Secondary Electron Count Imaging in a Scanning Electron Microscope

We have implemented secondary electron (SE) count imaging on a Zeiss LEO 1525 scanning electron microscope (SEM). We established the signal level of single SEs using two methods – image histograms and oscilloscope detector outcoupling. In both methods, we imaged a uniform, clean sample of aluminum at low beam currents (< 5 pA), pixel dwell times between 500 ns and 7 μs, and high magnifications, using both the in-chamber and in-lens SE detectors. In the first method, histograms of the sample images showed distinct peaks corresponding to the number of secondary electrons emitted from each pixel. We used these peaks to establish the single SE signal level and calculated the detective quantum efficiency of our detectors. In the second method, we outcoupled the signal from our SE detectors to a 2 GHz oscilloscope. The output signal trace showed a sequence of pulses of mean width ~ 180 ns, corresponding to single SEs. Histograms of the area of the output signal per pixel dwell time matched the image histograms and confirmed the origin of the histogram peaks. Finally, we synchronized data capture on the oscilloscope with the SEM scan signal to count the number of SEs from each pixel and generate SE count images. These images showed an improved signal-to-noise ratio compared to conventional images.