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Characterizing Local Misorientation Gradients Near Grain Boundaries

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Electron backscatter diffraction (EBSD) is a well established technique for measuring crystallographic orientations at spatial resolutions at the order of tens of nanometers and at angular resolutions as small as 0.1°. Such measurements can be automatically collected at each point in a regular measurement grid defined by the operator. The collection of points in this manner is sometimes termed orientation imaging microscopy (OIM) as images of the microstructure can be constructed by mapping various aspects of the orientation measurements to a defined color code. By comparing the orientations of neighboring points in the measurement grid it is possible to characterize the local misorientation present in the microstructure. OIM measurements performed on deformed materials often exhibit a network of low angle local misorientations. These local misorientations are indicative of local perturbations in the crystal lattice arising from dislocations. Several methods for quantifying the magnitude of these local misorientations have been proposed [1]. In this work we focus on the kernel average misorientation (KAM). The KAM is the average deviation in orientation at pixel with respect to the orientation of neighboring points in the measurement grid. This group of neighboring points is termed a kernel and is typically made up of just a few nearest neighbors. OIM measurements on deformed materials often show an increase in the measured KAM values near grain boundaries relative to the KAM values obtained in the grain interiors [2]. This phenomenon is physically expected due to dislocation pile-up at grain boundaries. However, it is likely that some of the increase the KAM values near grain boundaries is due to a loss of orientation precision in the EBSD measurements in the immediate vicinity of a grain boundary. When the electron beam is positioned near a grain boundary, the diffraction volume will spread across the boundary to include the crystal lattice from the grains on either side of the boundary. Thus, the resulting pattern will contain contributions from both lattices. These mixed patterns pose some challenge to the software used to determine the crystallographic orientation from the EBSD patterns. The objective of this work is study quantitatively characterize the ability of the indexing algorithm to precisely determine the orientation from these superposed patterns. High resolution experimental data on a series of deformed materials as well as simulated patterns are used in the study. Additional data has been obtained on twinned copper. With the twins it is possible to determine the nclination of the grain boundary plane. Thus, we can observe whether the grain boundary plane plays any perceptible role in the local misorientation gradient near the boundary. Both the experimental data The results clearly show an effect of the pattern mixing on the orientation precision in the immediate vicinity of grain boundaries. However, the contribution is relatively small and is likely only to affect KAM measurements on lightly deformed materials.

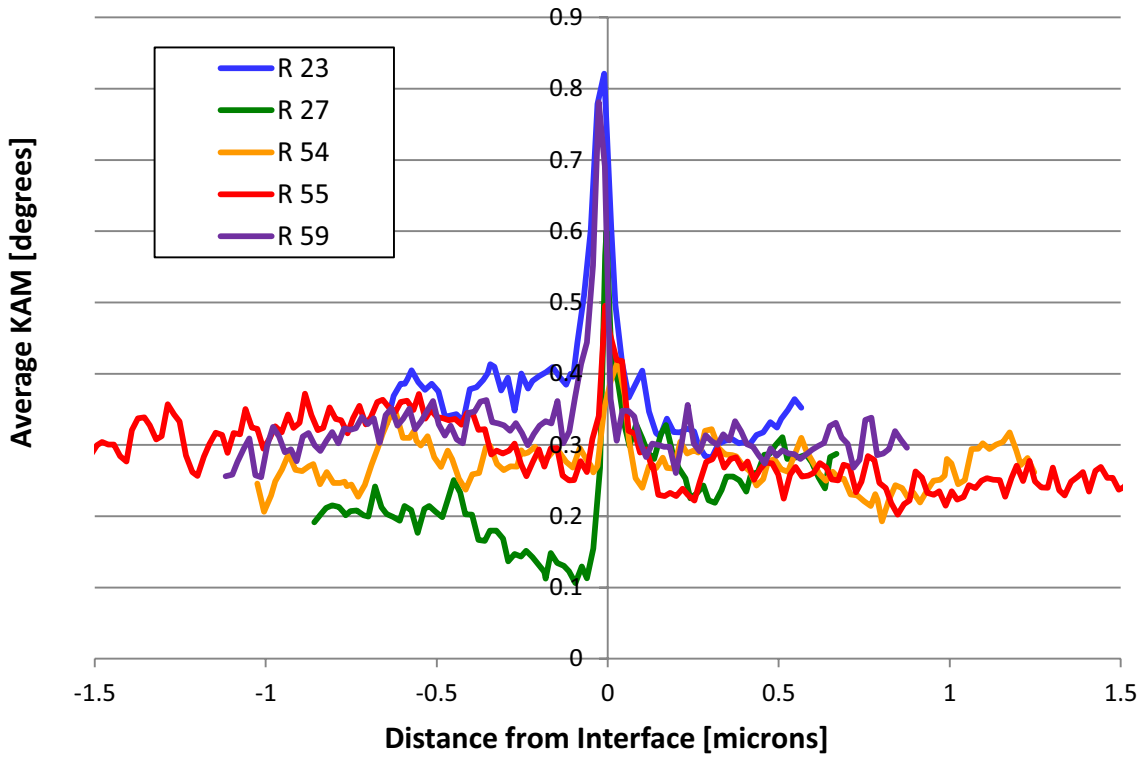

Fig. 1 KAM profiles from one side of a grain boundary to the other side for five different grain boundaries with misorientation angles as indicated. The profiles were calculated by averaging the KAMs measurements along a vector normal to the trace of the boundary in the OIM map as shown in Fig. 2.

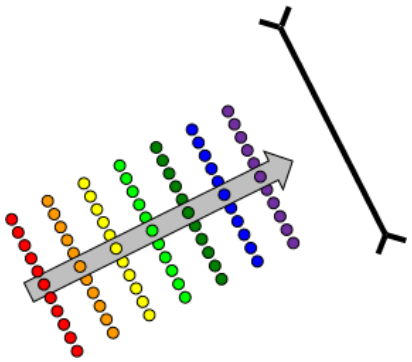

Fig. 2 Schematic of the KAM profile averaging scheme.

References

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