Understanding the Micromechanics of alpha-Ti Using High Energy X-Ray Diffraction Microscopy

Rachel Lim*[1], Darren Pagan[2], Joel Bernier[3], Paul Shade[4], and Anthony Rollett[5]

[1]Lawrence Livermore National Laboratory – United States
[2]Pennsylvania State University – United States
[3]Nuro – United States
[4]Air Force Research Laboratory – United States
[5]Carnegie Mellon University – United States

Abstract

On the grain scale, materials are heterogeneous and anisotropic, and these non-uniformities are often the initiation sites for failure. However, most traditional materials understanding assumes a homogeneous and isotropic material to predict performance and failure. Increasing understanding of the effects of anisotropy requires experiments which supply three-dimensional, in situ data to make accurate predictions. Titanium alloys are commonly used in many biomedical and aerospace applications. However, the alpha-phase in this material is both thermally and mechanically anisotropic due to its hexagonal closed packed structure. This anisotropy can lead to the development of significant grain-scale stresses in polycrystals. Previously, far-field high energy x-ray diffraction microscopy (ff-HEDM), a synchrotron-based in situ x-ray characterization technique, was employed to study the in situ micromechanical evolution of Ti-7Al under cyclic loading conditions. Now, near-field HEDM (nf-HEDM) is being used to study the microstructural changes under these loading conditions. In particular, a comparison is done between the grain-averaged orientation changes measured with ff-HEDM and the grain-resolved orientation changes measured using nf-HEDM. This work was prepared under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Document LLNL-ABS-858210.

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*Speaker