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X-RAY MICROBEAMS FOR 3-D MESOSCALE MATERIALS INVESTIGATIONS*

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High resolution x-ray microbeam measurements have been used to investigate the 3-dimensional deformation microstructure near nanoindents in single-crystal Cu. Broad band-pass (white) synchrotron x-ray microbeams of ~ 0.7 x 0.7 μm^2 cross-section were produced using elliptically figured Kirkpatrick-Baez mirrors on the MHATT-CAT beamline at the Advanced Photon Source. These beams have been used in connection with a CCD detector, interactive Laue diffraction software, and a newly developed technique for obtaining micron resolution along the penetration depth (~25 μm) to probe lattice rotations as a function of depth and position under Berkovitch nanoindents in <111> oriented Cu. Nearly one-dimensional tilts of up to ~3 degrees were found below and extending beyond the flat faces of the indenter, while a much more complicated distribution of tilts with compound lattice rotations was observed below the tip and the sharp blades of the indenter. The x-ray microbeam methods for performing the measurements and data analysis will be discussed, and the outlook for detailed investigations of the fundamental aspects of materials deformation by combining nanoindentation techniques with 3-D x-ray microbeam measurements will be considered.

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