SEM

X-Max^N Silicon Drift Detector Range

New, next generation, nanoanalysis

Size matters, sensitivity counts

OXFORD INSTRUMENTS

The Business of Science®

X-Max^N: Overview

New detector technology…

The world's largest SDD – 150 mm^2

X-Max^N exploits a new sensor chip, new electronics, and an innovative design to deliver truly 'next generation' SDD performance.

- A range of detector sizes, from 20 mm^2 for microanalysis up to an astounding 150 mm^2 for advanced nanoanalysis
- A doubling in speed over the previous generation
- Up to four detectors can be installed for an active area up to 600 mm^2

All detectors provide:

- The best low energy performance – all detectors clearly resolve Be
- The same excellent resolution, guaranteed on your microscope
- Count rates proportional to sensor size – the same short sample to detector distance

Size matters, speed counts

Under the same operating conditions, bigger detectors:

- Will do in seconds what used to take minutes – mapping can be an everyday tool
- Will dramatically improve precision for the same acquisition time

X-Max^N Large Area detectors – high-speed microanalysis is routine for all.

Low energy matters, sensitivity counts

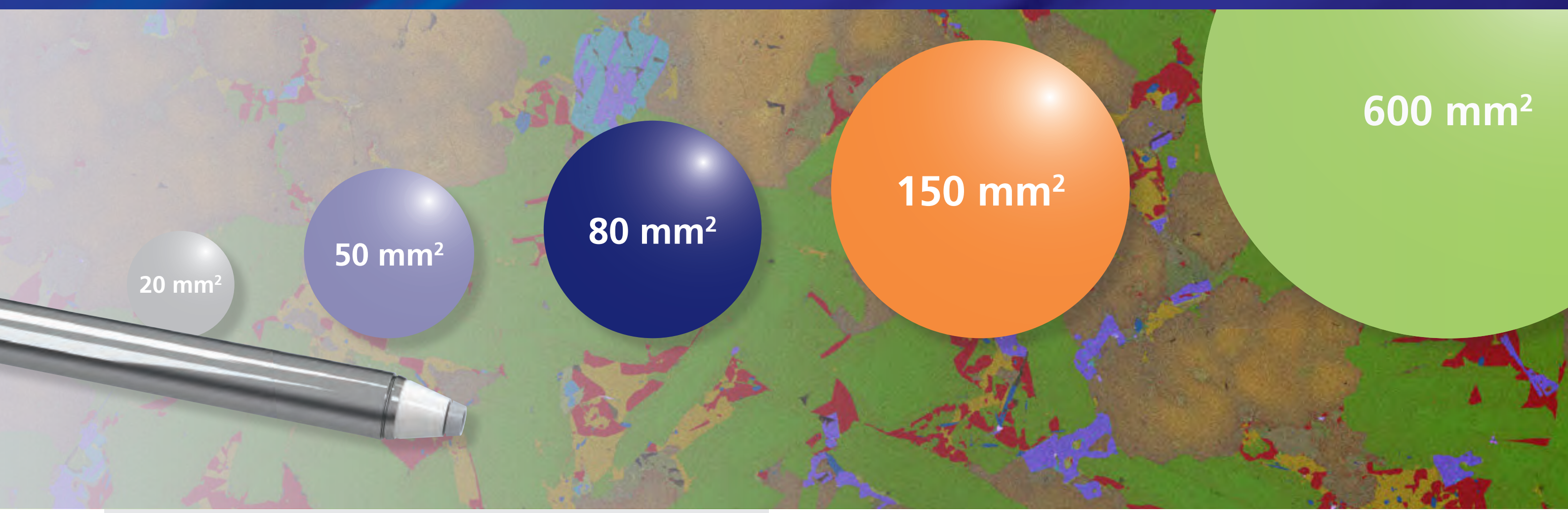
X-Max^N is optimised for low energy performance – no compromise on size. Nothing else comes close.

- Be detection guaranteed on all detectors
- Si Lℓ can be mapped

X-Max^N Very Large Area detectors – low energy analysis is practical for all.

NOVATION

...and up to 150 mm^2 active area per detector



Size matters, spatial resolution counts

High spatial resolution conditions give low X-ray yield.

- Large area detectors collect high quality low energy spectra in practical time scales
- Nanoscale features can be better characterised

X-Max^N Very Large Area detectors – advanced nanoanalysis is possible for all.

Quality matters, the result counts

Acquiring data is only the first part of the process, achieving quality results demands **AZtec**:

- Characterising the entire measurement chain for the best analytical performance
- Implementing the world's only real-time pile-up correction – vital when count rates are high

System solution: AZtec®

A key component of the **AZtec** EDS system, **X-Max^N** maximises everyone's speed and accuracy: from routine microanalysis applications to those working at the frontiers of nanoanalysis.

- Point&ID takes advantage of the high count rates generated by the **X-Max^N** to deliver accurate sample information in real-time
- New Tru-Q® technology automatically takes standardless analysis to the next level
- TruLine and TruMap show real-time elemental information automatically corrected for overlaps and background

This system detects and identifies more X-ray lines than any other

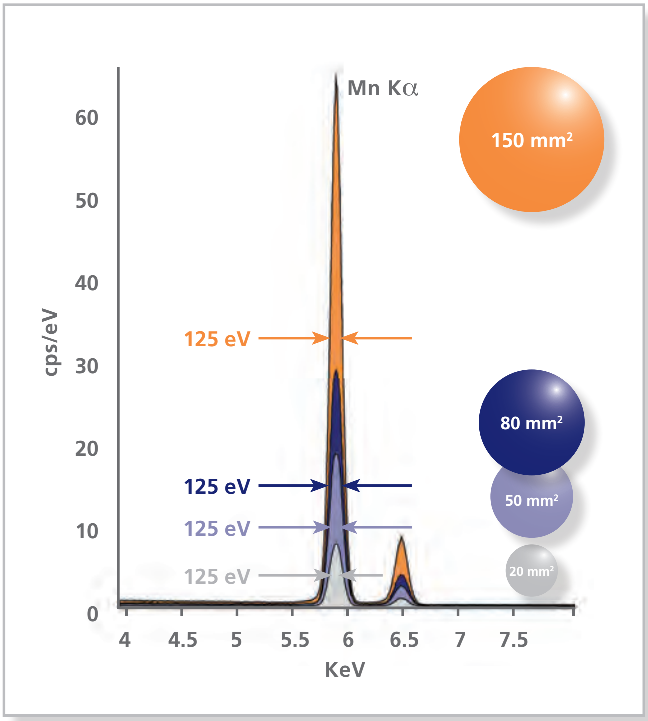
X-Max^N: 150 80 50 20

Size matters

Performance independent of size

X-Max^N comes in a range of detector sizes, from 20 mm^2 to 150 mm^2 – the largest SDD in the market. **X-Max^N** resolution and low energy detectability is independent of sensor size because of its external FET design.

- The same sensor position means that the count rate increases in proportion to sensor size
- The same outstanding resolution performance is guaranteed on all sensor sizes
- Excellent low energy analysis, including Be detection on all sensor sizes



Why size matters

Using a large sensor means:

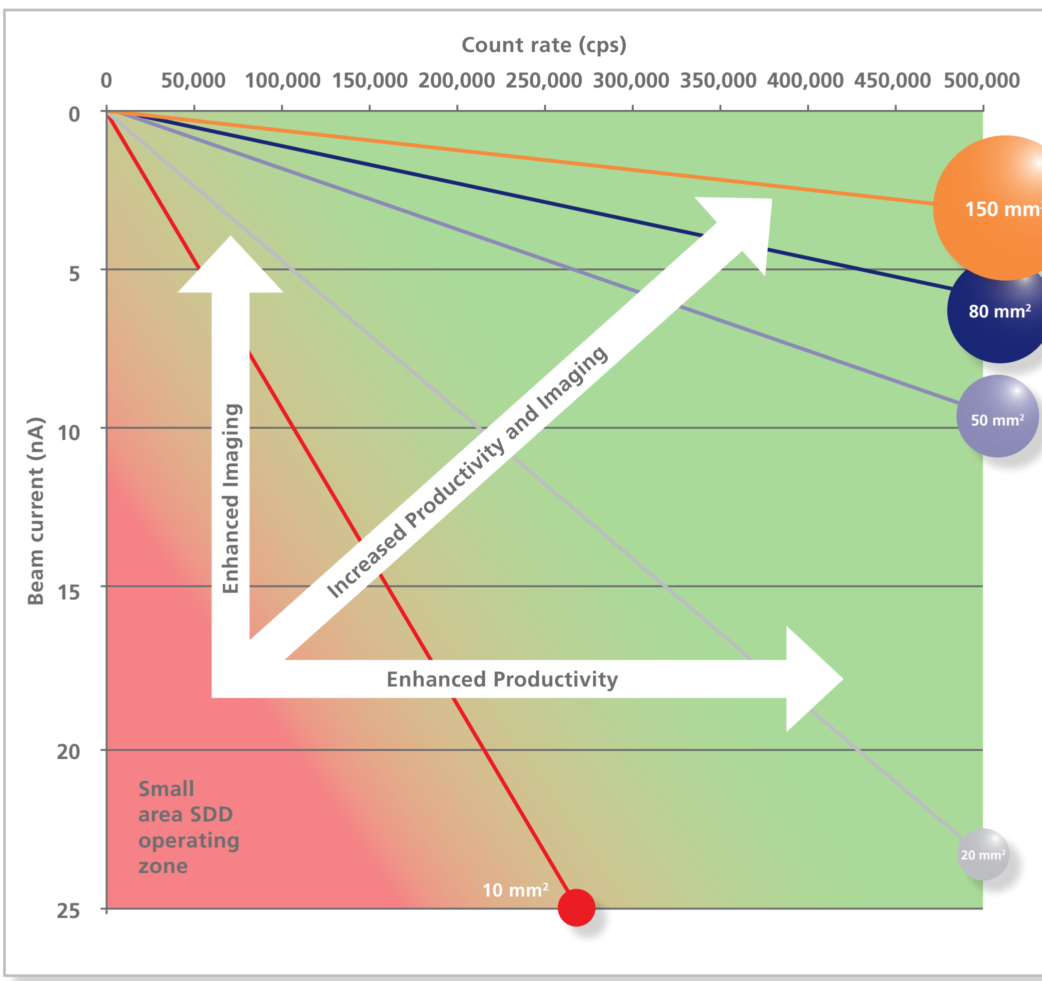
- Productive count rates at low beam currents
  - Maximising imaging performance and accuracy
  - No need to change imaging conditions for X-ray analysis
- Significantly higher count rates at the same beam current
  - Shorter acquisition times
  - Better statistical confidence
- Practical analysis with small beam diameters
  - Maximising spatial resolution
  - Get the best out of your high resolution SEM

With X-Max^N the bigger the size, the bigger the performance

DUCTIVITY

…for a dramatic increase in performance

At 20 kV a 150 mm² detector requires less than 2 nA to generate 200,000 counts per second. In contrast, a 10 mm² detector requires nearly 20 nA.



The graph shows typical count rate at different beam currents, when analysing Pure-Mn at 20 kV using a detector with 30° take off angle and 45 mm sample to crystal distance. Using a larger sensor, count rates are increased without increasing beam current. This means productive count rates are achieved under conditions where spatial resolution is maximised and beam damage minimised. The images to the left show the potential effects of increasing beam current on image quality.

Sensitivity

Big performance for the nanoscale

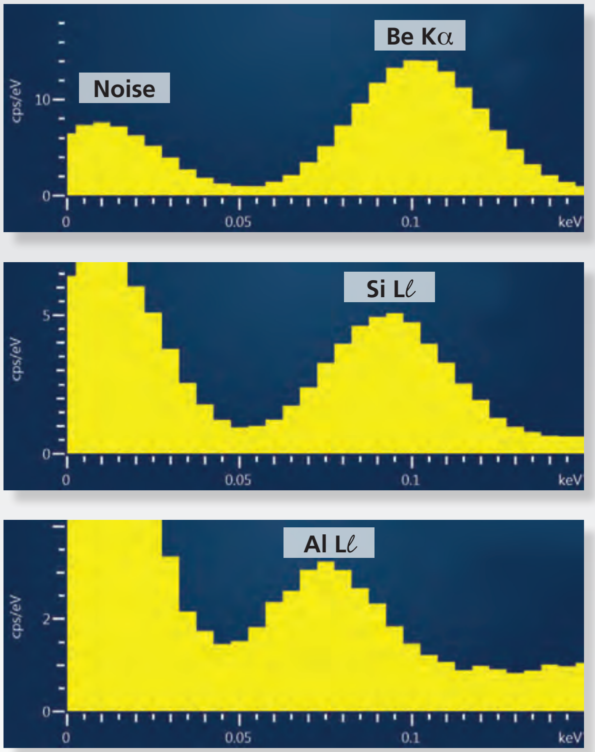
The **X-Max^N** 150 'Very Large Area' detector is a breakthrough in SDD design that opens the frontiers to advanced nanoanalysis.

- Excellent resolution and sensitivity at low energy to detect the limited range of X-rays emitted at low kV
- Maximised area for capturing the small number of counts generated
  - Small spot sizes at low kV are required to maximise spatial resolution and minimise sample contamination and damage

For the ultimate nanoscale analysis

X-Max^N provides:

- A large solid angle, meaning that **X-Max^N** 150 typically collects more than twice the counts of any other SDD under the same conditions
  - The largest area on the market, 150 mm^2
  - Innovative package engineering puts the largest sensor in the same size tube as other **X-Max^N** detectors
- New sensor design results in outstanding efficiency for very low energy X-rays (<150 eV)
  - Be guaranteed
  - Si Lℓ and Al Lℓ detectable
  - Resolution fully specified to ISO 15632: 2002 – including C and F guaranteed
  - Fully tested at the factory and at installation on your microscope



*Examples of very low energy X-ray lines. Be Kα and Si Lℓ spectra collected using **X-Max^N** 150. Al Lℓ spectrum collected using an **X-Max^N** 80 detector.*

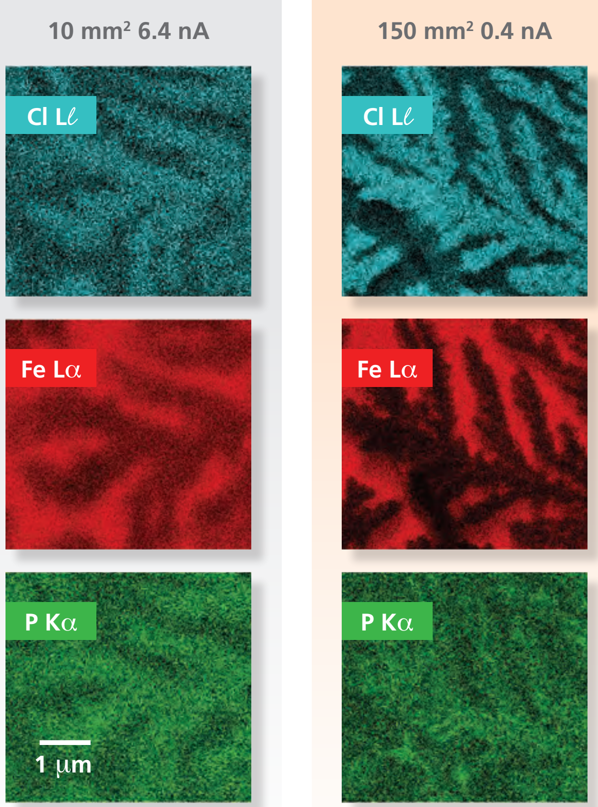
X-Max^N 150 collects more than twice the counts of any other SDD

ANOSCALE

X-Max^N 150
The only choice for FE-SEM

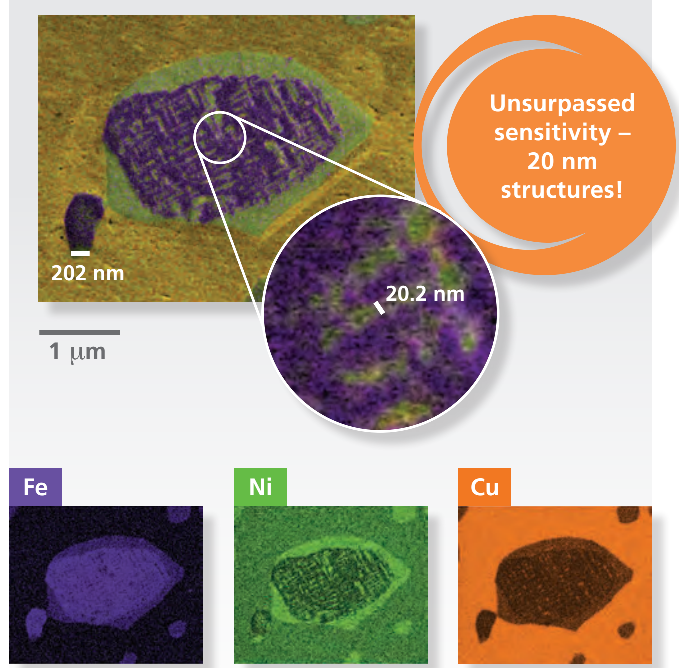
The effect of beam current on nanoscale analytical capability.

When using smaller detectors, the high beam current required to achieve usable count rate leads to poor spatial resolution. The **X-Max^N** 150 Very Large Area detector acquires high count rates at excellent spatial resolution, for successful analysis of the smallest nanostructures.



Above: *X-ray mapping of fragile nanostructures at 5 kV. For the same count rate, 150 mm² detector requires much lower beam current, meaning that the spatial resolution is good enough to clearly show nanoscale variations and minimise specimen damage. In contrast, higher beam current required for 10 mm² results in loss of nanoscale resolution and significant damage during the map collection.*

X-ray Mapping of 20 nm nanostructures in a memory alloy



Above: *X-ray maps collected at 0.2 nA, 3 kV using 150 mm²* ***X-Max^N*** *detector to investigate nanostructures in a memory alloy. Variations in Fe Lα, Ni Lα and Cu Lα clearly demonstrate chemical differences on a scale down to at least 20 nm.*

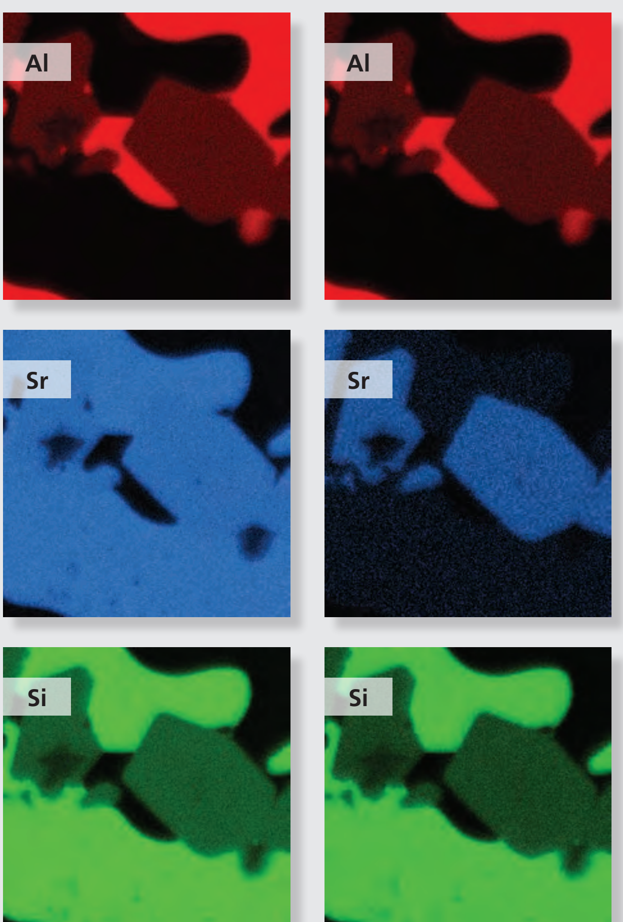
X-Max^N and AZtecEnergy

Quality results – fast and accurate analysis

X-Max^N and AZtec® make seeing the real picture in real-time a reality.

At low kV, **X-Max^N** large area detectors provide high resolution spectral mapping. Using real-time peak overlap and background corrected TruMaps in the new **AZtec** software, real chemical variations are shown instantly.

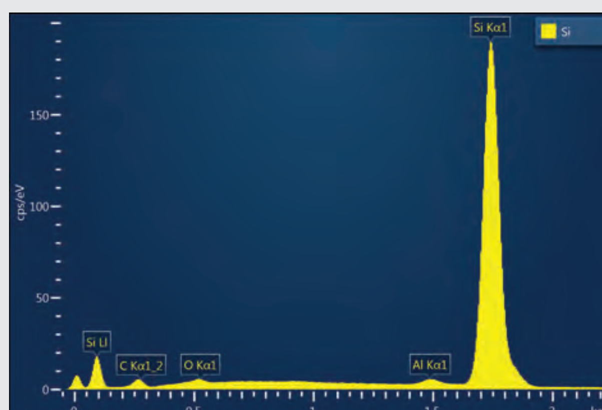
Standard Mapping | **With TruMap**



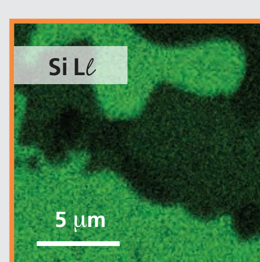
Real element variation where peaks overlap

Standard X-ray mapping of inter-metallic phases in an Al-Si-Sr alloy.

Using 5 kV for data collection allows excellent spatial separation of phases. However, the peak overlap of Si K and Sr L produces misleading information, particularly in the distribution of Sr. Switching to TruMap gives real-time peak overlap correction of Si K and Sr L to reveal the real distribution of these elements.



Spectrum acquired from a Si phase from the Al-Si-Sr alloy using ***X-Max^N*** *80 at 5 kV. This detector has the solid angle and enhanced very low energy performance required to detect Si Lℓ easily.*



Si Lℓ intensity is sufficient for this 512 resolution Si Lℓ X-ray map to be collected that correctly matches the Si distribution seen in the Si K TruMap shown to the left.

Unsurpassed sensitivity – Si Lℓ X-ray map

TRU-Q

Proving the accuracy of data acquired at very high count rates.

Very Large Area SDD promises the capability of very fast data collection. Only **X-Max^N**, in combination with **AZtec**Energy's unique Tru-Q technology, provides the necessary stable signal and data processing required for accurate analysis at high count rate including:

- The only guarantee of peak resolution AND peak position stability of <1 eV at high count rates
- Real-time correction of pile-up artefacts:
  - Removes sum peaks
  - Restores true peak heights and shapes
  - Reveals hidden minor element peaks

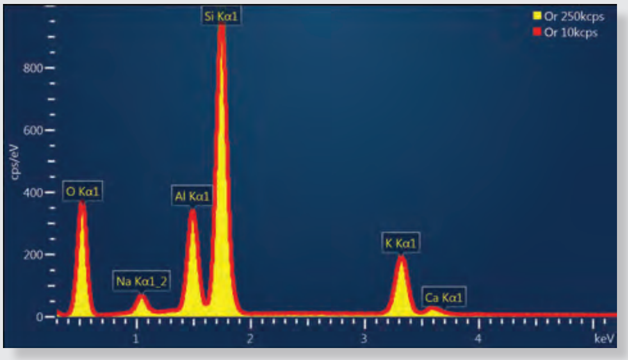
Proving high count rate quantitative accuracy using an orthoclase standard

At high count rates **X-Max^N** is uniquely stable.

No change is seen in Na, Al, Si and K Kα peaks from 10,000 cps to 250,000 cps when using unique pile-up correction.

Likewise, quantitative analysis of these spectra show identical results:

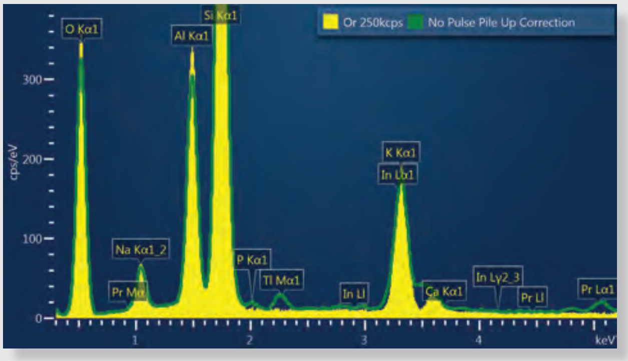
	O	Na	Al	Si	K	Ca
250 kcps	46.86	2.63	10.11	30.64	9.54	0.23
10 kcps	46.87	2.64	10.03	30.71	9.52	0.24



At 250,000 cps significant artefacts are seen without pile-up correction (green spectrum). For example misidentified elements such as:

- Si + Ca = Pr
- Si + O = Tl

As a result, significant quantitative errors are seen at this count rate without pile-up correction.



X-Max^N Multiple Detectors

Maximise sensitivity and speed for the most challenging samples

Double, treble, or even quadruple count rate with no trade-off in performance.

With **AZtec**Energy and **X-Max^N**, data from multiple detectors is seamlessly combined for even greater sensitivity.

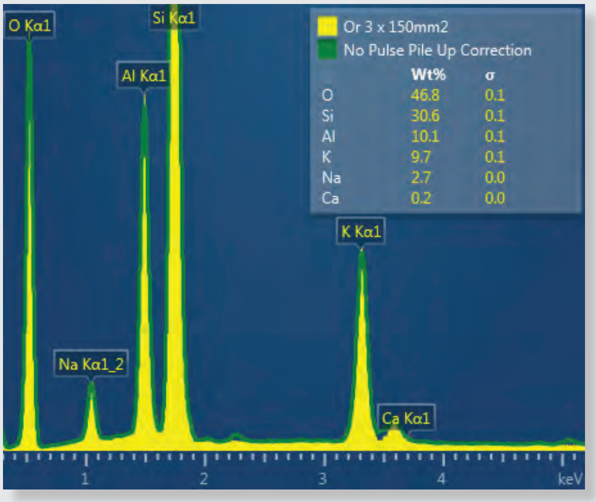
- Increase count rate, with no loss in spatial or spectrum resolution
- Up to four detectors on one microscope
- Up to 600 mm^2 real active area!

Benefits

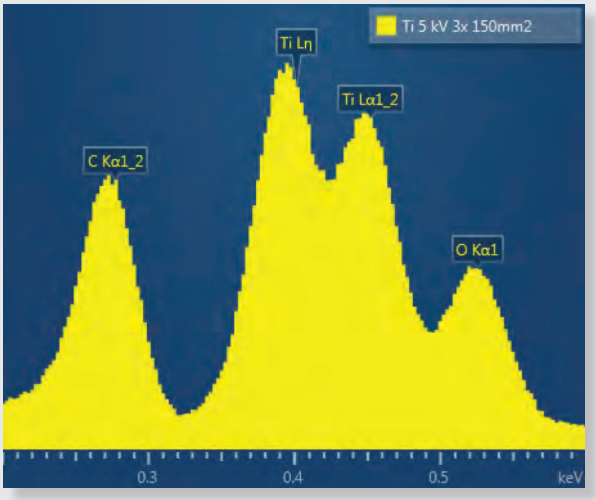
- Collect X-ray maps using only a few pA on the most unstable samples
- Maximise information from the smallest nano-particles and features
- Quantitative analysis with pulse pile-up correction at many 100s of thousand counts per second
- Detect low concentrations of minor elements faster

*A configuration with four **X-Max^N** 150 detectors - together making up a system with an overall effective area of 600 mm^2.*

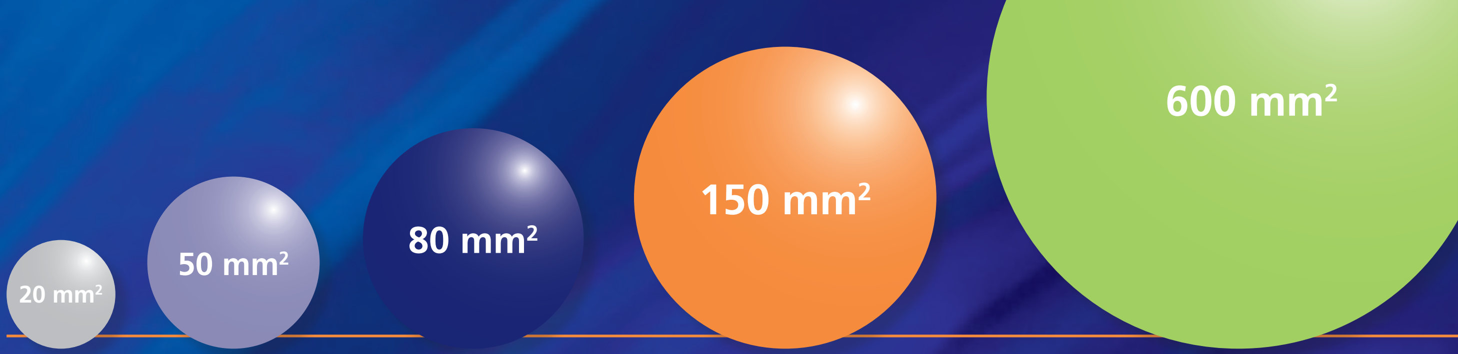
Spectra collected using three **X-Max^N** 150 detectors.



__Above__ is a pile-up corrected spectrum from Orthoclase. The total count rate is similar to the spectrum on page 9, however resolution is improved and pile-up reduced due to the three processing channels. The same accurate quantitative result is calculated using __AZtec__Energy.

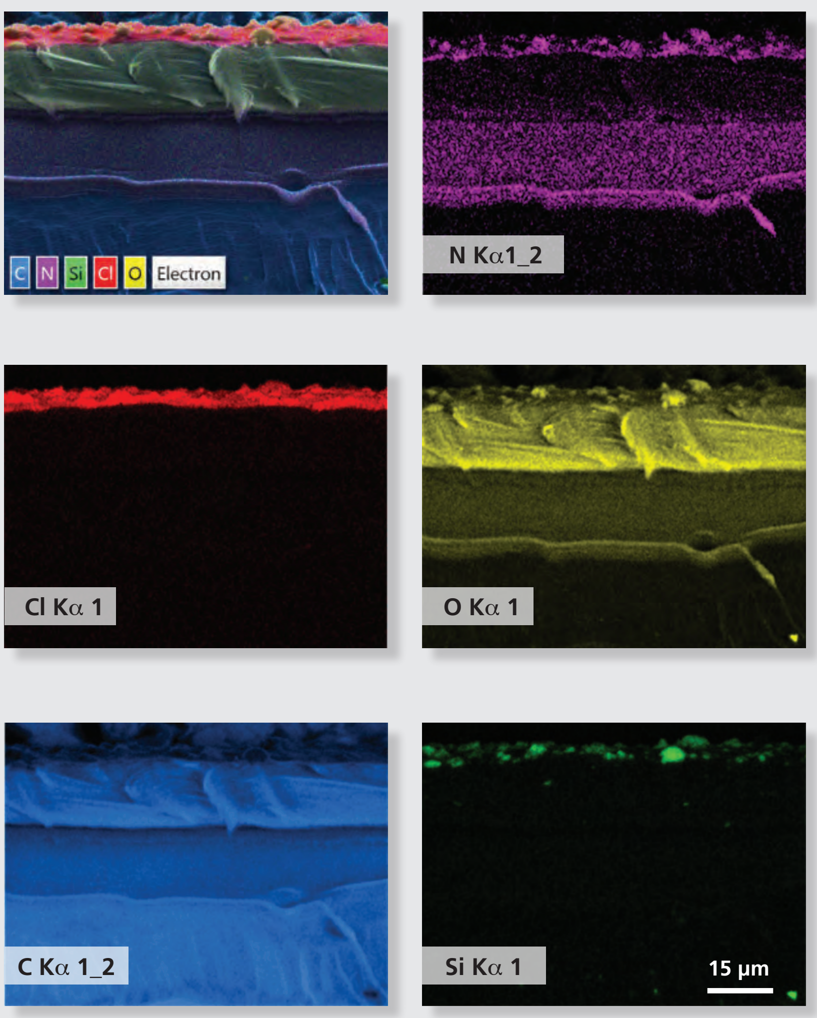


Above, the spectrum showing excellent low energy peak shape and separation is achieved from the combined output. This is a key requirement for high spatial resolution nano-analysis at low kV. Spectrum collected from oxidised Ti at 5 kV.

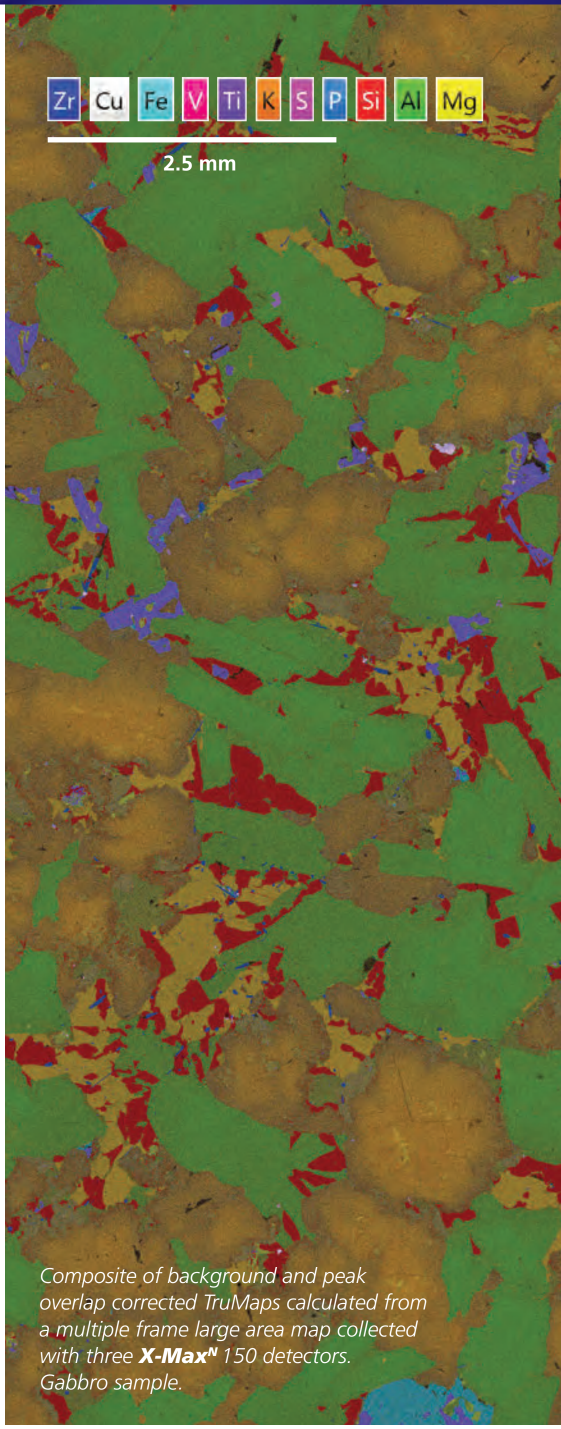


Nanostructures, polymers, organic materials…

X-ray mapping of coatings on packaging polymers



*Beam sensitive polymer samples are difficult to analyse with conventional methods due to surface charging and beam damage. With two **X-Max^N** 150 mm^2 detectors on a W-SEM, layers in the polymer cross-section can be rapidly characterised with count rates above 10,000cps, revealing not only the elements in the coating but also the different light elements (C, N, O) that make up the polymer structure.*



*Composite of background and peak overlap corrected TruMaps calculated from a multiple frame large area map collected with three **X-Max^N** 150 detectors. Gabbro sample.*

OISERVICE

Global Customer Support

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Oxford Instruments recognises that your success requires not just only world-class products, but also world-class service and support. Our global service team is renowned for delivering outstanding service to customers and microscope vendors:

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- On-site training tailored to your specific needs
- Web-based courses and training videos
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