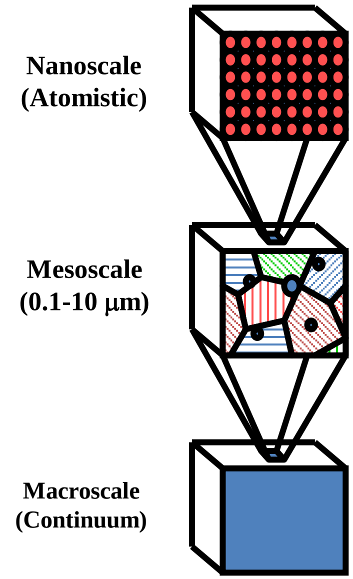
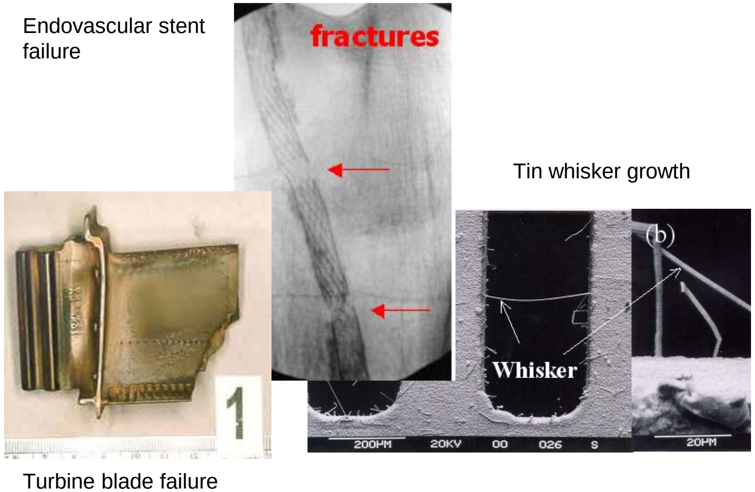
Mesoscale Plasticity by synchrotron X-Laue Microdiffraction and reverse modeling simulation

Opportunity

Materials reliability ultimately depend on their Mesoscale properties.

- **Mesoscale simulation tools are becoming increasingly sophisticated to bridge the gap between the macroscopic and microscopic length scales.**
- **New experimental tools are now available to directly and quantitatively probe the Mesoscale (ex: Synchrotron Laue X-ray microdiffraction).**
- **This leads to a whole world of opportunities for interpreting complex Mesoscale experimental data and provide experimental feedback to theoretical models.**





Meso Challenge

The Mesoscale is the least understood of the materials length scales due to its intrinsic heterogeneity and multiple interacting factors (grains, grain boundaries, inter and intragranular strains/stresses, defects,…). It is however the most important in terms of understanding materials reliability (crack formation, stress fatigue, whisker formation,…)

References: Kunz M., Tamura N., et al.., Review of Scientific Instruments, 80(3) (March 2009) 035108.
P. Dawson, J. Gerken, and T. Marin. (2011) In S. Ghosh and D. Dimiduk, editors, Computational Methods for Microstructure- Property Relationships. Springer, pp. 363-392

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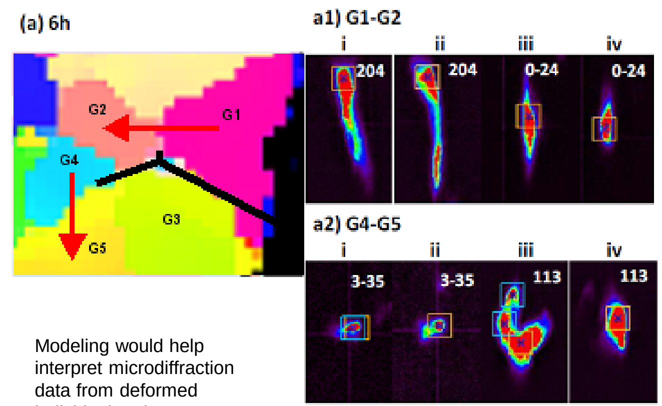
Contact: Nobumichi Tamura & Martin Kunz, LBNL
(ntamura@lbl.gov/mkunz@lbl.gov)

Mesoscale Priority Research Direction

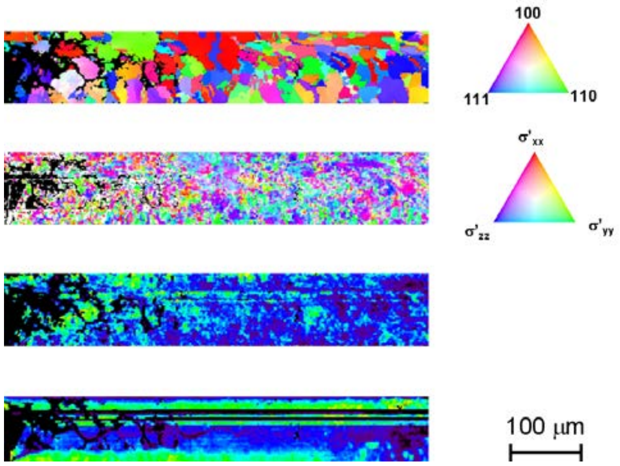
Mesoscale Plasticity by synchrotron X-Laue Microdiffraction and reverse modeling simulation

Approach

Synchrotron Laue x-ray microdiffraction is a powerful experimental tool for measuring materials mesoscale heterogeneities. Data interpretation is however non trivial and would greatly benefit from the availability of a High Performance Computing Mesoscale simulation and modeling hub right at the beamline.



Modeling would help interpret microdiffraction data from deformed individual grains



Experimental mesoscale data of grain orientation, strain, dislocation density around a crack in a high pressure nuclear steam generator tube, obtained by Laue x-ray microdiffraction.

Impact

Provide answers to materials reliability problems by interpreting complex mesoscale experimental data.

- **Real time analysis of complex mesoscale behavior (ex: in situ multi-load plastic deformation of polycrystalline sample)**
- **Direct comparison of theoretical models to experimental observations.**
- **Applications to all engineered materials, microelectronics, biomaterials, …**

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