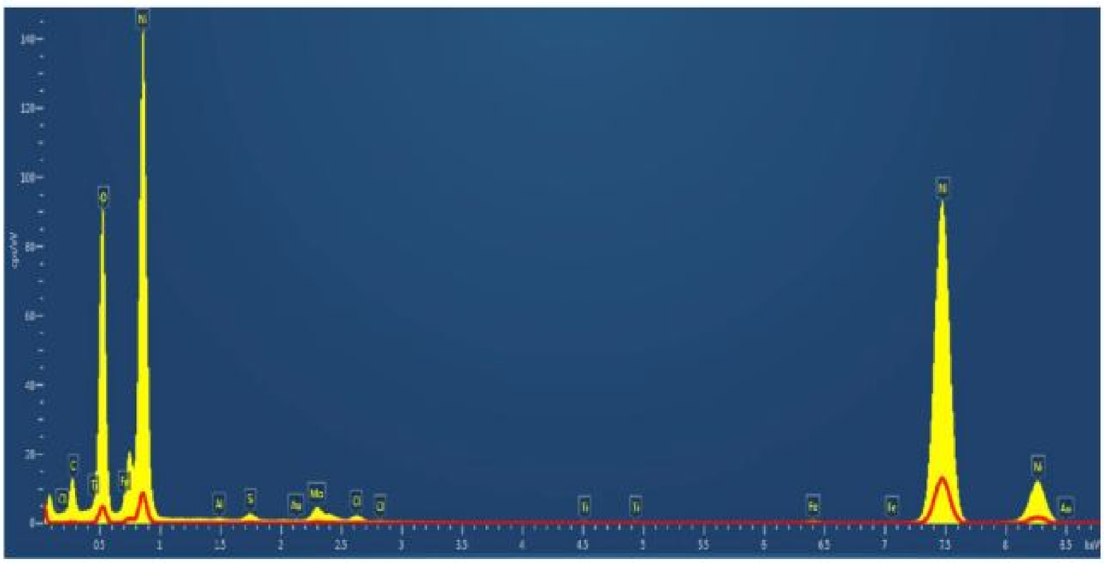
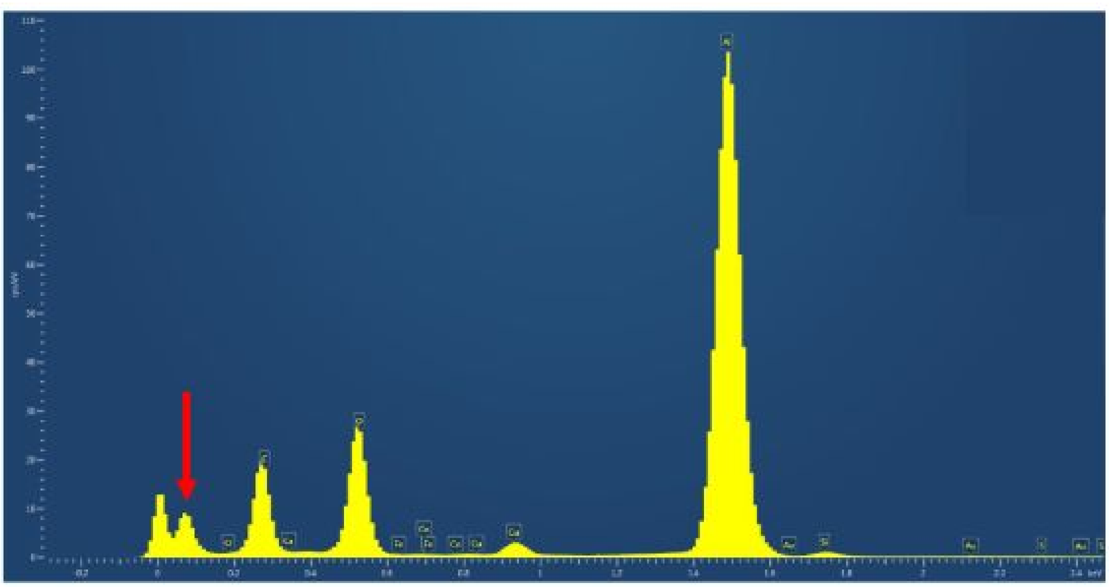
New High Solid Angle SDD X-ray detector for ARM (August 2013)

Oxford Instruments has supplied RRC with a prototype windowless, large solid angle XEDS detector which is compatible with the UHR pole piece fitted to our JEOL ARM-200CF. The **X-Max100TLE** detector is capable of nearly an order of magnitude increase in count rate compared with the previous detector (X-Max80) under exactly the same operating conditions (specimen, probe current, tilt etc). Its unique sensor design allows for the 100 mm2 active area to get very close to the sample, and it is windowless to reduce absorption effects and increase light element sensitivity and detection of low energy X-rays. Encouragingly we do not see a significant increase in spurious peaks due to scattering from either the pole piece or specimen holder. The detector also has a reduced tilt sensitivity allowing good XEDS spectra to be collected over a much larger specimen tilt range than with the X-Max80 detector.

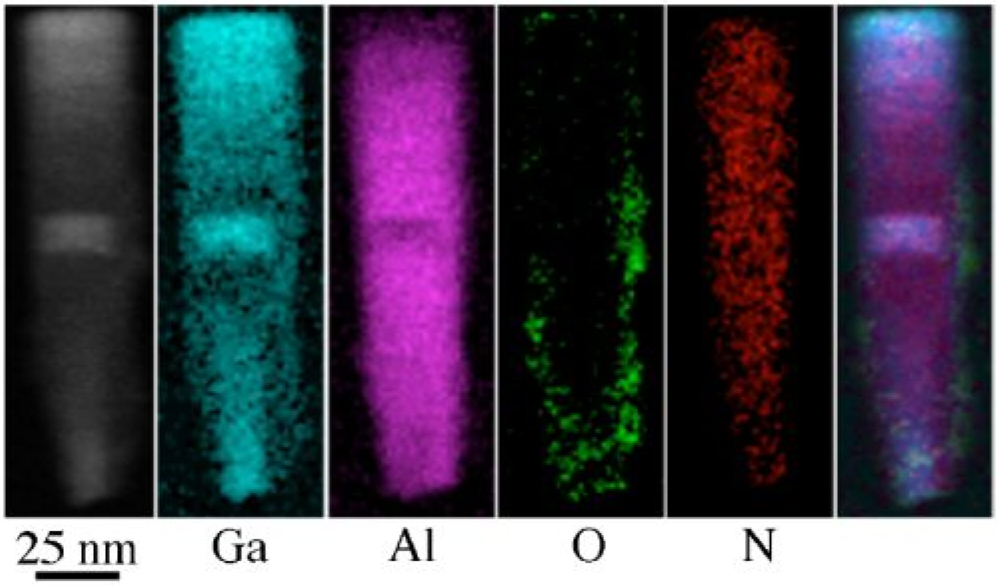


< Comparison of XEDS spectra, from a NiOX test specimen under the same operating conditions, collected with the X-Max100TLE SDD (yellow bars) and the X-Max80 SDD (red line). On top of the significant increase in intensity there is a vast improvement in low energy detection due to removal of the detector window.

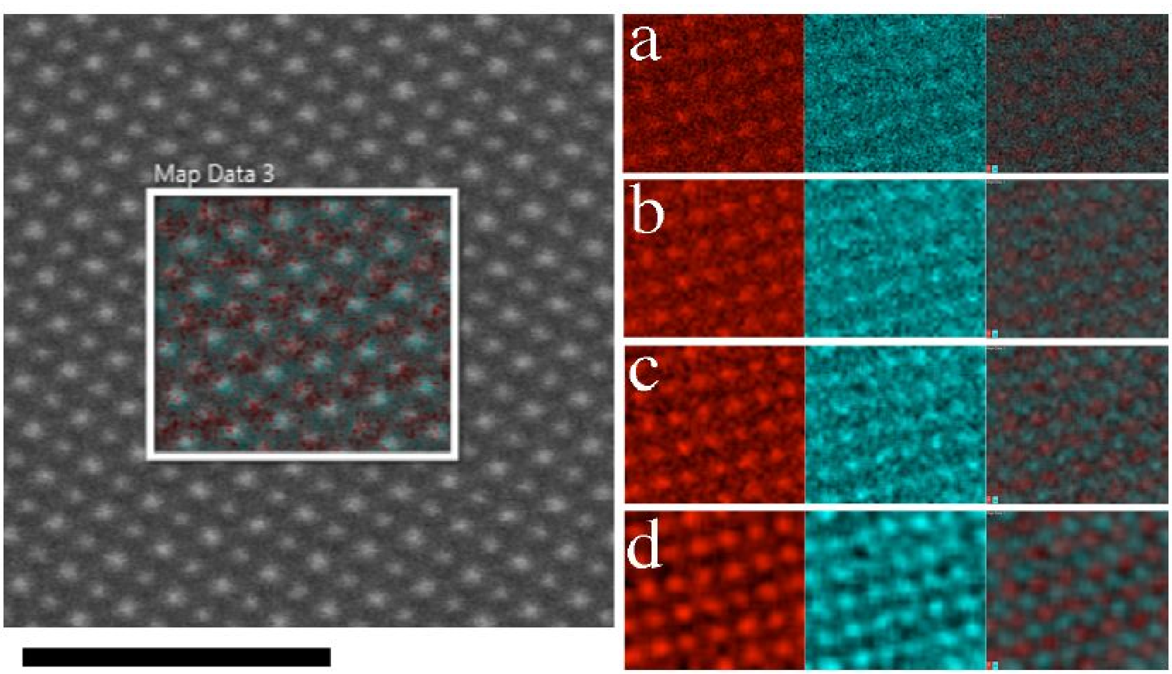


<The improvement in low energy detection can be seen in this spectrum from an Al thin film where the AlL peak is clearly visible

This detector is particularly suited for XEDS mapping. The high solid angle allows XEDS maps that would have taken 15-30 minutes to be collected in just a few minutes.



XEDS maps from an Al(x)Ga(1-x)N nanowire acquired in 2 minutes. The wires, which are compositionally graded from x=0 to x=1 and then back again after a Ga-rich quantum well (QW), will have properties (e.g., bandgap) that are intimately linked to physical characteristics such as the QW thickness, composition, etc. As the high angle annular dark field (HAADF) STEM signal approaches the square of the atomic number, you can roughly determine the Ga-rich regions. However, the Al gradation is nicely indicated by the XEDS map,identifying increasing Al content moving toward the quantum well on either side. The oxidation heterogeneously coating the nanowire is something that is not at all apparent in the HAADF image, yet revealed in the XEDS map. For example, in terms of optimizing device performance, as Al is known to be an oxygen-getter, it is important to be able to identify any such oxide shells forming during the growth process. Thus, the ability to map O simultaneously with Al and Ga cannot be understated, yet is considerably more difficult in EELS, given the either higher energy or delayed-onset edges involved. In this case, however, it appears that the sample has simply oxidized post growth, as there is evidently no aluminum associated with the oxygen.



Atomic Resolution XEDS mapping. Using a 100pm probe with approximately 0.25nA of beam current it becomes possible to collect X-ray maps that show the composition of the atomic columns. In this example using a strontium titanate sample, (a) is the raw unbinned data; (b) raw binned 2x; (c) smoothed 3x3, unbinned;(d) smoothed 3x3, binned 2x. The overlaid map in the HAADF image is from data set (a). The Scale bar is 2.5 nm, applicable to the HAADF image. The Sr and Ti atomic columns are clearly visible in the raw data, without any processing.