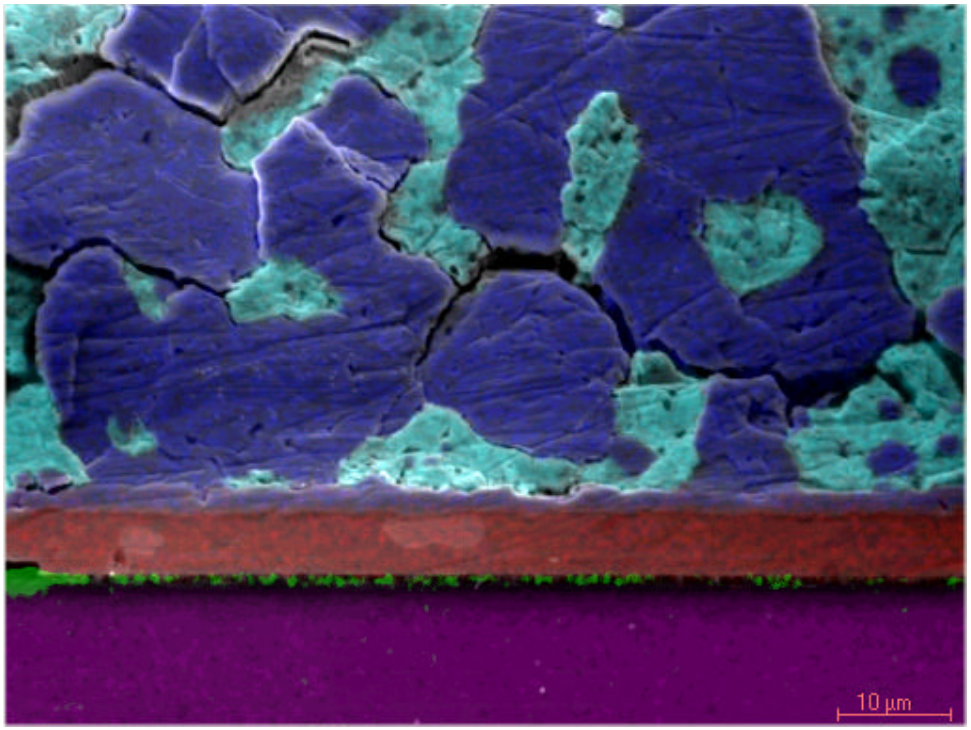
Examples for Application

Flip chip metallization



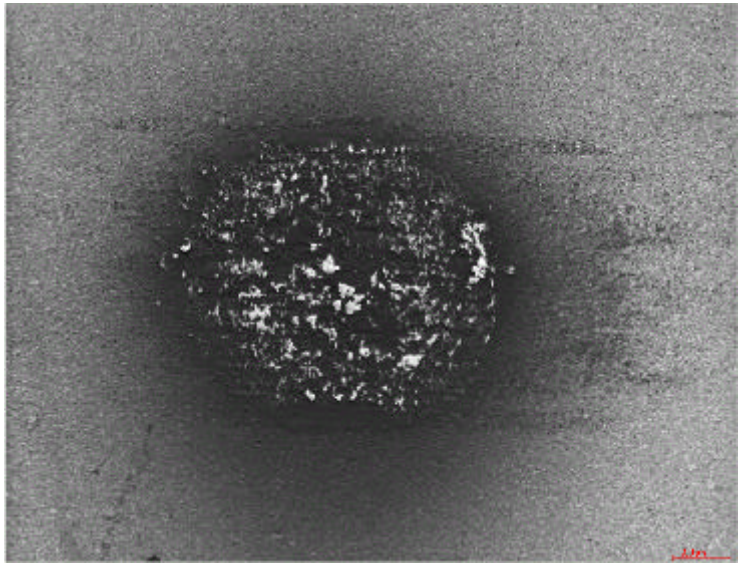
Flip chip technology is an alternative method of mounting electronic components on wiring carriers (circuit boards, ceramics substrates). The metallisation between the solder bump and the component, the so-called UBM (under bump metallisation), presents a particular technological problem.

The samples in this example are cross-sections of the Sn(Pb) solder bumps with a UBM consisting of an Al/Ni(P) double layer on silicon after various thermal loads. The expressiveness of the classical electron image can not be compared with that of the new element imaging.



Examples for Application

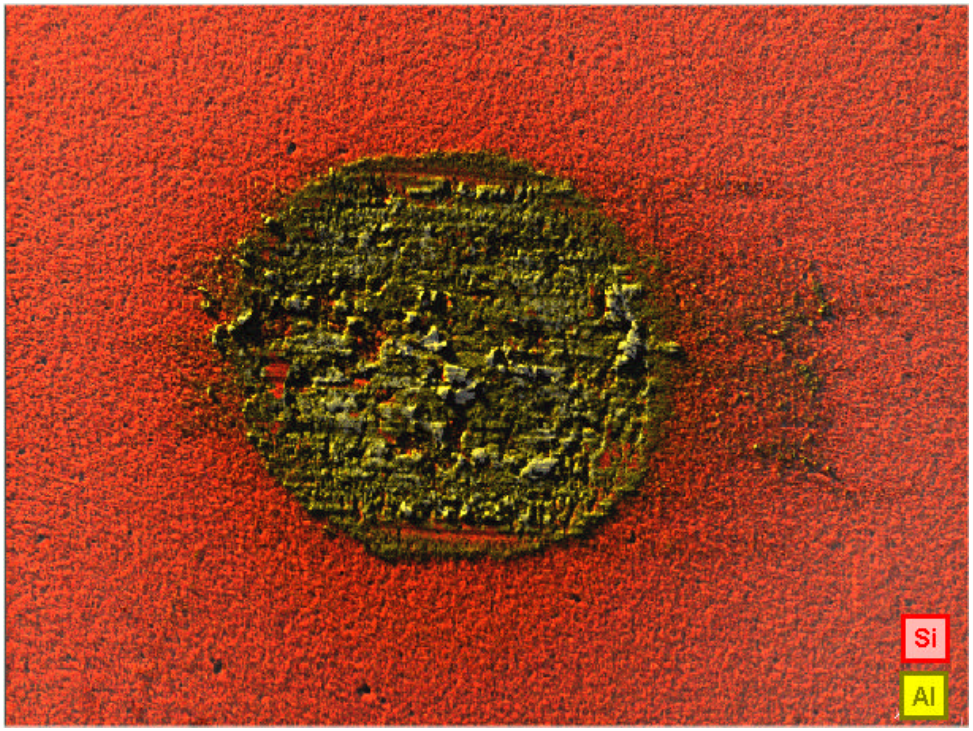
Corundum scuff mark



A solid cut sample made of mechanically resistant SiC ceramic material was compared with another sample body made of corundum for wear resistance. The form of the scuff mark and the amount of abrasion are essential characteristics of the attrition behaviour of the material:

Again, adding the colour component clearly enhances the plasticity of the image.

The electron image shows what the object observed looks like. The colour image shows in addition what it consists of.



Summary

- MultiMax is able to deal with up to 400.000 cps (processed counts!)
- MultiMax is more than 10 times faster in comparison to conventional MAP with EDX, even with lower deadtime (100 kcps input -> deadtime ≈ 5% !)
- ElementImaging provides element images with high resolution and high data depth in reasonable time!
- Electron images become colours due to merging with element images!

The age of Element Imaging with Electron Microscope is just beginning.

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