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THE RIGHT TOOL FOR LOW ENERGY X-RAY MICROANALYSIS

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EDS Microanalysis has been performed on the Scanning Electron Microscope for over 30 years; the improvements in the hardware and software capabilities over the years have heralded many innovative ideas and solutions for microanalysis. The Si(Li) x-ray detector has long been the standard detector for x-ray microanalysis, other detectors have come along to try and remove it from the detector of choice, detectors such as Ge and WDS. Most recently the microcalorimeter and Silicon Drift Detector have brought new analytical capabilities to the material scientists.

This paper will describe the performances of the latest generation of x-ray detectors for low energy x-ray analysis, from the Si(Li) LN_2 cooled and LN_2 Free detectors, to the latest parallel beam x-ray spectrometer, the silicon drift detector and finally the microcalorimeter. Application data will show the different applications areas where the detectors will bring new capabilities to tomorrow's material scientists.

The Si(Li) LN_2 cooled detector and LN_2 Free detectors can achieve 60 ev resolution at C and 126 ev at Mn with Peak to Background ratios of ~20,000/1 for Mn X-rays. This performance can be used for general purposes such as qualitative and quantitative analysis. Figure 1 shows low energy spectra acquired with a Si(Li) detector. The Silicon Drift Detector has more modest resolution performance, but is capable of much higher count rates with low dead time. This allows maps to be collected in time periods comparable with the time to collect a single spectrum with a Si(Li) detector. Failure Analysts are then able to show maps of their specimens as well as just spectra of a few spots on a defect.

For higher resolution requirements, the Polaris microcalorimeter and the LambdaSpec WDS detectors are new choices for X-ray analysis. The microcalorimeter detector is an EDS detector with high resolution; <20 eV for Si. Because it is an EDS detector, it has the advantage of simultaneous data collection, and also a small change in resolution with energy over a range from 0.1 to 2.5 keV. These characteristics allow qualitative analysis to be done on samples with difficult elemental overlaps such as Si-W, Si-Ta or Ti-N. These overlaps and others are commonly found in the Semiconductor manufacturing industry. Figure 2 shows the latest acquired EDS data from the microcalorimeter with and without the x-ray optics fitted to the system.

The LambdaSpec WDS detector is a new device using an X-ray focusing optic to parallelize the X-rays from the sample onto a flat crystal. The use of flat crystals allows a very compact spectrometer design to be implemented. The resolution of this spectrometer is variable depending on the crystal being used, and the Bragg angle required for the energy of radiation being detected. In some cases it is better than the microcalorimeter, and in other cases poorer. It has a higher efficiency, allowing its use on SEM's with W or LaB6 electron sources. Its energy range is similar to that of the microcalorimeter. Fig. 3

shows a scan for B in a borated glass. It shows the ability to detect B in glass that exceeds any EDS type of detector.

Each one of these detectors has strengths that can be used in various application areas. Also these detectors can be used in combination, with two or even three of these detectors to be used on an SEM for different aspects of an application need.

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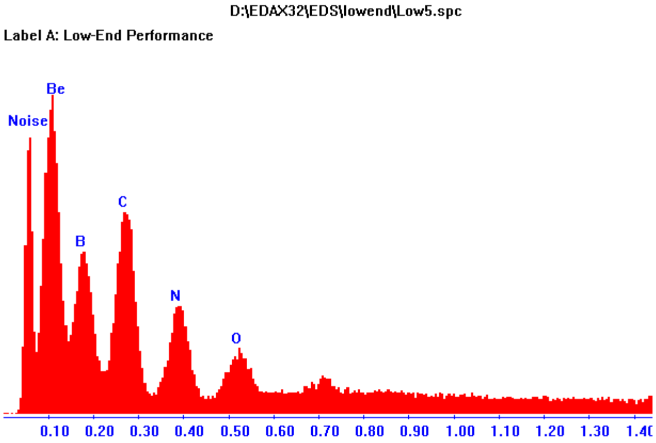

Figure 1: Low Energy Spectra using a Si(Li) EDS Detector

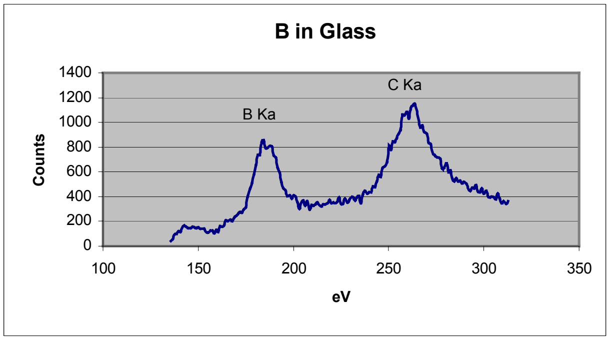

Figure: B in Glass acquired using a LEXS WDS spectrometer

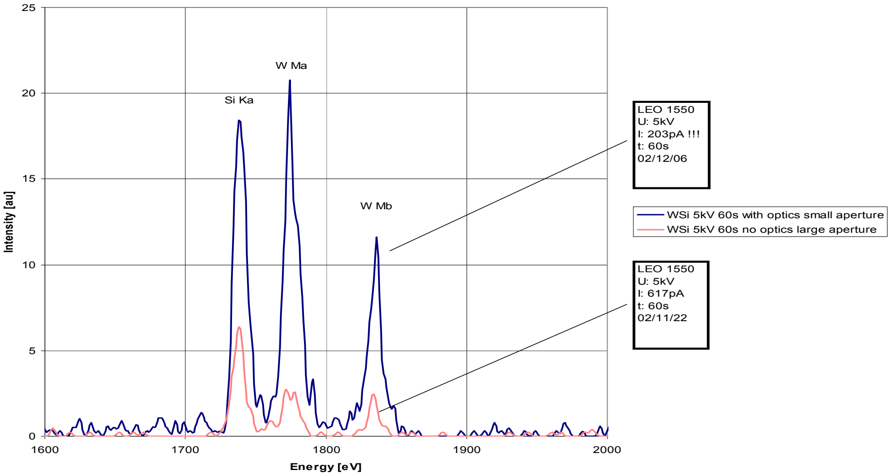

Figure 3: EDS Spectra acquired from the Polaris Microcalorimeter, with and without the X-Ray optics