Latest Developments for Advanced 3D EBSD

Volkenandt, T.[1], Pérez-Willard, F.[1], Rauscher, M.[1], Bauer, F.[2], Mansour, H.[2] and Goulden, J.[3]

[1] Carl Zeiss Microscopy GmbH, Germany, [2] Oxford Instruments NanoAnalysis, United Kingdom

Electron back-scatter diffraction (EBSD) in a scanning electron microscope (SEM) is the only technique that enables high-resolution site-specific microstructural characterization including phase relationships, local mis-orientations and grain properties. The combination with focused ion beam (FIB) tomography allows to extend this analysis to the third dimension. In an iterative process, the ion beam removes a slice of material before image and EBSD map are acquired. This way a data stack is generated slice by slice that can be used afterwards to reconstruct the information about the volume of interest in 3D. The established 3D EBSD workflows have been limited by resolution, accuracy and speed. These restrictions are now addressed by a powerful combination of new software and hardware, which will be presented here.

The software controlling the acquisition of the analytic tomography offers a unique system to track and adjust the slice thickness in real time. To achieve this, a pair of angled fiducial lines is patterned in advance and imaged during the run. The measurement of the distance between these lines allows to calculate the thickness of the milled slice and to estimate the current sample drift. The milling progress is then adjusted accordingly to assure homogeneous slice thicknesses and compensate for the drift. This system provides optimal resolution in Z direction. To achieve optimal resolution also in XY for the imaging, it is necessary to reduce the primary beam energy and make use of advanced detectors capable of filtering the detected electrons. These conditions, however, are not ideal for high signal-to noise EBSD map acquisition. Therefore, a new unique feature has been introduced that allows setting a second set of conditions for the EBSD map acquisition. These conditions typically include higher primary beam energies and larger beam currents. The switching between the two sets of conditions happens automatically during the run, while advanced algorithms assure perfect repositioning and fine tuning of the beam. This way, SEM images and EBSD maps are acquired under their ideal conditions respectively.

On the hardware side, the development of next generation CMOS based EBSD detectors which can collect high quality EBSD data at high acquisition speeds also facilitates the collection of 3D datasets. This new technology can collect and index EBSD data at speeds up to 3000pps. As a result data collection in 3D is far more achievable on a greater range of samples.

This paper will present results to illustrate the recent developments for an advanced 3D EBSD workflow combining ZEISS Atlas 5 with the Oxford Instruments Symmetry EBSD detector.