DOI: 10.1017/S1431927605501582
Microsc Microanal 11(Suppl 2), 2005

Defining Electron Backscatter Diffraction Resolution

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Automated electron backscatter diffraction (EBSD) mapping systems have existed for more than 10 years [1,2], and due to their versatility in characterizing multiple aspects of microstructure, they have become an important tool in microscale crystallographic studies. Their increasingly widespread use however reinforces the importance of defining their accuracy in both determining crystallographic orientations, as well as ensuring that the orientation information is spatially correct.

The issue of orientation accuracy (as defined by angular resolution) has been discussed previously [3-5]. While the resolution of EBSD systems is typically quoted to be on the order of 1^{o}, it has been shown that by increasing the pattern quality via acquisition parameter adjustment, the angular resolution can be improved to sub-degree levels. Ultimately, the resolution is dependent on how it is identified. In some cases it can be identified as the orientation relative to a known absolute orientation, while in others it is the misorientation between nearest neighbor points in a scan. Naturally, the resulting values can be significantly different. Therefore, a consistent and universal definition of resolution that can be applied to characterize any EBSD system is necessary, and is the focus of the current study.

In this work, a Phillips (FEI) XL-40 FEGSEM coupled to a TexSEM Laboratories OIM system was used. The pattern capturing hardware consisted of both a 512 by 512 pixel SIT CCD camera and a 1300 by 1030 pixel Peltier cooled CCD camera. Automated scans of various sizes, each consisting of 2500 points, were performed on a commercial-grade single crystal silicon wafer used for angular resolution measurements. To adequately quantify angular resolution for all possible EBSD applications we define two angular values. The first is ω_{center}, the mean of the misorientation angle distribution between all scan points and the scan point coincident to the calibration source (typically the scan center). The ω_{center} value is used to describe the overall system resolution, as it effectively quantifies the deviation of all orientations in the scan relative to the diffraction pattern least affected by distortions. The second is ω_{max}, the largest misorientation angle possible between any pair of points in the dataset, and describes the worst possible case.

Fig. 1 shows the effects of scan size and captured pattern resolution (bin size) on both angular values, illustrating that smaller scan and bin sizes have the effect of increasing angular resolution. However, it can be observed that the benefits of utilizing smaller bin sizes (and consequently slower data collection) diminish with scan size. Fig. 2 shows the effect of the number of pixels used in the Hough transform (defined as the ratio of pixels used to maximum possible pixels) on the angular values. It can be seen that the best angular resolutions are achieved at a pixel ratio of 0.80, again illustrating that the use of higher resolutions is not always beneficial.

As evidenced by the results, the use of ω_{center} and ω_{max} not only permits the characterization of the angular resolution of an EBSD system, but it also permits a more efficient utilization of the system by identifying appropriate settings depending on the desired angular resolution [6].

References

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[6] This work was supported primarily by the MRSEC program of the National Science Foundation under DMR-0079996. This work also supported in part by the U.S. Department of Energy Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

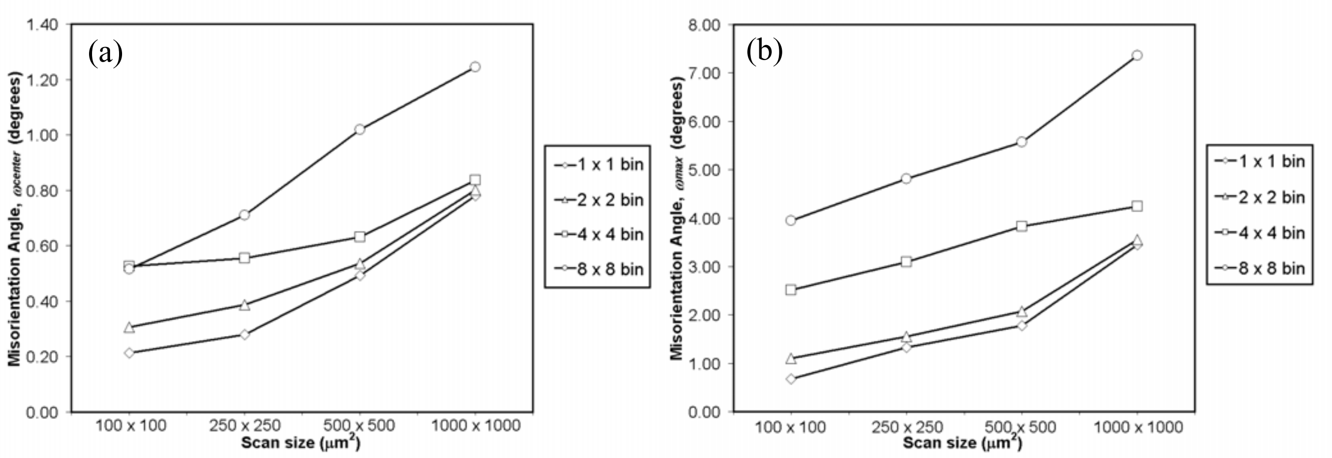

FIG. 1. Effect of scan parameters on the angular resolution as defined by a)ω_{center}, and b) ω_{max}.

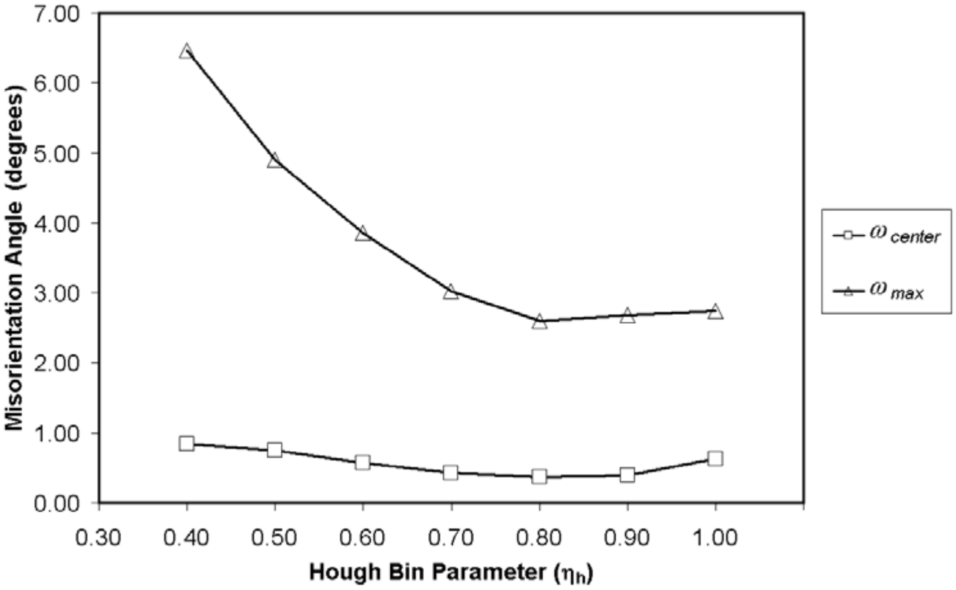

FIG. 2. Effect of the Hough binning parameter on ω_{center}, and ω_{max}.