High voltage EDS on a low Voltage FESEM

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The Agilent 8500A FESEM is a compact field emission electron microscope (FESEM) optimized for low voltage imaging. Microscopy in this low energy range (from 0.5keV-2keV) allows imaging non-conductive, biological and energy sensitive samples without adding protective or conductive materials which can alter or obscure nano-scale features. It can't, however, generate beam energies greater than 2keV and therefore is not capable of uniquely identifying a significant portion of the periodic table for energy dispersive x-ray spectroscopy (EDS) applications.

We have developed a solution to overcome the low voltage limitation by biasing the sample to positive voltage and increasing electron landing energy to match the EDS capabilities of conventional systems. The solution includes:

1. A sample holder that provides isolated high-voltage sample biasing. The current design uses spring loaded contact to make the high voltage connection to the sample carrier allowing the sample carrier to be safely disconnected from the high voltage during sample exchange.
2. Image processing and a calibration procedure that maps the high voltage bias images to the zero bias images. Biasing the sample creates fields in typically field free regions that distort the beam degrading image quality and the ability to do accurate elemental mapping.
3. Real-time display of x-rays for elemental mapping at video rates. A high-speed data path was developed to capture and process individual x-ray events in the system FPGA.
4. A qualitative and quantitative x-ray analysis package.

The proposed solution was successfully implemented on a modified Agilent 8500A FESEM. As shown in Figure 1, a silicon drift detector (SDD), a digital pulse processor (DPP) and a 20kV HV power supply are integrated to the existing system to support the x-ray generation and collection capability.

Experimental results show that up to 15keV x-rays could be generated with a 2keV beam energy and a 13keV sample bias using the proposed approach. The spectrum of a magnesium sample shown in Figure 2 demonstrates an energy resolution, defined as the full width half maximum (FWHM) of the magnesium Kα peak, of 135eV. Due to the large retarding field surrounding the SDD, background radiation was extremely low eliminating the need for an electron trap. This is close to the best energy resolution that the SDD detector used can achieve, as verified with a Fe^{55} source. The system, the components and the preliminary results will be discussed at the presentation.

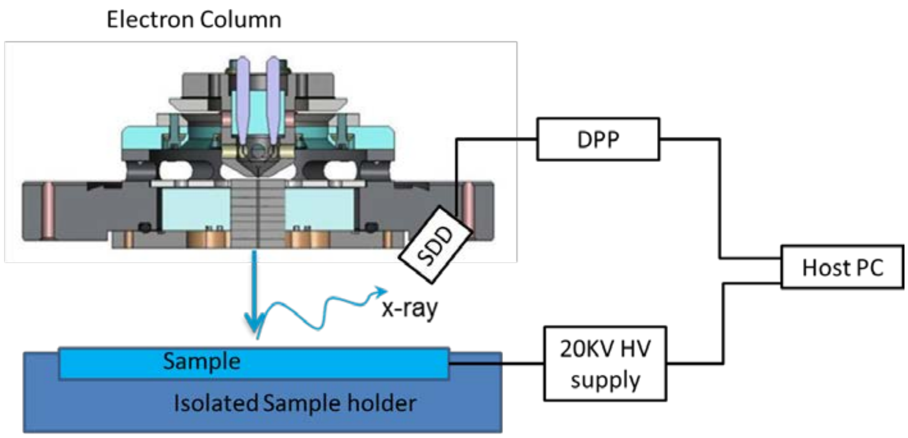

Figure 1: Schematic block of the Agilent FESEM 8500 modified for high voltage EDS

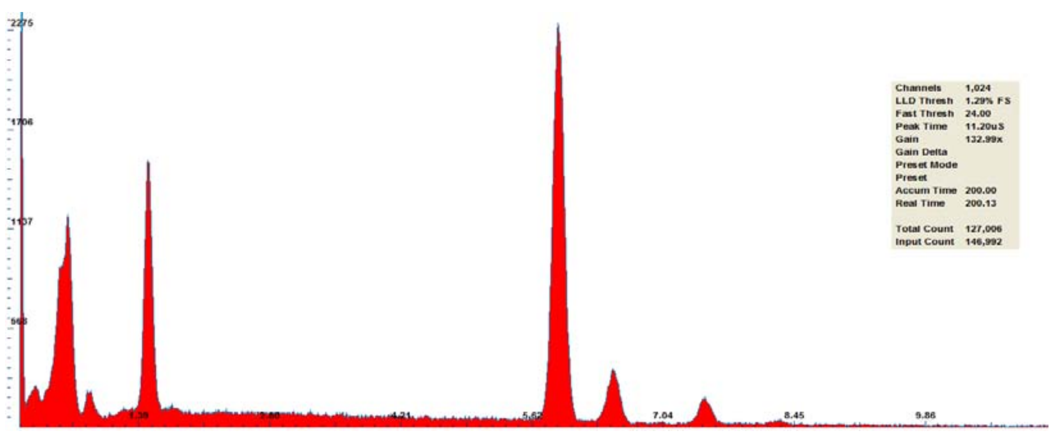

Figure 2: x-ray spectrum of magnesium sample with 2keV beam energy and 13keV positive bias. An electron trap was not installed.
(FWHM 135eV @ Mn kα)