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Tilt-free EBSD

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Recent developments in electron detection technology, particularly in pixelated semiconductor detectors, enable the acquisition of electron diffraction patterns in various geometries. Diffraction patterns acquired on thin samples in transmission configuration were presented in [1]. On top of that acquisition of electron backscattered diffraction patterns above the sample is discussed here.

Electron backscatter diffraction (EBSD) is a well-established technique for crystallographic characterization, addressing a wide-ranging and growing number of application areas [2]. Conventionally, EBSD diffraction patterns are collected through means of a scintillator coupled to a CCD/CMOS sensor, with the sample typically tilted 70° from the horizontal position in order to maximize the signal contrast of the backscattered electrons patterns. High-tilt analysis has implications for electron imaging however; ultimate spatial resolution is reduced, dynamic focusing becomes a requirement and there are difficulties in analysing large diameter samples (e.g. Si wafers). Various geometries for the acquisition of EBSD patterns have been investigated historically [3,4], however, for low tilt and horizontal specimens where the detector location is placed directly above the sample, a considerable reduction in diffraction pattern contrast was observed.

Here we discuss the use of a novel scheme for tilt free electron capture using high sensitivity pixelated detection. Specifically, we use the Timepix detector family operating in one of several inherited modes, including thresholded electron counting, time over threshold, and time of arrival [5]. This configuration can be used in standard SEM imaging geometries, with backscattered electrons collected at takeoff angles from 0 to 90°.

To demonstrate this concept, a pixel detector was integrated with a semiconductor sensor such that impinging particles are converted directly into detectable electric signals. This geometry and setup arrangements are described in Figure 1. Electron backscattered patterns were acquired from various materials such as electro polished iron, FIB milled silicon and freshly stripped highly oriented pyrolytic graphite at conditions similar to those used for conventional EBSD analysis i.e. 20 keV, 3 nA (Figure 2). The signal level of these patterns allow for use of the presented geometry for standard EBSD applications. Further, we discuss comparable analysis using electron channeling contrast imaging [6] combined with serial sectioning in a FIB/SEM system, discussing the future developments of the presented configuration.

References:

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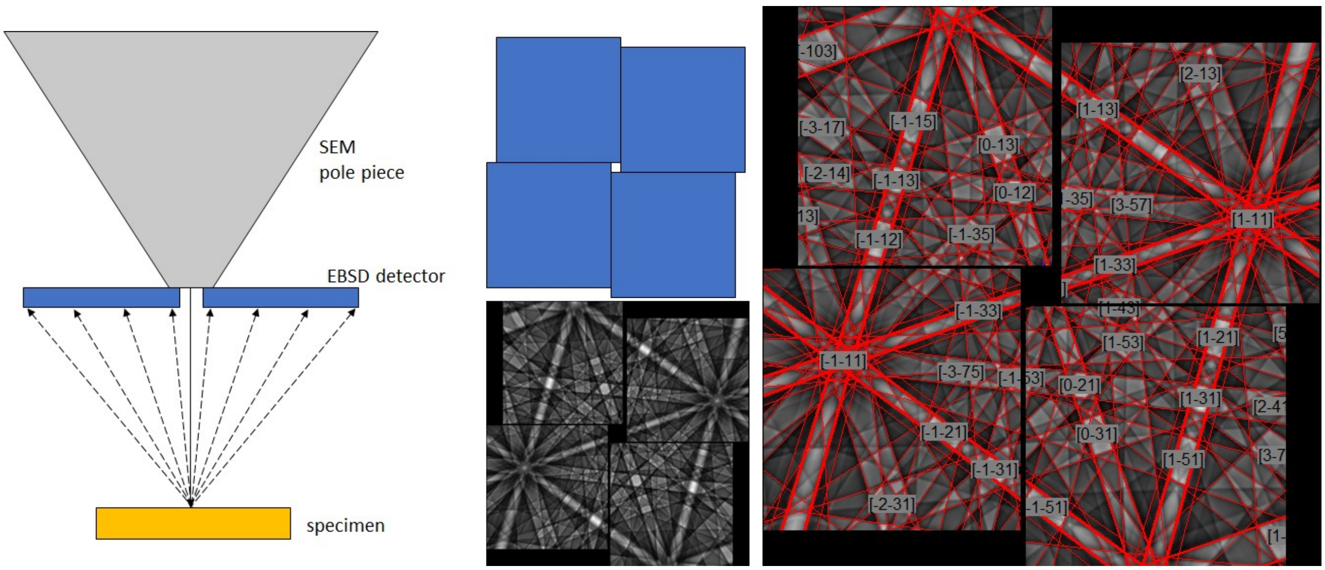
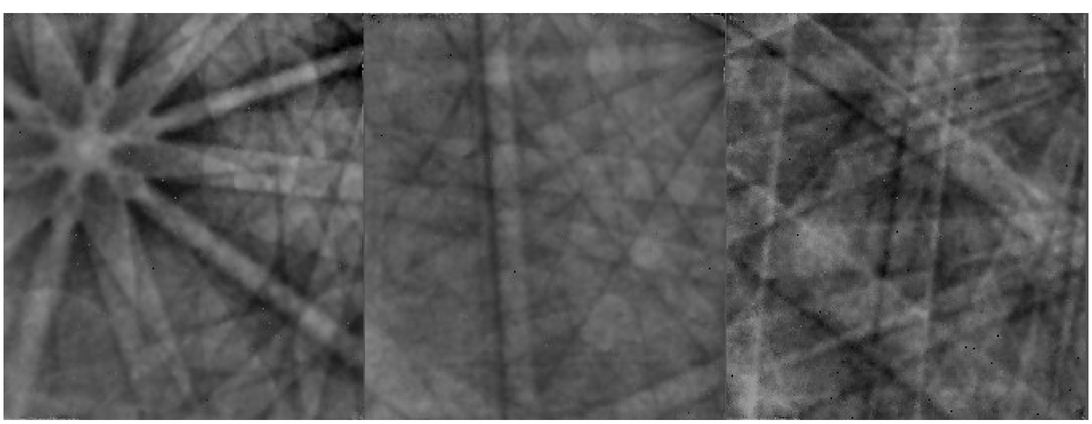


a) b) c)

Figure 1. Schematics showing the setup of the EBSD tilt-free method, a) detector is placed directly below pole-piece with the sample parallel to the detector, b) assembly of four detector segments arranged around the pole-piece and simulated pattern of iron (ferrite) at working distance 12 mm at 20 keV, c) automatically indexed pattern for tilt-free geometry.



a) b) c)

Figure 2. Experimental EBSD patterns acquired at 20keV, beam current 3nA with exposure of 2.5 sec taken from surfaces of a) electropolished iron, b) FIB milled silicon and c) freshly stripped highly oriented pyrolytic graphite at normal incidence using semiconductor hybrid detector.

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