I/UCRC Executive Summary - Project Synopsis	**Date:** April 3, 2018

Center/Site: CANFSA/Colorado School of Mines

Tracking No.: 19 Mechanism of Dwell Fatigue Crack Initiation in Ti-7Al Under Biaxial Tension-Tension Loads	**Phone:** (715)456-5754	**E-mail:** ghommer@mymail.mines.edu

Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Garrison Hommer	**Proposed Budget:** $ 200,000

Project Description: Stress dwell periods are detrimental to the fatigue life of some commercial titanium alloys. Failure prediction is based on uniaxial loading studies and does not accurately predict failure under biaxial tension-tension loads, as are experienced in the service conditions of cold compressor turbine disks in jet engines where the relevant alloys are used. It is therefore desired to understand the effect of biaxial tension-tension loads on dwell fatigue in these Ti alloys.

Experimental plan: In situ high energy diffraction microscopy (HEDM) tension-tension planar biaxial dwell fatigue experiments were conducted that nondestructively produced 3D grain scale data including grain positions, volumes, orientations, and lattice strain tensors.

Related work elsewhere: The Air Force Research Laboratory at Wright-Patterson Air Force Base has conducted several monotonic uniaxial HEDM studies on Ti-7Al. Tension-tension biaxial dwell fatigue experiments have been conducted on Ti-6Al-4V at Ecole Polytechnique in France.

How this project is different: Combines the nondestructive 3D mechanics data of HEDM with biaxial tension-tension loading, as is experienced by components in service.

Milestones for the current proposed year: The project has been completed. Mechanics of the interactions between plastically soft and hard grains (fundamentally, the source of dwell fatigue) have been elucidated. Cyclic evolution of the mechanics, including slip system behaviors, have also been elucidated.

Deliverables for the current proposed year: A PhD thesis on this project has been completed and successfully defended by Garrison Hommer. Several journal publications based on the work of the thesis are in preparation.

How the project may be transformative and/or benefit society: Better understanding of the mechanics of dwell fatigue will advance modeling efforts and allow for safer and more efficient designs of jet engine cold compressor disks.

Research areas of expertise needed for project success: Solid mechanics, titanium alloy materials science, experimental and machine design (mechanical engineering).

Potential Member Company Benefits: Increased understanding of the mechanics of dwell fatigue, as well as broader micromechanical behaviors in the alpha phase of Ti alloys. Guidance in the selection of areas for further investigation.

Progress to Date: The project has been completed and a PhD thesis has been written and successfully defended. Major achievements of the project are outlined in more detail above.

Estimated Start Date: Fall 2015	**Estimated Knowledge Transfer Date:** Spring 2018