Improved EBSD indexing by camera auto exposure during pattern acquisition

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Electron backscatter diffraction (EBSD) is a powerful technique for characterizing the crystallographic orientations in the scanning electron microscope (SEM). One challenge for collecting EBSD data from a highly tilted specimen, typically at 70°, a small difference in height from the surface will create significant shadow effects. As the electron beam is scanning through such a shadow area, the EBSD pattern will have lower intensity, i.e., due to its lower signal-to-noise ratio, which will result as a final poor indexing at the shadowed region.

The topographic difference on the prepared surface is mainly generated during EBSD specimen preparation. In this application, a super duplex stainless steel (SDSS) is employed and prepared by electropolishing, where the topographic difference generated by the different polishing rates between austenite and ferrite phases. The offline EBSD raw data collection was carried out on a Zeiss Ultra FESEM 55 by using a NORDIF UF-1100 EBSD acquisition detector. The NORDIF EBSD version 3 software was employed to acquire and stream the diffraction patterns directly into HDD. Usually the camera exposure time is set to maximum given by inverting the frame rate. In this project, to minimize the negative effect of the shadowing, the EBSD camera which always is running at a fixed frame rate, is operated in auto exposure mode. With the auto exposure mode, the camera exposure time is reduced by for instance 25% from its maximum and the camera gain increased to compensate for less exposure time. During pattern acquisition through an area with topographic difference, the pattern intensity may vary and display as from bright to dark. In areas with higher intensity the exposure time is automatically reduced, while the electron beam is scanned through a shadow area with a lower intensity, the exposure time is automatically increased. The saved offline EBSD patterns were indexed by EDAX/TSL OIM version 7.3b. The present EBSD investigated area is from a 50.6 x 39.8 μm^2 with the step size of 0.2 µm and the constant camera frame rate of 600 pattern per second. The acquisition patterns were with resolution 120x120 pixels. The exposure time was set to 1212 µs in the constant exposure time mode, and under the auto exposure mode, the exposure time could vary up to maximum 1616 µs. The EBSD pattern acquisition was carried out with an acceleration voltage of 20kV and a magnification of 1000X at tilt angle of 70° and WD of 26.3mm.

Figure 1 shows an orientation contrast image acquired by ATEX software with use of the EBSD phosphor screen [1]. Figure 2 shows Inverse Pole Figure (IPF)-, Phase (p)- and Image Quality (IQ) maps from the same area, and the effect of auto exposure is clearly illustrated, and the maps in the right column are acquired in auto exposure mode. The fractions of indexed patterns (non-black pixels in the IPF-maps) are 99.6% and 96.1% for the auto exposure and standard constant exposure, respectively. The non-indexed patterns (black pixels) are mainly located along the phase boundaries with pronounced topography, as shown in Figure 1 and the phase maps in Figure 2. From the IQ maps it is convincing that the auto exposure improves the pattern quality. Auto exposure improves the EBSD indexing without any increase in pattern acquisition time.

Reference:

[1] B. Beausir and J.-J. Fundenberger, Analysis Tools for Electron and X-ray diffraction, ATEX - software, www.atex-software.eu, Université de Lorraine - Metz, France. 2017

Figure 1. Orientation contrast image.

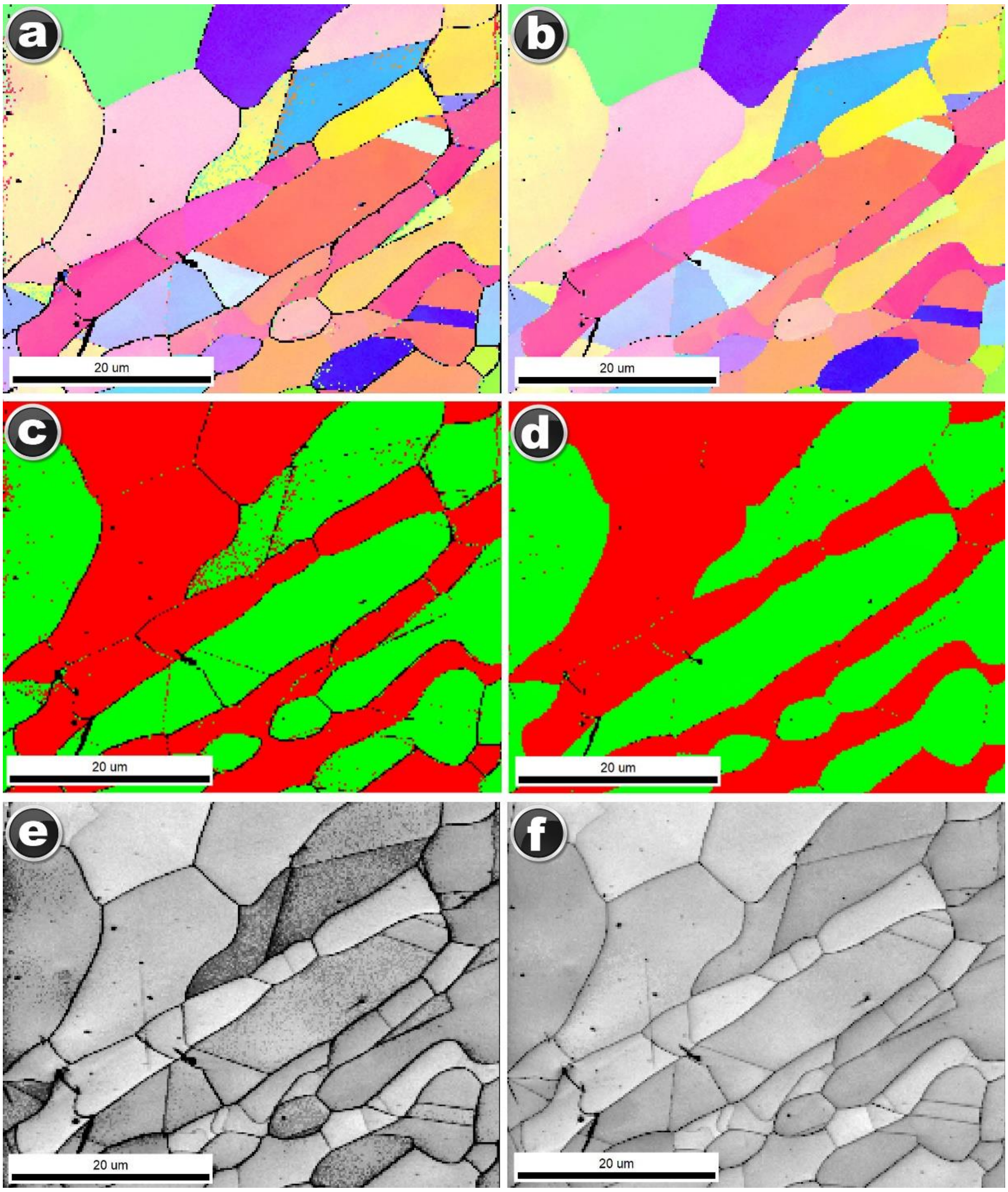

Figure 2. IPF maps (a and b), Phase maps (c and d) and IQ maps (e and f) from the same area, under the standard exposure mode (a, c and e) and auto exposure mode (b, d and f). Black pixels in the IPF maps represent non-indexed patterns.

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emc2020@rms.org.uk Thu, Apr 23, 2020 at 12:19 PM

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Thank you.

Best and safe wishes to you,

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