

## 3D MEASUREMENTS OF DISLOCATIONS AND STRAIN GRADIENTS IN THE NEAR SURFACE MICROSTRUCTURES VIA POLYCHROMATIC MICRODIFFRACTION

Barabash R.I.

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

Three-dimensional (3D) measurements of the orientation (texture) distribution, lattice curvature, defects and strain gradients are now possible due to an emerging class of instrumentation: the 3D X-ray crystal strain microscope. This method is ideal for studies of mesoscale evolution of FIB and growth induced defects and lattice reorientation. Several examples are discussed:

(\*) An inhomogeneous plastic deformation in a natural Ni bicrystal after uniaxial pulling. The formation of geometrically necessary (GN) and statistically stored (SS) dislocation arrangements together with lattice rotations were observed during *in-situ* uniaxial pulling of a natural Ni bicrystal. The local lattice rotations and GN dislocation density depends on the distance from the boundary, depth of the location under the surface and on the orientation of the grain relative to the tensile axis. In the vicinity of the boundary, patterned dislocation structure was observed in the A grain, while lattice rotations dominated in the B grain. Crystal plasticity analysis together with finite element simulations find a similar dependence of the plastic response of both grains depending on their orientation and initial structural conditions.

(\*\*) Nearly perfect fiber/matrix composite formed from directionally solidified eutectic provide model systems of small-scale and interface behavior. To understand the small-scale mechanical behavior of micropillars/fibers in composite materials, it is critical to develop techniques to characterize their defect distributions at appropriate length scales. Here we describe a new characterization technique appropriate for these samples, based on polychromatic and scanned monochromatic microdiffraction method. These techniques exploit small (~ 100nm) beams that are now being available. These small penetrating beams can be used to probe very small volumes of materials to determine local strain gradients and defect states. We show how micro-focused x-ray beams can be used to characterize the buried interface properties and strain gradient distributions in the as grown directionally solidified Ni-Mo composite.

Research supported by the Materials Sciences and Engineering Division, Office of Basic Energy Sciences, U.S. Department of Energy. X-ray microbeam measurements were performed at 34-ID-E at the Advanced Photon Source. The use of the APS was supported by the Scientific Users Facilities Division, Office of Basic Energy Sciences, U.S. Department of Energy.