SEM-based diffraction with compact direct electron detectors - new geometries and new analyses

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Abstract

Direct electron detectors have received increasing interest for electron microscopy due to their low noise nature, higher signal-to-noise ratio (SNR), higher dose efficiency and higher dynamic range. Of particular interest are event-counting hybrid pixel detectors (HPD) such as Medipix and Timepix families, which produce spatially resolved signals directly related to the incoming electron dose and/or energy. Furthermore, these detectors can be made into compact devices by adapting a USB feedthrough, and the reduced footprint is advantageous for constructing new experimental geometries for diffraction studies in the scanning electron microscope (SEM). In this work, we demonstrate a few new developments and applications of a compact, Si-based MiniPIX Timepix3 (1) direct detector (80 x 21 x 14 mm3 with 14 x 14 mm^2 sensing area) for electron backscatter diffraction (EBSD) and transmission Kikuchi diffraction (TKD) in SEM.

Static EBSD geometry: We designed a new EBSD setup where the sample and the detector are co-mounted on a sub-stage, creating a simple, static and compact geometry which enables EBSD patterns to be captured over a wide area (_~10x10 mm2) with consistent indexing. The benefits of the analysis approach will be demonstrated, including simple mapping and direct calibration of the setup.

Static on axis-TKD geometry: We designed an on-axis TKD in SEM geometry and new multi-exposure analysis method to capture very high anglular range diffraction patterns from nanocrystalline materials. The DED system provides high signal to noise which we increase through new analysis methods, to realise capture angles that exceed 95◦ in a single pattern. The alignment and fidelity of this approach is demonstrated by reprojecting crystals to demonstrate the fundamental symmetires of the analysed unit cell.

Keywords: EBSD, TKD, electron microscopy, direct electron detectors

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