

Prediction of Material Property Distributions from Small-Scale Models

A. Goals:

- develop probabilistic methods to investigate microstructural influences on the mechanical behavior of materials
- Study microtexture regions in titanium alloys

B. Brief Description:

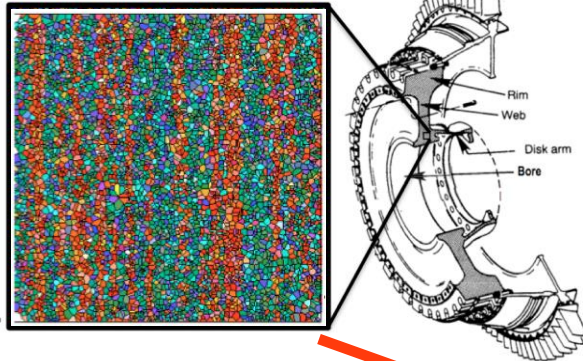
Titanium alloys are used extensively in the aerospace industry, in critical components such as gas turbine engine fan disks, bulkheads, and landing gear. Increasingly, computer models of the material at the microstructural length scale are used to study the inherent stochastic nature of the the elastic and plastic behavior of these alloys. Regions within a structure that have grains with a preferred crystallographic orientation have been linked to early fatigue crack formation. Very little work has been done to statistically characterize these microtexture regions. This project is focused on studying these regions with spatial statistics, and predicting macroscopic material property distributions with simulated micro-scale models.

C. Highlights of Achievements this semester:

- Coded Inverse Pole Figure and Inverse Pole Figure Maps for Visualization
- Developed micro-texture Orientation Distribution Function (ODF) probability estimators
- Developed 3D model of micro-scale volume with micro-texture regions

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IPF Map – grains with similar color have similar crystallographic orientation

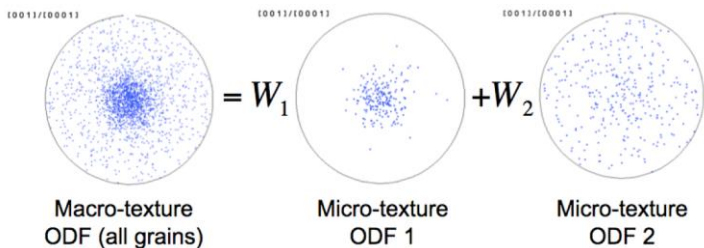
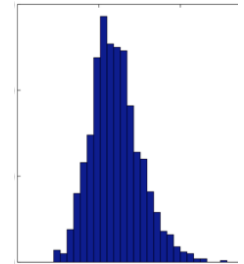
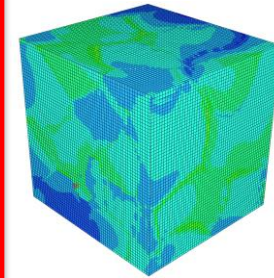


Inverse Pole Figure (IPF)

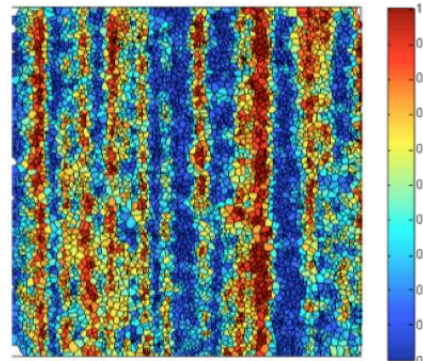


Micro-textured Regions in turbine engine discs can form in bands of grains with similar crystallographic orientations

Next Steps: Implement in Micro-scale Finite Element Model and estimate property distributions



Decomposition of the Macro-texture ODF into Micro-texture ODFs 1 & 2



Map of estimated probability that a grain's orientation is described by Micro-texture ODF 1