Advanced BSE detection capabilities of the TESCAN CLARA UHR-SEM

The BSE (Back Scattered Electron) image contrast differs depending on both the take-off angle and energy of backscattered electrons. This contrast change needs to be visualized as some information may remain hidden when using more conventional BSE detection systems.

The new TESCAN CLARA ultra-high-resolution scanning electron microscope (UHR-SEM), based on TESCAN's BrightBeamTM technology, enables variable, filtered BSE detection. One of the features of the TESCAN CLARA's BSE detection system is the electron filtering based on take-off angle which allows users to explore three different contrast mechanisms.

The TESCAN CLARA UHR-SEM is equipped, as standard, with three BSE detectors:

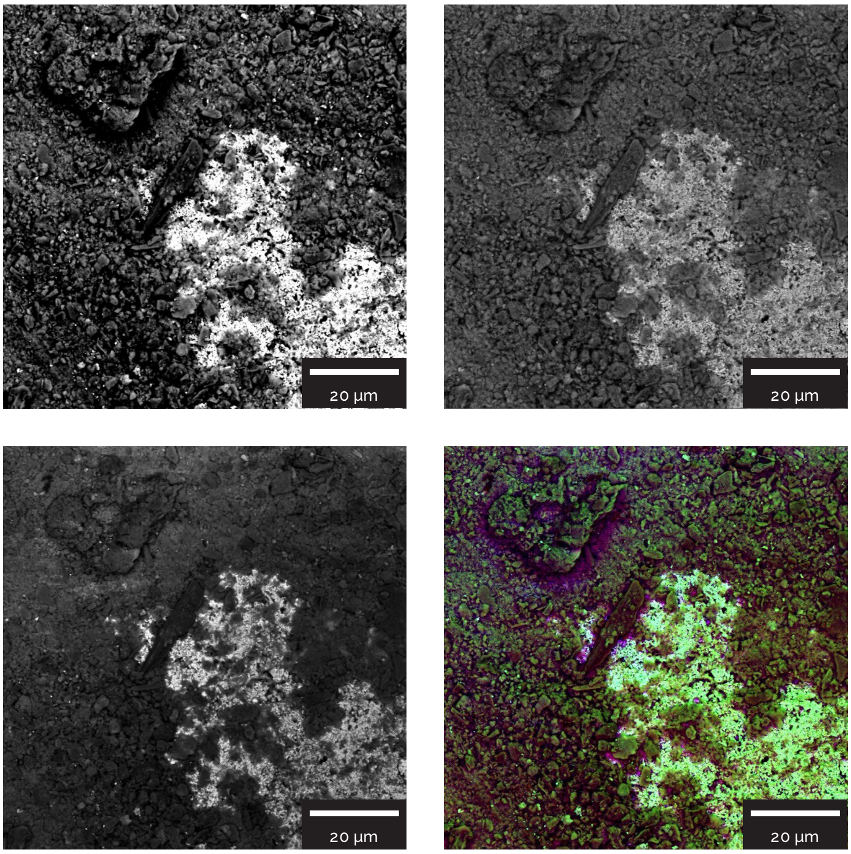
(1)Fully retractable in-chamber detector collecting the wide-angle electrons. This, wide-angle BSE signal, significantly highlights topographical contrast.

(2)In Beam Axial detector, collecting the narrow-angle electrons. The take-off trajectories of BSEs collected by the Axial Detector are, of course, close to the optical axis of the SEM column and as a result provide topography-free compositional contrast.

(3)Multidetector (BSE) collects the so called 'mid-angle' backscattered electrons. The unique capability of this detector is that areas which were hidden from the in-chamber BSE detector are now visible here, however, moderate topographical contrast of the sample is also maintained.

This application example presents the benefits of the angular filtration of backscattered electrons.

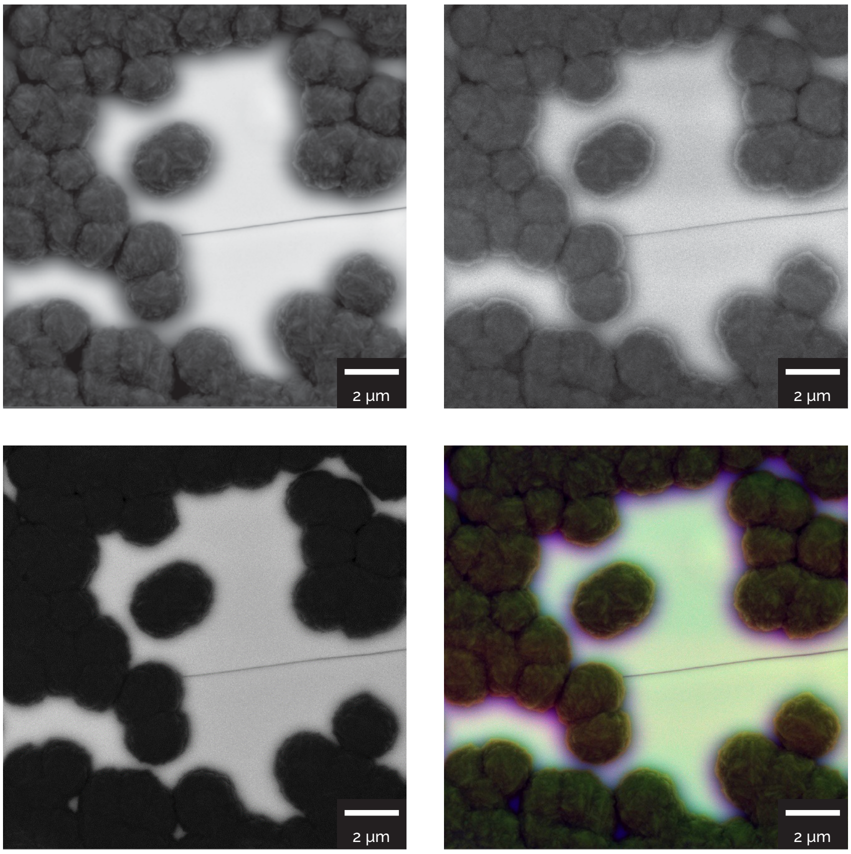
The first set of images is shows the analysis of the oxidation on the metal surface. These images were acquired simultaneously by collecting the BSE signals at different angles, as described above. The retractable LE-BSE (Low Energy in this case) was used to collect the wide-angle signal. The Multidetector collected mid-angle BSEs, where topographical contours were still visible, and the Axial detector has collected narrow-angle BSEs where topographical contours on the sample were minimized, hence the BSE contrast was significantly enhanced.



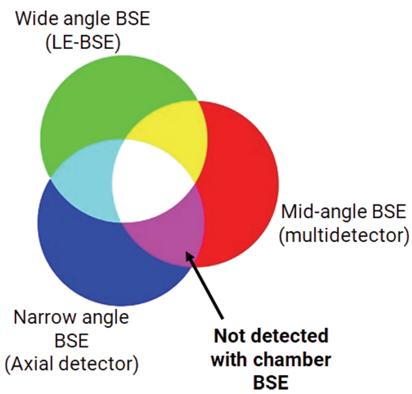
c **Fig. 1:** Images of natural oxidation of the metal surface collected with different TESCAN CLARA BSE detectors. LE BSE (wide-angle), Multidetector (mid-angle), Axial (narrow-angle) and color-coded image where each angle is represented by a color.

The fourth image is a combination of the all three signals where each of the signals is represented by a different colour, wide-angle BSEs (green), mid-angle BSEs (red) and narrow-angle BSEs (blue). The scheme of the signals and the colors is described in Figure 9. When evaluating the color-coded image, it is evident that some features (purple) are hidden to the conventional BSE detectors. On the other hand, some topography is not visible when collecting BSEs with the axial detector (yellow areas). However it is evident that the complete information is captured with the multidetector (yellow and purple area). The BSE angular filtering effects are well displayed on the second set of the images where the nano-diamond coating, produced by CVD (Chemical Vapor Deposition), was used to demonstrate different angular filtering capabilities of the TESCAN CLARA UHR-SEM.

All images were acquired simultaneously by the retractable BSE chamber detector, multidetector (BSE) and Axial (BSE) detector.



c **Fig. 2:** Images nano-diamond coating deposited in Si, collected with different TESCAN CLARA BSE detectors. LE BSE (wide-angle), Multidetector (mid-angle), Axial (narrow-angle) and color-coded image where each angle is represented by a color.



c Legend for the color-coded image

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