Detection Capabilities of Ultra-High-Resolution Scanning Electron Microscopes

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Controlling surface sensitivity of the detected signal electrons is important for modern scanning electron microscopy. We compare images obtained with ultra-high-resolution SEM columns equipped with extended detection systems optimized for low energies. These systems allow angular filtering of secondary electrons (SE), energy-filtering of back-scattered electrons (BSE) and angular BSE selection. All three filtering possibilities lead to enhanced surface sensitivity of the detected signal.

The Triglav SEM column utilizes both field-free and immersion ultra-high-resolution electron optics. TriBE, the triplet of complementary BSE detectors, enables angular-selective BSE imaging [1], see Figure 1. An additional filtering grid, enabling surface-sensitive BSE imaging, enhances the imaging capabilities of the system. Sample topography is mapped using a triplet of secondary electron detectors - TriSE. Specifically, the In-Beam SE detector, in smart partnership with the magnetic field in the chamber, directs all the SEs into the column where they are attracted to the scintillator. The BrightBeam SEM column combines a high-potential tube with a magnetic-electrostatic objective lens delivering ultra-high resolving power in the field-free mode [2]. Two specialized detectors in the column complemented with in-chamber detectors enable multiple signals for angular SE and BSE selection, see Figure 2. The increased surface sensitivity can be seen in the signal close to the optical axis. The energy filtering provides a low-loss BSE image. The strongest point of the system is BSE detection using the E-T detector placed in the chamber. Thanks to this detector, topographic images can be acquired free of all charging artefacts.

Since both columns are capable of ultra-high-resolution imaging, the detection system is the main factor determining the choice of a device best-suited for the intended application. We have observed excellent image contrast while imaging biological samples with the BrightBeam column and semiconductor chips with the Triglav column.

References:

[1] J Jiruse, M Havelka and J Polster, Microscopy and Microanalysis, 2016, 22, pp. 578-579

[2] P Sytar, J Jiruse and A Zavodny, Microscopy and Microanalysis, 2017, 23, pp. 38-39

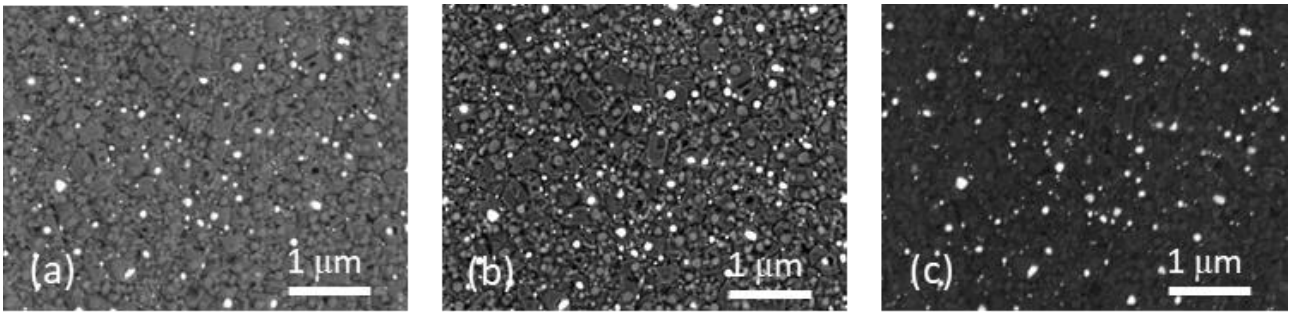

Figure 1. (a) topographic and Z-contrast in the image from the in-chamber BSE detector, (b) Z-contrast from whole interaction volume from the Mid-Angle BSE detector, (c) Z-contrast from a thin surface layer from the In-Beam BSE detector.

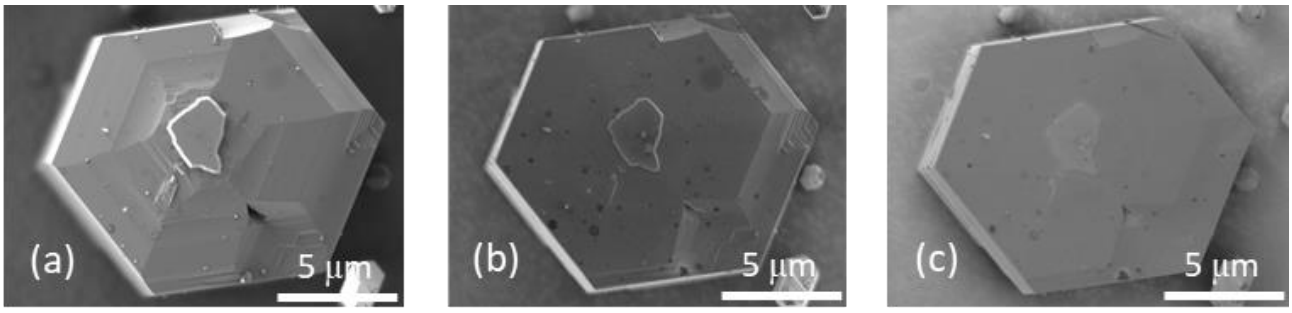

Figure 2. (a) strong topographic contrast in the image from the E-T detector, (b) material contrast from the Multidetector, (c) surface-sensitive material contrast from the Axial detector.