Studies of Materials on Mesoscopic Length-Scales

- Studies of materials on mesoscopic length-scales require a penetrating structural probe with submicron point-to-point spatial resolution.
- Three-dimensional scanning Laue diffraction microscopy provides detailed local structural information of crystalline materials such as crystallographic orientation, orientation gradients, and strain tensors.

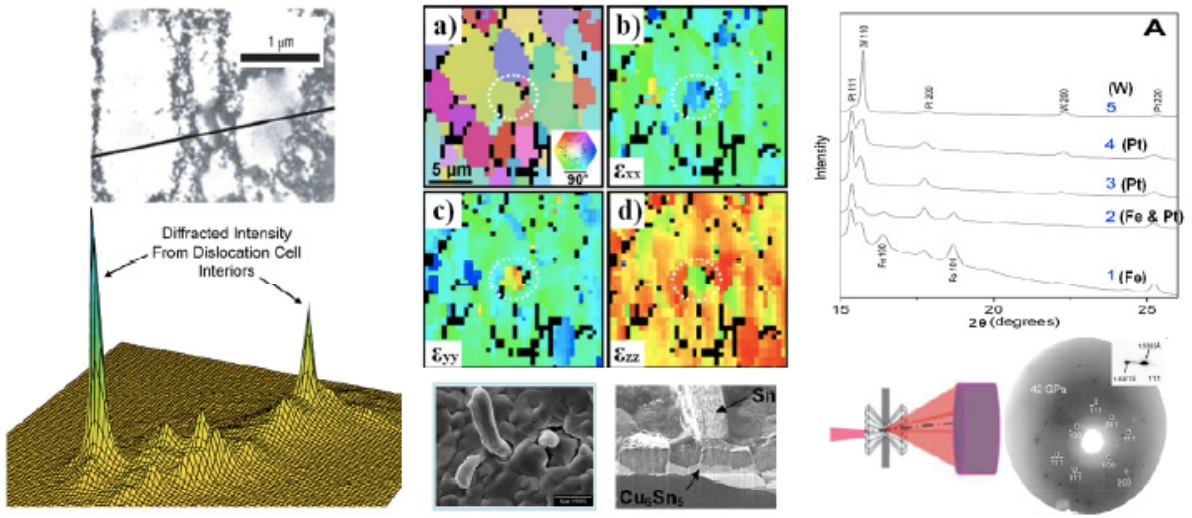

FIGURE 2. Applications of x-ray Laue diffraction 3D microscopy. Left: dislocation microstructure and the variation of the local long-range internal stresses in strained single-crystal copper. Middle: local strain gradients induced Sn whisker growth. Crystallographic orientation (a) and strain tensor (b, c, d) maps of the Sn grains near the whisker root are shown. Right: submicron-scale single-crystal x-ray diffraction studies in polycrystalline samples at ultra-high pressures.

"X-ray Laue Diffraction Microscopy in 3D at the Advanced Photon Source,"
W. Liu, P. Zschack, J. Tischler, G. Ice, and B. Larson, AIP Conf. Proc. 1365, 108 (2011)

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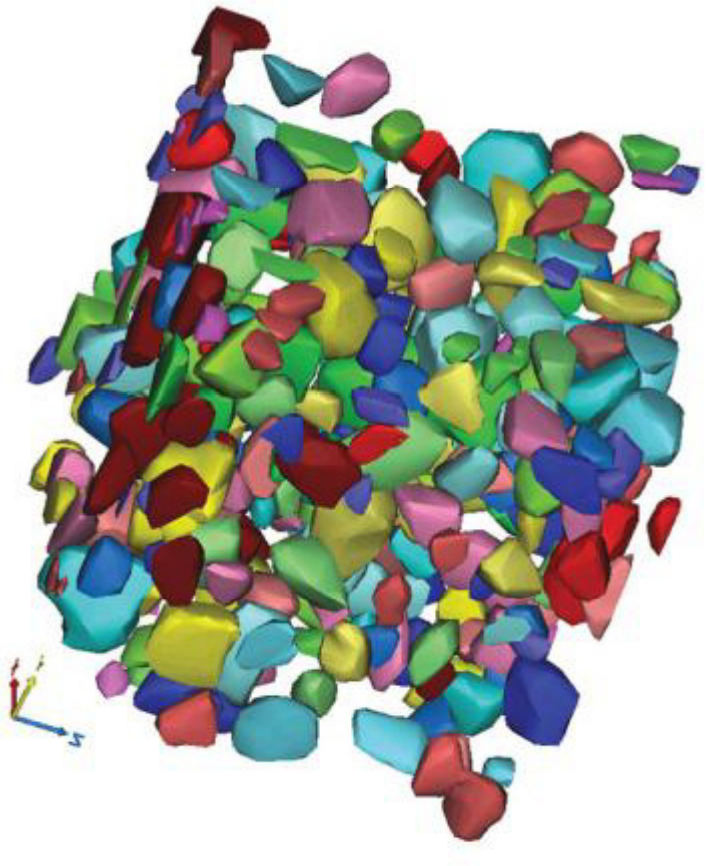
Why Materials Fail: Characterizing Damage in Aluminum Matrix Composites

- The properties of materials can be improved by studying how, why they fail.
- Techniques to investigate microstructures in metal matrix composites (MMCs, lightweight, high-stiffness materials of interest in automotive and aerospace applications, primarily from a fuel efficiency point of view) are limited to surface images that cannot yield information about the composite's 3-D structure; or (3-D imaging) are time consuming, destructive to the sample.
- X-ray tomography at the U.S. Department of Energy's Advanced Photon Source at Argonne National Laboratory examined the microstructure of an SiC MMC before and after tensile damage, captured high-resolution 3-D images of MMC samples.
- Technique is non-destructive, requires minimal time for sample preparation.
- Study produced several important findings, added to our knowledge about damage evolution in MMCs.



J.J. Williams, Z. Flom, A.A. Amell, N. Chawla, X. Xiao, and F. De Carlo, "Damage evolution in SiC particle reinforced Al alloy matrix composites by X-ray synchrotron tomography," Acta Mater. **58**, 6194 (2010).

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