1806
doi:10.1017/S1431927620019418
Microsc. Microanal. 26 (Suppl 2), 2020

An Optimized In-column Detection System for the Ultra-high Resolution BrightBeam^{TM} SEM Column

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Recent trends in Scanning electron microscopy (SEM) aims at fast imaging of electron-beam sensitive samples. Controlling surface sensitivity of detected electrons is also becoming increasingly important. We are continuously developing an ultra-high-resolution microscope with extended detection systems optimized for low energies [1, 2]. These detection systems allow angular filtering of secondary electrons (SE) and both angular and energy filtering of backscattered electrons (BSE). These filtering possibilities lead to an enhanced surface sensitivity of the detected signal and generally allow to get more detailed results of the sample analysis.

TESCAN BrightBeam^{TM} SEM column combines a high electrostatic potential tube with magnetic-electrostatic objective lens. The electrostatic part is located inside the magnetic polepieces with a negligible portion of both magnetic and electrostatic fields penetrating to the sample surface. Therefore, the resolution at low beam energies is improved without any restriction on sample stage tilt. This is very beneficial for analytical applications of SEM or for Focused Ion Beam (FIB) milling, where the sample stage needs to be tilted at least several tens of degrees. The maximum SEM probe current reaches up to 400 nA.

A dedicated, so called Wide Field Optics^{TM} technology incorporates two objective lenses located below and above the double-stage scanning deflectors. This configuration provides several display modes which deliver both high resolution imaging and a large field of view (see Fig. 1) using optimization of the scanning pivot-point position and an advanced engine for dynamic correction of SEM image distortion. The technology further allows a mode with the controlled depth of focus, applicable for observation of highly topographic samples. Rocking beam mode with the pivot point on the sample allows studying of crystalline materials or directions of tiny sample cracks.

In this lecture we describe the development of the second generation of TESCAN BrightBeam^{TM} SEM column. It is used for TESCAN CLARA single SEM and TESCAN AMBER dual beam FIB-SEM instruments. The detection system was optimized for high signal of in-column detectors. Compared to the first generation, we increased SE signal 6x and BSE signal 3x at energies above 1.5 keV. Special attention was paid to the situation of the tilted sample located at FIB-SEM coincidence point. Here the signal-to noise ratio was increased 5x.

Three BSE detectors are used. The narrow-angle BSE detector gives standard bulk BSE contrast, wide-angle BSE detector increases topography contrast from electrons with low initial take-off angles and axial BSE detector enhances surface sensitivity without topography. The filtration grid of BSE can be biased up to 6 kV to yield low-loss BSE signal. Two detectors inside the column can acquire SE signal. The column reaches imaging resolution of 1.4 nm at 1 kV in field-free mode and 0.9 nm at 15 kV.

As a result, a unique combination of detection possibilities with ultra-high field-free resolution, wide-angle rocking beam and extra-wide field of view for live sample navigation has been achieved.

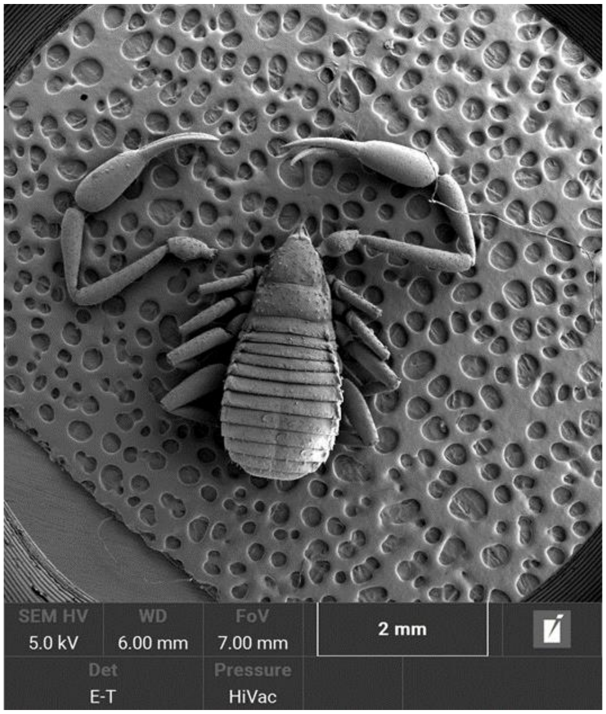

Figure 1. Large insect imaged at a single undistorted scan in FIB-SEM coincidence point (working distance 6 mm, field of view 7 mm).

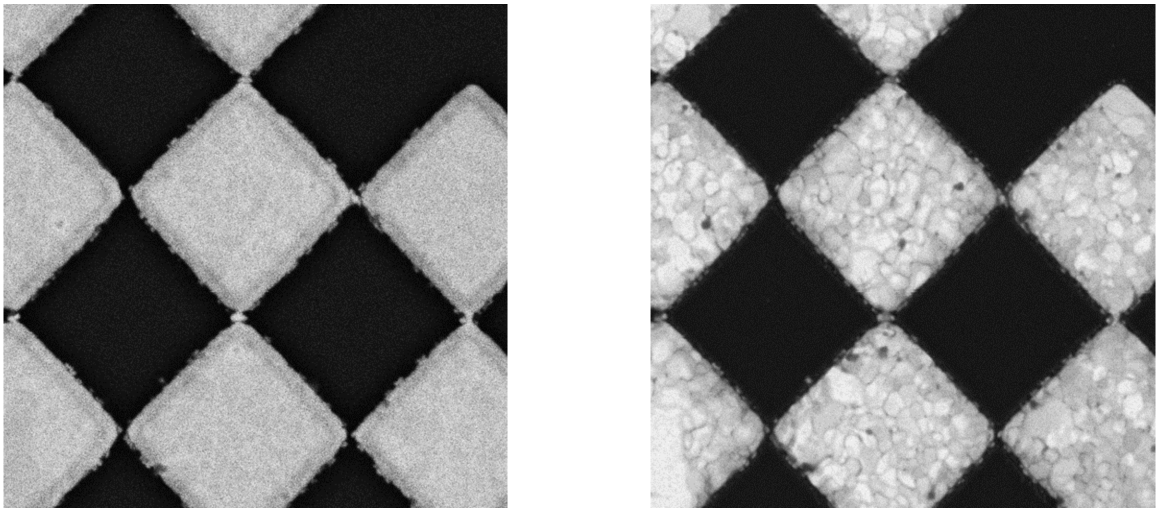

Figure 2. Left: Bulk Z contrast (narrow-angle BSE detection by Multidetector); Right: Surface Z contrast (Axial BSE detector). Lithography gold on silicon, 5 keV, WD 6 mm, FOV 2.9 µm, filter 2 kV.

References
[1] P. Sytař, J. Jiruše and A. Závodný, Microscopy and Microanalysis, 2017, 23, pp. 38-39.
[2] J. Jiruše, M. Havelka, J. Polster, P. Sytař, J. Páral, J. Kološová, Microscopy and Microanalysis, 2018, 24 (Suppl 1), pp. 606-607.

https://doi.org/10.1017/S1431927620019418 Published online by Cambridge University Press