

ANALYSIS OF HIERARCHICAL DISLOCATION ARRANGEMENTS AT DIFFERENT LENGTH SCALES

Barabash R.I.^{1,2}, Ice G.E.¹

¹Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge TN 37831

²Materials Science and Engineering Department, The University of Tennessee, Knoxville, TN

The intensity distribution is sensitive to the kind of dislocations present in the crystal and to the organization and/or correlated arrangement of the dislocations. Around each reciprocal lattice point corresponding to a reciprocal lattice vector site \mathbf{G}_{hkl} the scattered intensity is a function of the diffraction vector $\mathbf{Q}=\mathbf{k}_2-\mathbf{k}_1$ or of the deviation vector $\mathbf{q} = \mathbf{Q} - \mathbf{G}_{hkl}$. Here $\mathbf{k}_1, \mathbf{k}_2$ are wave vectors of the incident and the scattered waves. In the presence of dislocations, there are two distinct directions in reciprocal space:

The radial direction: q_{\parallel} parallel to \mathbf{G}_{hkl} . The radial intensity distribution of the reflection depends mainly on the dilatation part (strain) of the long - range displacement fields caused by lattice defects. Broadening in the radial direction can be qualitatively understood as due to the local variation of the lattice plane spacing caused by dislocations strain fields. Different versions of line broadening and/or line profile analysis can be used to determine statistically stored (SS) dislocations density and distance between different kinds of dislocation walls.

Transverse plane (orientation space): q_{\perp} transverse to \mathbf{G}_{hkl} . Transverse intensity distribution depends essentially on the misorientation part (lattice rotations) of the displacement fields caused by lattice defects. Broadening in the transverse plane represents a local variation in the lattice plane orientation and is related to the formation of geometrically necessary dislocations. Several nondestructive probes with different resolution and penetration depth have been recently developed for the analysis of the local orientation. The transverse intensity distribution can be used to characterize the gradients of local orientation distributions and Geometrically Necessary (GN) dislocations density tensor using white beam techniques, rocking curve analysis, Kossel lines and reciprocal space mapping. Probing materials with different diffraction techniques gives information about hierarchical dislocation arrangements at different length scales.

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