The Importance of the Orientation Precision Performance of Electron Backscatter Diffraction EBSD

Electron Backscatter Diffraction (EBSD) has become the preferred technique for measuring crystallographic orientations and for quantifying microstructural features such as texture, grain size, and phase distribution in polycrystalline materials. EBSD provides rapid orientation measurements combined with high spatial resolution and excellent orientation precision for characterizing a wide range of materials. However, it is important to recognize that the performance and capabilities of EBSD as a technique are determined not only by the physics of EBSD pattern formation but also by the specific analytical approaches used to capture and analyze EBSD patterns. The TEAM™ Pegasus and TEAM™ EBSD Analysis Systems implement industry-leading EBSD pattern analysis Smart Features that provide enhanced capability to improve microstructural characterization capability.

One analytical approach incorporated in the TEAM™ Pegasus and EBSD systems is orientation precision. Orientation precision is the spread in repeated measured orientations from a single reference orientation and defines the lower limit of detecting small changes in orientation. Typical estimates of EBSD orientation precision range from 0.5° to 2.0°. These values are often specified as dependent on both camera resolution and camera position. However, TEAM™ Pegasus and TEAM™ EBSD Analysis systems, through their innovative EBSD pattern analysis, are able to provide orientation precision values less than 0.1° even at standard EBSD mapping resolutions and camera positions. This unparalleled orientation precision performance allows a more accurate determination and visualization of deformed microstructures, as shown in Figures 1 and 2. In these figures, EBSD maps were collected from deformed ferritic steel with acquisition settings producing orientation precision values less than 0.1° and with settings producing precision values greater than 0.3° from the same area to compare the effects of orientation precision with standard Inverse Pole Figure (IPF) and Kernel Average Misorientation (KAM) maps shown for both values. With the less than 0.1° precision data, the subgrain structure within the grains is clearly defined indicating that dislocation lines have organized during the deformation process as expected. With the greater than 0.3° data, this detail is lost as the orientation precision value approaches the magnitude of the orientation changes within the grains. The resulting measurements produce a much noisier and undefined view of the microstructural changes occurring during deformation compared to the high orientation precision data. It is important to note that the IPF orientation maps, due to the wide range of orientations they display, do not accurately represent the effects of orientation precision, and this type of map can hide poor orientation precision results.

Understanding deformation is a key application of EBSD. Material fabrication and forming methods - such as solidification, forging, rolling and drawing - strengthening mechanisms - such as strain hardening - and failure modes - such as creep and fatigue - all cause some level of deformation. Accurate characterization of this deformation through improved orientation precision allows better understanding of the deformation process. With this insight, optimization and improvements of the process may be realized.

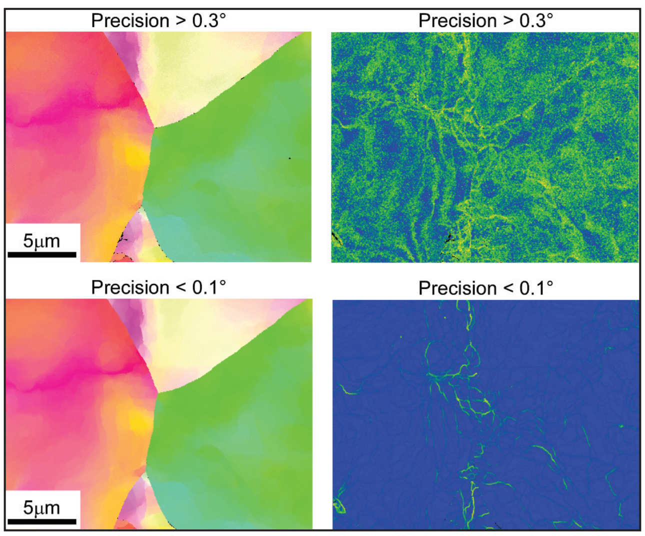

Figure 1. Standard Inverse Pole Figure (IPF) and KAM orientation maps at >0.3°

Figure 2. IPF and Kernel Average Misorientation (KAM) maps at < 0.1°