Extended opportunities for diffraction imaging in FIB/SEM systems

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Developments in direct electron detection technology, particularly pixelated semiconductor detectors, enable the acquisition of diffraction patterns in both transmitted (STEM) and backscattered (EBSD) mode without the requirement for conventional tilted geometries.

For STEM applications, e.g. lamella characterisation, it is beneficial to collect diffraction patterns from a number of points, such as standard scan or maps, in order to understand the structural properties often in combination with the underlying chemistry. Diffraction patterns from thin specimens have already been presented in [1] using a pixelated detector from the Medipix family [2]. Such detectors have an almost unlimited dynamic range and noise-free operation enabling additional dimensional analysis through the interpretation of diffraction spots and Kikuchi bands. A typical diffraction pattern acquired for single scan point in STEM is shown in Figure 1.

For EBSD applications, pixelated detectors can be used to acquire diffraction patterns in a flat geometry as depicted in Figure 2 with four sensors staggered around the beam. This represent a significant departure from conventional EBSD, where the sample is tilted typically to 70° in order to maximise the diffraction contrast. Whilst beneficial for many sample types, such arrangements impair the electron imaging performance. Ultimate spatial resolution is reduced and is highly anisotropic, whilst dynamic focusing becomes a requirement. Further, high tilts can be problematic when analysing certain sample types, e.g. Si wafers. Whilst other geometries have been investigated historically, these tended to involve extremely high probe currents or small angles of capture [3-4]. Figure 3 acquired at 3.2 nA is more inline with conventional EBSD acquisition conditions.

To demonstrate this method, a retractable Timepix detector was integrated into Thermo Scientific Scios microscope. Preliminary results will be presented and advantages and limitations of such an approach discussed.

References

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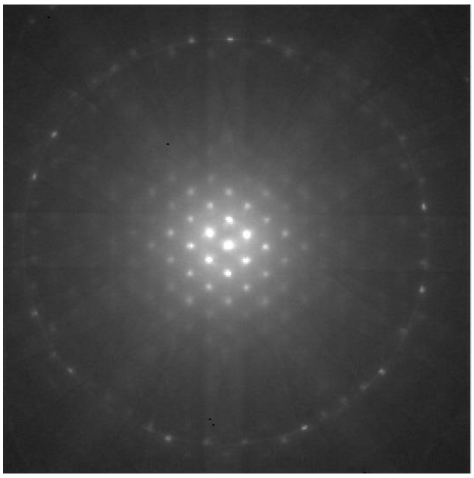

Figure 1: *Diffraction pattern from Silicon substrate of a 14 nm semiconductor device at [100] zone axis taken at 30 kV.*

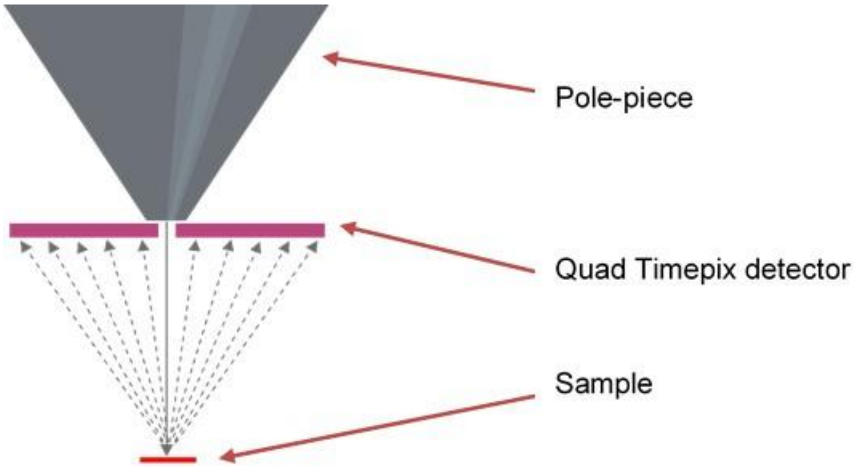

Figure 2: *Setup of EBSD tilt-free method. Detector is placed directly below pole-piece with sample parallel to the detector.*

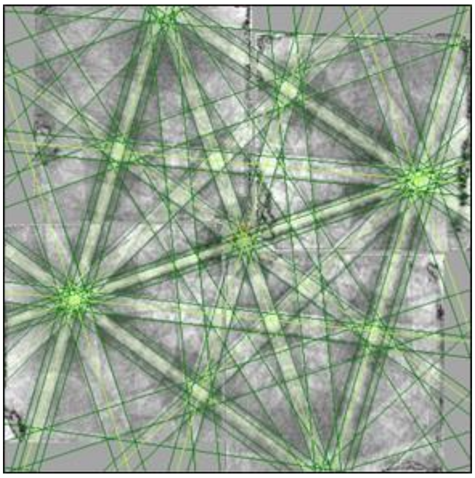

Figure 3: *Acquired and automatically indexed EBSP of monocrystalline iron (ferrite) in tilt-free geometry.*