Low noise quantitative EBAC imaging in SEM

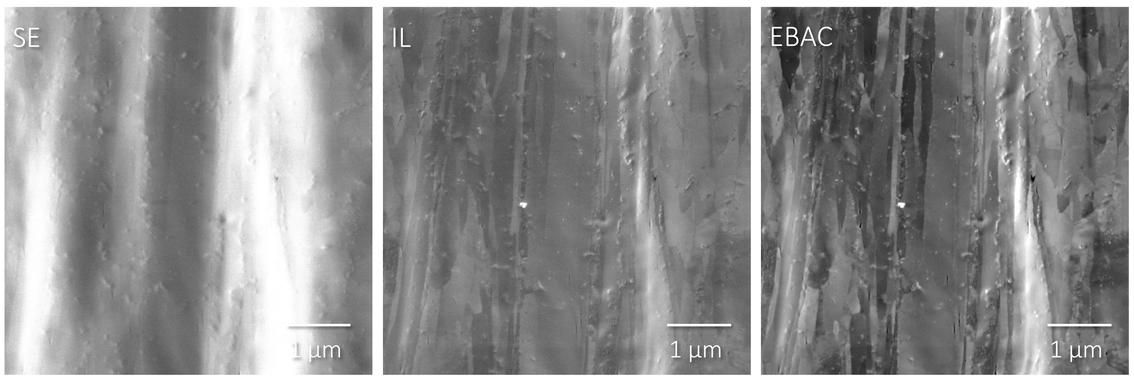
Dr Grigore Moldovan, Uwe Grauel, Wolfgang Joachimi
point electronic GmbH, Halle (Saale), Germany

Abstract: The Electron Beam Absorbed Current (EBAC) technique is updated with the latest amplification technology and found to bring essential new gains to conventional SEM, in particular for automation.

In situ pre-amplification technology

Two stage amplification is used, with the first stage placed in situ. Pre-amplifier gain is fixed at 10^9 V/A, main amplifier gain is 0.1…100x. Signal is acquired with a calibrated 12-bit ADC and is fully quantified.

High resolution and contrast

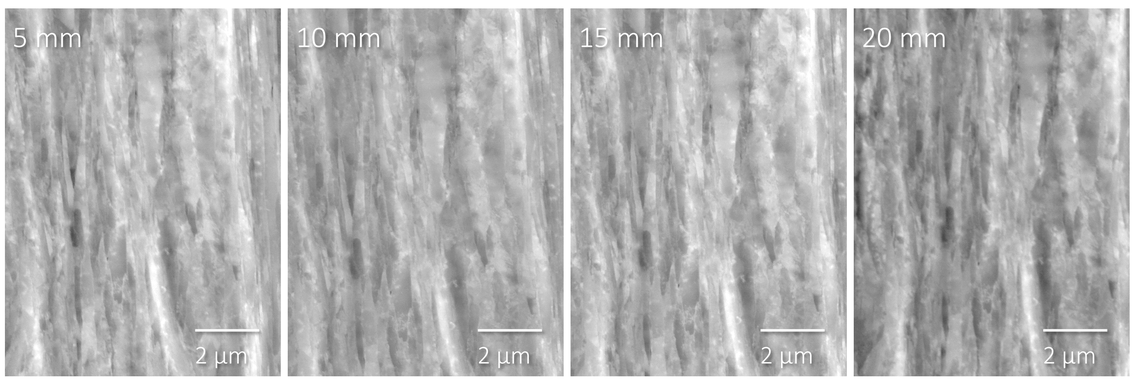


Simultaneous high magnification micrographs of a Tungsten surface illustrate that

- resolution is higher than SE, similar to IL
- contrast is higher than IL, including orientation contrast (OC)

This is attributed to their complementary nature and the different collection efficiencies.

Independence from working distance

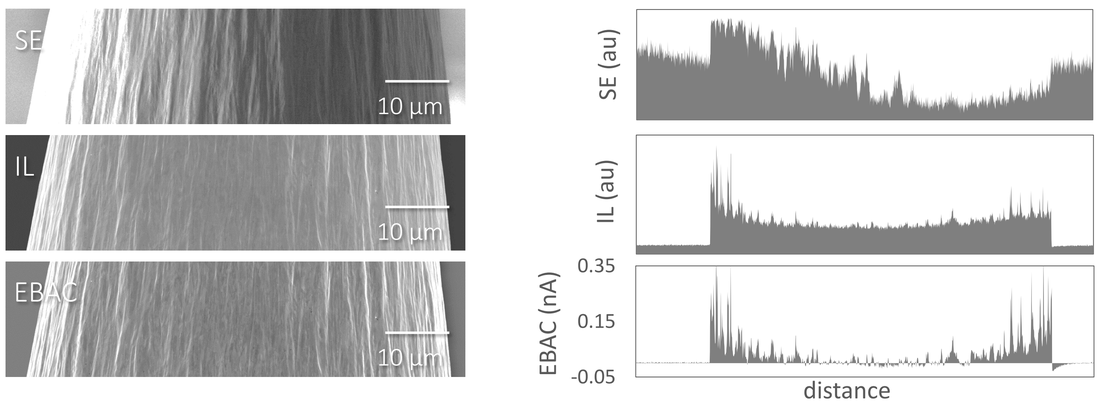


Series of EBAC micrographs at increasing working distance, showing that

- good resolution is maintained even at very long working distance
- contrast is independent from working distance

This is explained by the EBAC independence from detector geometry.

Uniform “illumination” and removed background



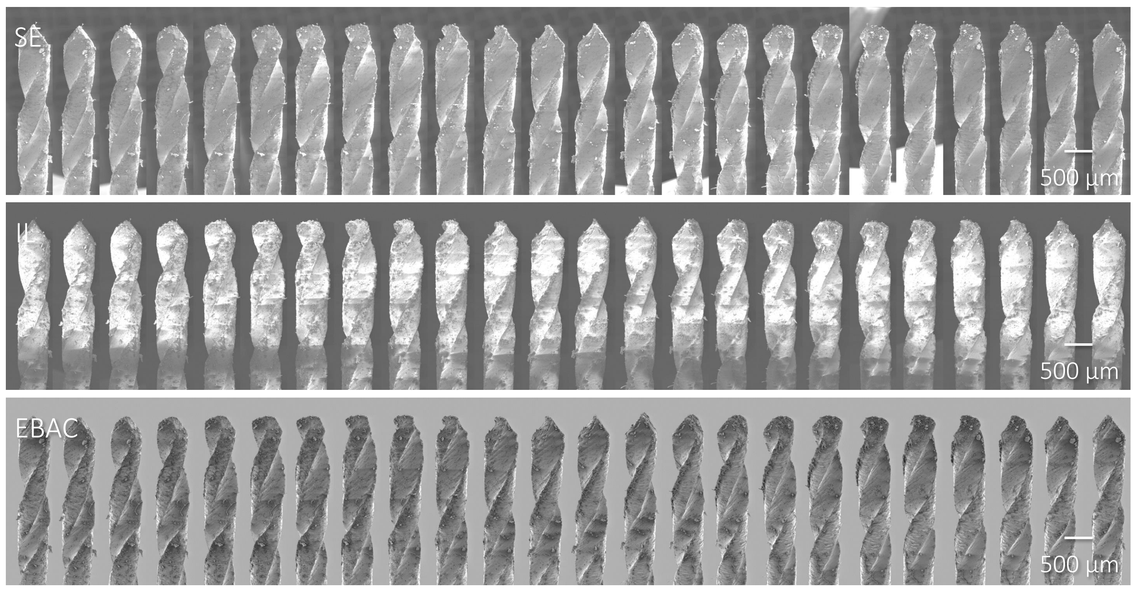
Simultaneous low magnification micrographs of a conical wire illustrate that

- there are no strong side shadows, as is the case for SE signal
- surfaces facing “the camera” have an uniform flat apparent illumination
- background is entirely removed from the images

These are essential requirements for automatic image recognition and analysis.

3D data acquisition

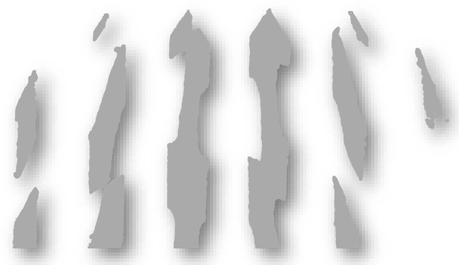
The improvements in EBAC are expected to bring new developments in SEM automation.



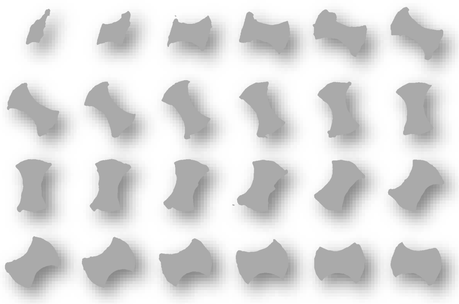
A standard 0.5 mm drill piece was placed in an electrical holder on the SEM stage, standing normal to the stage. The stage was tilted to 75° and rotated by 15° for a series of 24 micrographs covering the entire 360° range.

Observe differences in contrast, shadows, apparent illumination and the background.

High density 3D surface reconstruction



Longitudinal sections
at 70 µm intervals



Transversal sections
at 600 µm intervals

Automated 3D surface reconstructed from EBAC micrographs, with

- standard photogrammetry processing without any manual intervention
- very high density point cloud and detailed surface mesh
- texture may be taken from simultaneous signals, e.g. EDS or CL

Reconstruction attempts from corresponding simultaneous SE and IL signals have failed.

All data is recorded with the EBAC acquisition add-on installed on a Zeiss DSM982 FEG-SEM upgraded by point electronic GmbH, including DISS5 scan control and image acquisition, automated stage control, automated focus & stigmatism. Data is available upon request from the authors. Detailed technical specifications can be found at www.pointelectronic.de