JEOL FE-SEM – Innovative Design

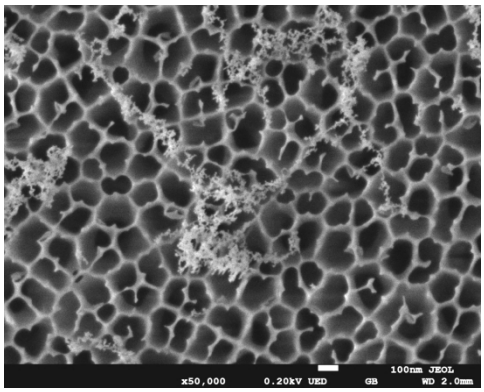
Extreme Low Voltage Imaging

SMART – POWERFUL – FLEXIBLE

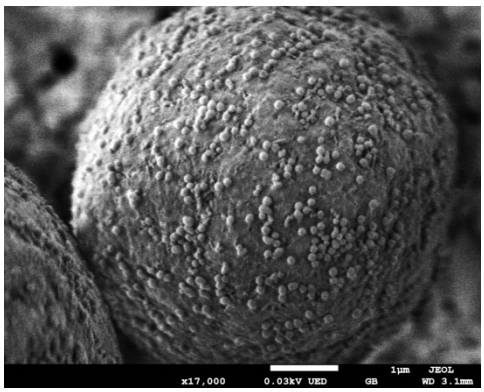
In the last decade there has been a quantum leap in the ability of scanning electron microscopes to observe a variety of materials and biological specimens with ultrahigh resolution and exceptional surface detail, in particular employing low voltage SEM. Low voltage imaging has become a key technique for charge control and reduction, especially in the cases where no surface modification (for example conductive coating) can be employed to alleviate specimen charging during SEM observation.

The current lineup of JEOL FE-SEMs offers a cutting edge Through-The-Lens (TTL) electron column design that minimizes effects of chromatic and spherical aberrations on the ultimate probe size (improved resolution). This novel electron column design also features a TTL detector with an energy filter combined with a precise control of the landing energy of the primary electron beam (beam deceleration via Gentle Beam function), which has created new opportunities for specimen observation. In particular, these new design improvements have significantly advanced the ability to image insulating specimens with previously unattainable nanometer scale resolution at landing voltages as low as 10V.

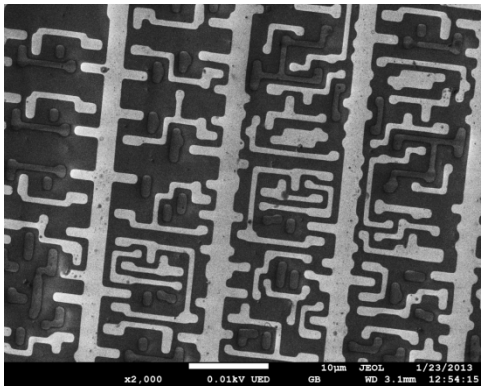
When beam deceleration is employed, the accelerating voltage, along with lens aberrations, determines the minimum probe size and thus the resolution limit is retarded by a negatively charged bias to a lower landing energy. The landing voltage ($E_{landing}=E_{gun}-E_{bias}$) can be varied with a combination of electron source voltage and specimen bias to achieve the necessary charge balance as well as high resolution performance at ultra-low voltages. Beam deceleration also serves as a form of aberration correction; the aberration coefficients (both spherical and chromatic) are reduced when the ratio $E_{landing}/E_{gun}$ is reduced for a fixed E_{gun}, meaning larger specimen bias enhances image resolution at ultra- low kVs. The use of the Gentle Beam function preserves all the advantages of high kV imaging (gun brightness, small probe size) with added advantages of reduced charging, reduced specimen contamination, improved surface detail and increased signal to noise ratio.



Membrane filter imaged at 200V



Toner particles imaged at 30V



Passive voltage contrast in a semiconductor specimen at 10V

References:

[1] D.C. Bell and N. Erdman. *Low Voltage Electron Microscopy: Principles and Applications* (2012)
[2] S. Asahina et al., *Microsc. Anal*., (2012) p.S1