

Nanoscale Analysis

Latest Innovation in JEOL FE SEMs

SMART - POWERFUL - FLEXIBLE

The ability to increase the probe current for fast microanalysis, while still maintaining a small spot size and small volume of excitation for high resolution, has been the holy grail of microanalysis in SEM. One of the unique features of JEOL's FE SEMs is the patented Aperture Angle Control Lens (ACL). This lens automatically optimizes for both high resolution imaging at low probe currents and high spatial resolution X-ray analysis at high probe currents with a seamless transition between the two. This is essential for rapid analysis and superb image quality and is particularly true for low kV microanalysis. The ACL works by considering effects of all aberrations (spherical, chromatic and diffraction limitations) on spot size and automatically optimizing the convergence angle.

When the SEM is optimized for the smallest spot size (largest convergence angle) there is some beam tailing that produces X-rays from areas "not in the spot". For low beam current applications this is insignificant. The best analytical data comes from the smallest convergence angle. Therefore, when the ACL is optimized for image resolution, the resulting high current image (large convergence angle) has somewhat 'hazy' background but shows great resolution. However, when the ACL is optimized for analytical work the ultimate resolution is slightly decreased, yet the analytical signal is no longer affected by the beam tailing resulting in smaller analytical signal delocalization (Figure 1).

The automatic optimization of the ACL maintains high resolution imaging at a wide range of accelerating voltages and probe currents, from a few pA to hundreds of nA. Chart 1 shows resolution versus probe current at the analytical WD for 15 kV and 5 kV. High magnification images of gold on carbon at large probe currents are shown in Figure 2. The images are taken at 15 kV, analytical WD, and a beam current of 1 nA (left) and 100 nA (right).

	15 kV	5 kV
1 nA	1.4 nm	1.5 nm
5 nA	1.9 nm	2.0 nm
10 nA	2.3 nm	2.5 nm
50 nA	2.8 nm	4.1 nm
100 nA	3.7 nm	6.0 nm

Chart 1: Spot size versus probe current at analytical WD.

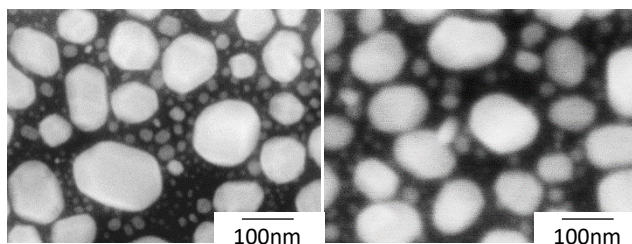


Figure 2: Gold on carbon images taken at 15 kV and analytical WD with 1 nA beam current (left) and 100 nA beam current (right).

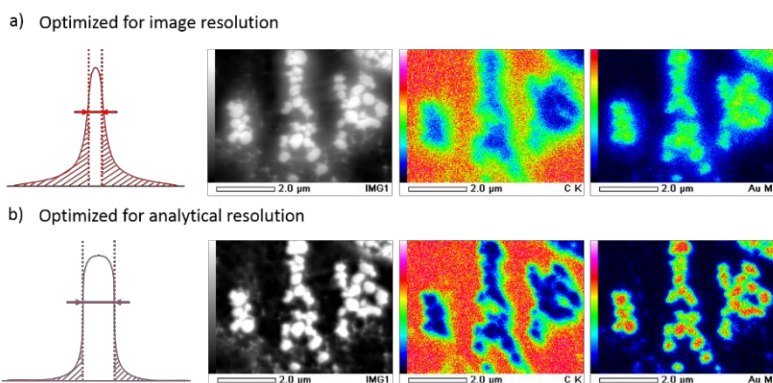


Figure 1: Beam current density on a Gaussian plane. ACL optimization at high beam currents for (a) image resolution, and (b) analytical resolution. Nano gold images and EDS analysis completed at 5 kV, 20kX, and 73 nA.

Implementation of the ACL function at large beam currents allows collection of very fast EDS maps at high spatial resolution using low kVs. One such example is shown in Figure 3 using JEOL integrated EDS detector. This is an EDS map of nickel pillars on ITO with sub-25nm resolution. The map was collected at 6 kV using a beam current of 4 nA in under 3 minutes!

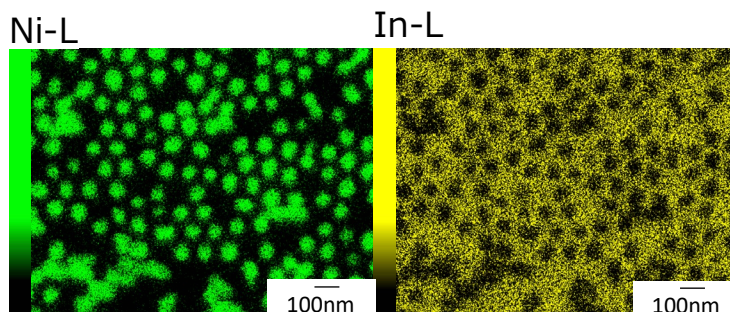


Figure 3: EDS map of nickel pillars on ITO which has sub-25nm resolution. The map was taken at 6 kV, 4 nA of beam current in 160 s.