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High Resolution Imaging and X-Ray Microanalysis in the FE-SEM

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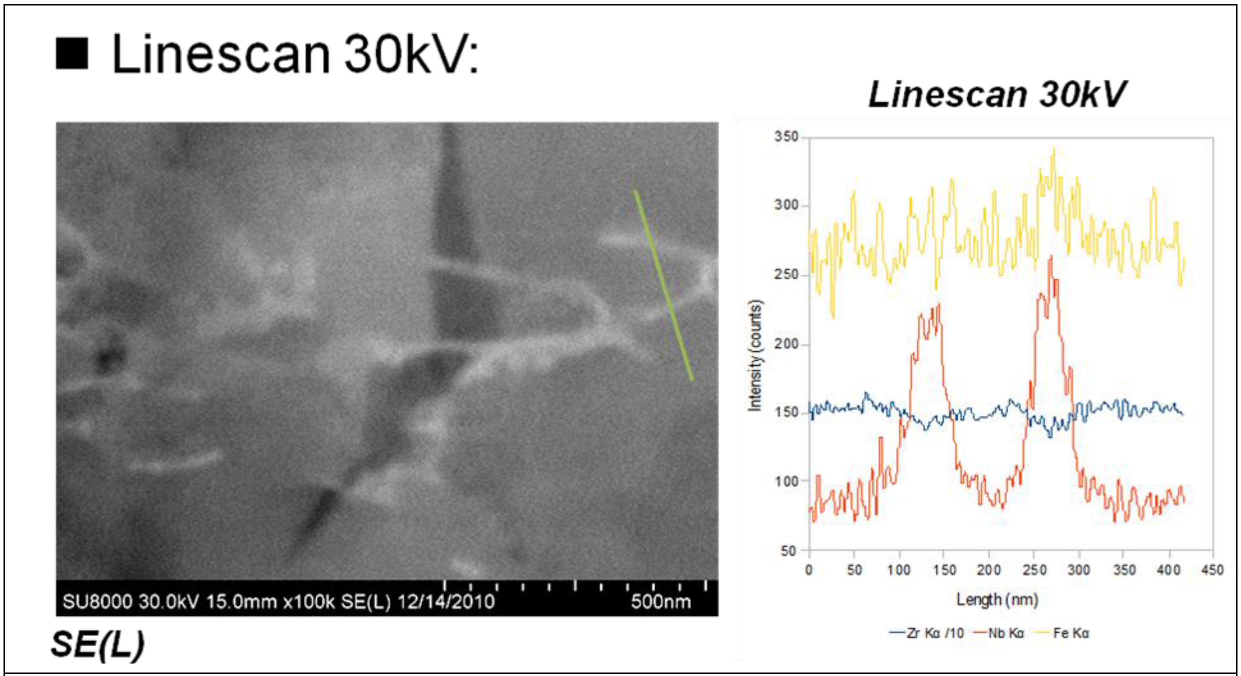
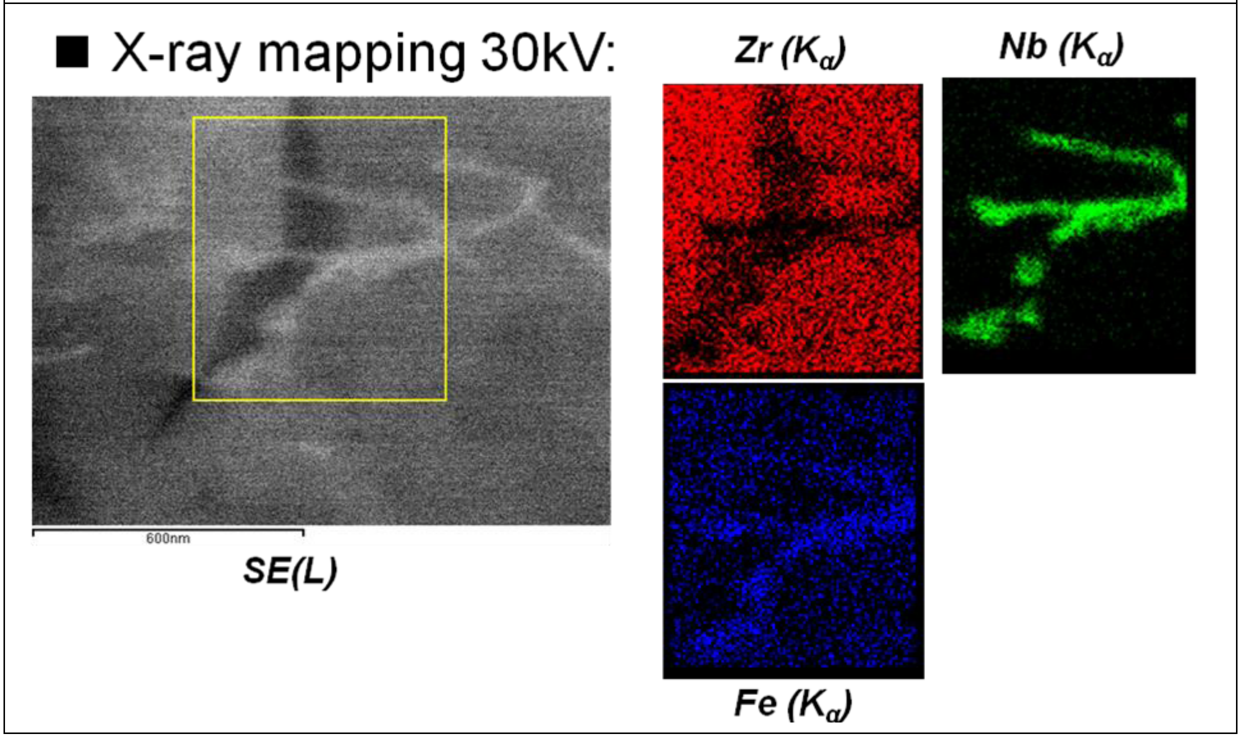
The new generation of Field Emission Scanning Electron Microscope (FE-SEM) can perform high resolution imaging at incident electron beam energy below 1 keV. Images with resolution smaller than 2 nm are now guaranties by various manufacturers. Since imaging below 1 keV allows obtaining surface details of nanomaterials and reduces beam damage for sensitive materials, it is clear that electron microscopy is now entering in a new era. With FE-SEM that can operate in the 50 eV to 30 keV range, with many images modes like conventional bulk secondary electron (SE) or backscattered electron (BSE) imaging or new scanning transmission electron microscopy (STEM) imaging of transparent materials in bright field or dark field mode, the versatility of these microscopes is obvious. Also, if we keep in mind that we can also perform quantitative x-ray microanalysis with start of the art SDD EDS detectors and crystallographic characterization of materials with EBSD detectors, FE-SEM has a very bright future and its importance in science and technology will growth faster than ever because we have now microscopes that can deliver enough current with high spatial resolution to fully exploit the advantages of low voltage scanning electron microscopy as predicted by Von Ardenne as far as 1942.

This paper will present new results for the characterization of various nanomaterials obtained with the new Hitachi SU - 8000 cold field FE-SEM recently acquired by the research group of Prof. Gauvin. This FE-SEM has 1 SE lower detector, 2 SE upper detectors with various modes of energy filtration, a five quadrant BSE detector, a STEM detector that works in bright field, an electron convertor that allows to use the SE lower detector for dark field STEM imaging, a 80 mm^2 SDD EDs detector (Oxford Instrument) and an EBSD Nordlys II System (Oxford Instrument). The maximum probe current of 40 nA allows to perform quantitative x-ray microanalysis at low voltage and also to acquire EBSD elemental maps at a faster rate, eliminating the problems of drift current issues and flashing. In order to acknowledge Raymond Castaing's work, a strong emphasis in quantitative x-ray microanalysis will be given in this presentation. As an example, the following figures shown x-ray line scans and maps at 30 keV of a 80 nm thin foil of a Zr2.5Nb alloy that was fibbed with a Hitachi NB-5000 NanoDuet. It is possible to map at high spatial resolution Fe which is present in this alloy at a composition of about 500 ppm.


■ Linescan 30kV:
Linescan 30kV
SU8000 30.0kV 15.0mm x100k SE(L) 12/14/2010
500nm
SE(L)
Intensity (counts)
350
300
250
200
150
100
50
0
50
100
150
200
250
300
350
400
450
Length (nm)
Zr Kα /10
Nb Kα
Fe Kα


■ X-ray mapping 30kV:
Zr (Kα)
Nb (Kα)
600nm
SE(L)
Fe (Kα)