Exploring The Relative Magnitudes of Diffraction-Based Residual Strain Measurements

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Abstract

From micro-focus X-ray diffraction (XRD) to electron microscopy based microtexture measurements, modern diffraction-based tools offer exciting possibilities for multi-scale residual strain quantification. The different techniques differ in scale and resolution, and also yield significant numerical differences in terms of the measured strain values. This study shows that the measurements sensitive to changes in interplanar angle (Δ
theta/
theta) (high resolution electron backscattered diffraction (HR-EBSD) and transmission Kikuchi diffraction (TKD)) provide quantitatively higher residual strain values than those sensitive to changes in interplanar angle (Δd/d) (micro-Laue XRD and transmission electron microscope (TEM) based precession electron diffraction (PED)). Furthermore, it is shown that there appears to be a consistent scaling factor between the two measurement types as residual strain increases. A scaling factor by which HREBSD underestimates (Δd/d)-based strain, compared to (Δ
theta/
theta)-based strain, is derived from pattern simulations. Interestingly, this scaling factor is similar in magnitude to the difference between XRD-based and EBSD-based measurements. This point is further emphasized by comparing strains obtained from identical location, with TKD and PED. They exhibit different resolution but provide similar lattice distortions numerically.

Keywords: Residual Strain, Pattern Simulation, micro, Laue XRD, HR, EBSD, TEM, PED

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