# A Systematic Study of Pseudo-Symmetry Problems in EBSD

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EBSD has proven to be a powerful tool for characterizing polycrystalline microstructures. However, some crystal structures produce patterns that are difficult to unambiguously index. A good example is a material structure that is only slightly tetragonal. In this case, it can be very difficult to differentiate a (010) pole from a (100) pole from an EBSD pattern. Figure 1 shows an example of two potential indexing solutions to a pattern from a material that is only 2% tetragonal. This ambiguity can be overcome by simply indexing the patterns as if the diffracting lattice possessed cubic crystal symmetry. However, such an approach introduces a pseudo-symmetry in data collected from such materials. In other materials, such ambiguities appear only for patterns from specific orientations. This is apparent in the orientation map for quartz shown in Figure 2 shown without any filtering to remove ambiguities. The speckled appearance of a few of the grains shows that the indexing software selected multiple orientation solutions to the patterns from these grains. The pseudo-symmetry problem in these grains can be removed by identifying the pseudo-symmetry relation and then selecting the majority solution within the grain. These ambiguities may also occur when trying to differentiate between phases, even when the phases have dissimilar crystal structures [1].

Using simulated patterns, it is possible to identify orientations for which it may be potentially difficult to obtain unambiguous indexing solutions. The confidence index [2] is a good indicator of ambiguity. If the confidence index has a value of 0 then an unambiguous indexing solution cannot be found for a pattern. By tracking the confidence index while simulating patterns throughout orientation space it is possible to identify orientations that may exhibit the ambiguity problem. An example is shown in Figure 3 for the zirconium oxide for two conditions. Such figures can be generated to reflect a variety of parameters used in automated indexing of EBSD patterns. Such factors include the solid angle, the number of bands detected and the tolerances allowed on the interplanar angle matching. The effect of parameters such solid angle and or those associated with band detection can be tracked using confidence results from simulated patterns. In this way, it is possible to optimise indexing parameters to mitigate the pseudo-symmetry problem.

1. M.M. Nowell and S. I. Wright, Journal of Microscopy (2004), in press.
2. D.P. Field, Ultramicroscopy **67** (1997), p. 1.

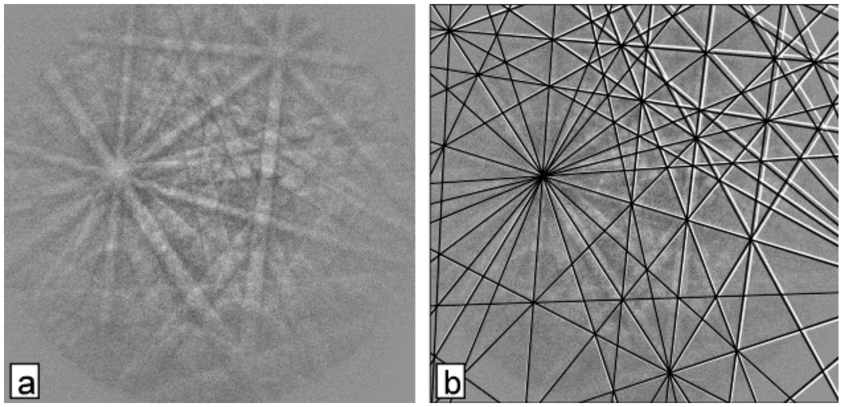


**Figure 1.** (a) Pattern from tetragonal zirconium oxide. (b) overlay of two potential indexing solutions to the pattern.

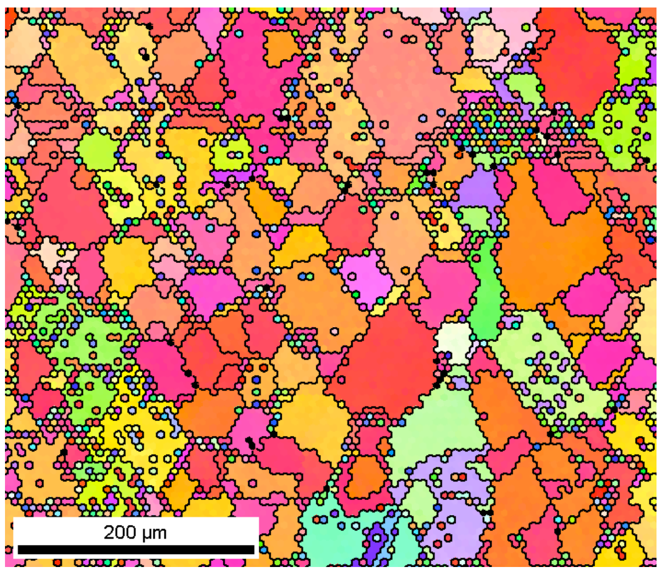


**Figure 2.** Orientation map from quartz without any post-processing.

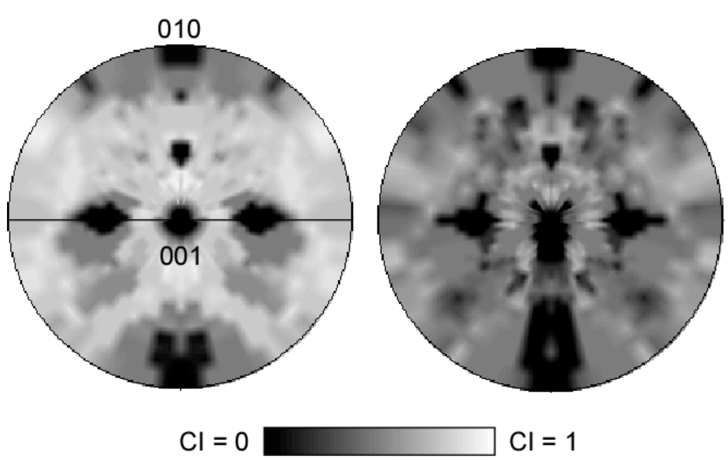


**Figure 3.** Stereographic projections showing the confidence index as a function of orientation for simulated patterns for zirconium oxide. These plots were generated assuming 6 bands were detected and using interplanar tolerance angles of (a) 3 degrees and (b) 6 degrees.