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Alternatives to Image Quality (IQ) Mapping in EBSD

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Image Quality (IQ) is an important parameter in the EBSD (Electron Backscatter Diffraction) technique. IQ is defined as the sum of the detected peaks in the Hough Transform, and describes the quality of an electron backscatter diffraction pattern. The definition of IQ is somewhat arbitrary and is not clear what physical information it contains. Nonetheless, it has been found empirically to be very useful. Experiment shows that the IQ parameter can give a qualitative description of the strain distribution in a microstructure [1]. The mean, standard deviation and entropy are important quantities for describing images. In this research, we revised TSL's OIM collection program and introduced these concepts into EBSD mapping. Besides doing ordinary mapping, our program can also generate maps using these parameters. We found some interesting phenomena that can help us understand IQ mapping.

In this research, we used an FEI XL30 SEM, with a W filament, and TSL's OIM EBSD system. This EBSD configuration has a SIT camera and an IMAGRPAH video capture card. The sample used for the experiment was polycrystalline Nickel. Figure 1a is a secondary electron image; the foreshortening along the vertical direction is corrected. Figures 1b, 2a and 2b are the normalized images formed by the mapping of the mean, standard deviation and entropy respectively. Figure 2c is the IQ map and figure 3 is the inverse pole figure map. For each point, 16 frames are averaged (about 0.5s capture time) and the chosen step size is 0.5μ. It is obvious that figures 2a, 2b and 2c are very similar. Even though figure 1a and figure 1b are different in the shadowing direction, both of them show topographic contrast and similar details of the specimen. Figures 2a and 2b show the grain boundaries clearly, but the diffraction contrast is not very obvious, if compared with figure 3. Typically, the histogram of a background corrected EBSD pattern is bell shaped, see figure 4. If we further assume a Gaussian distribution, then the standard deviation and the entropy are related. This explains the similarity of these two maps. The similarity between the IQ map and the maps of entropy and standard deviation suggests that the IQ map is doing nothing more than providing a measure of the spread of intensities across the pattern (with background normalization). The calculation of the Hough transform and the summation of the peaks is a more elaborate calculation than is necessary.
All the maps show grain boundaries clearly, and scratches below the surface of the sample can also be seen.

Conclusions:
The mean of the diffraction pattern gives good topographic contrast.
The entropy and the standard deviation of the EBSD pattern are sensitive to grain boundaries.
In low noise maps at least, entropy and standard deviation maps are similar to IQ maps.

References:
[1] OIM™ Data Collection Manual. TSL Company.
[2] We are grateful to TSL for allowing us to use their source code.
[3] Support from DOE, under grant DE-FG02-00ER45819, is gratefully acknowledged.

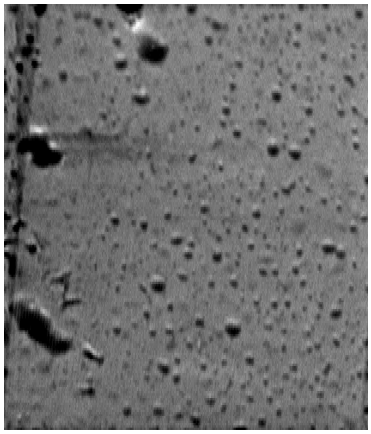
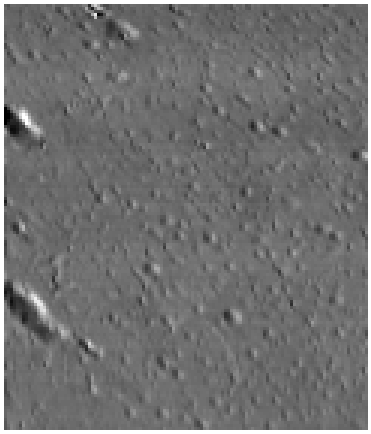


Figure 1a

The secondary image with the distortion corrected.

Figure 1b

The image formed by the mean of the diffraction pattern.



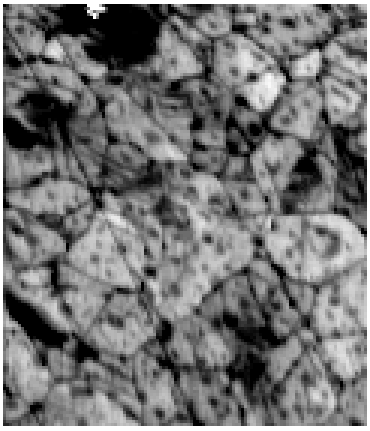


Figure 2a
The map of the entropy of the EBSD pattern

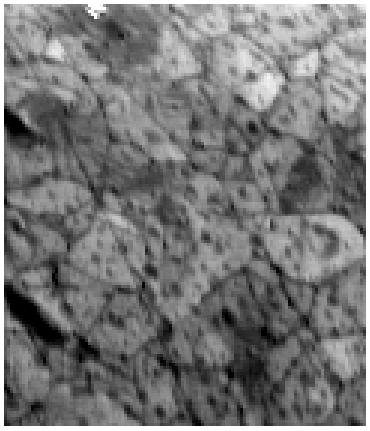


Figure 2b
The map of the standard deviation of the EBSD pattern

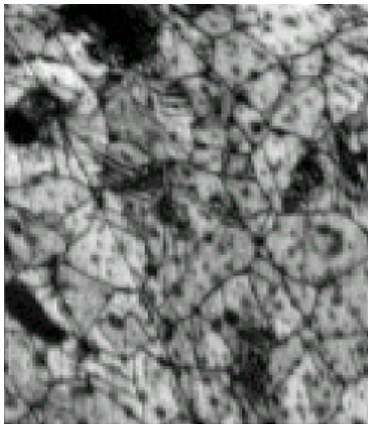
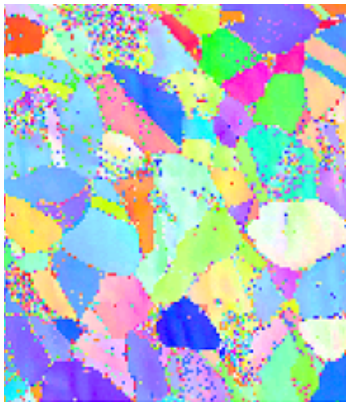


Figure 2c
IQ map



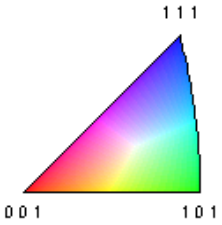


Figure 3 The inverse pole figure map

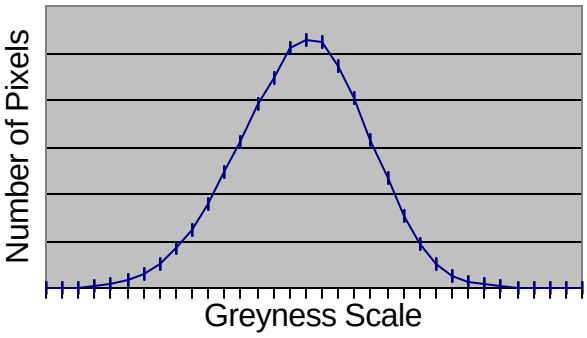


Figure 4 The typical histogram of an EBSD pattern

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