I/UCRC Executive Summary - Project Synopsis	**Date**: April 2022
Center/Site: CANFSA/Iowa State University	
Tracking No.:48: Grain Boundary Fracture Analysis in Aluminum	**E-mail :** blazanin@iastate.edu **Phone :** (612) 875-7690
Center/Site Director: A. Clarke/P. Collins	**Type: (Continuing)**
Project Leader: Scott Blazanin	**Proposed Budget**:

Project Description: Aluminum alloy 7085-T7452 exhibits atypical fatigue crack growth behavior. This material has shown delamination crack branching under certain grain orientations. If these failure events can be quantified and connected to the microstructure, the crack propagation mechanisms may be used to improve the performance of Al 7085 and expand its potential for use within industry.

Experimental plan: Al 7085 sheet samples were received from the Air Force Research Laboratory (AFRL). Comprehensive metallographic characterization will be conducted (across length scales) including analyses of crack behavior with known rolling orientations for the samples, quantifying crack characteristics (number of branching events, total crack length, and microstructure-crack interactions). Analyzed microstructural data will be used to characterize the delamination and crack branching events observed in the samples.

Related work elsewhere: Neely has conducted work correlating stress intensity factors with crack deviation in Al 7085. Rao and Ritchie have shown atypical crack growth behavior and delamination in second generation Al-Li alloys.

How this project is different: The fracture properties of Al-7085 remain understudied. Prior work has examined fatigue crack behavior and stress intensity factor variations. This project aims to address secondary crack growth while accounting for microstructural influences in Al 7085 samples.

Milestones for the current proposed year: Optical microscope imaging will be used to examine the number, length, and length density of secondary cracks. EBSD analysis will provide texture and local grain orientation information for necessary conditions for delamination and branching of cracks to occur. Microstructural metrics will be paired with existing work on stress concentration values.

Deliverables for the current proposed year: Fitting of Neely stress intensity data to optical micrographs. EBSD analysis of texture, grain boundary misorientation, and Kernel average misorientation along grains bounding secondary cracks. A completed thesis document detailing in full the research for this project.

How the project may be transformative and/or benefit society: Al 7085 is a promising material for use in aerospace structures due to its excellent corrosion resistance and comparable mechanical properties to Al 7075. However, due to atypical cracking behavior under cyclical loading, the application of 7085 has been limited. This work aims to expand knowledge of such behavior and may allow for greater application of 7085 in structural components within the aerospace industry.

Research areas of expertise needed for project success: High-precision metallographic preparation equipment, including the Allied MultiPrep precision polisher. MIPAR image analysis software for secondary crack analyses. MTEX MATLAB toolbox for analyses of EBSD data.

Potential Member Company Benefits: Improved knowledge of microstructure-crack interactions in forged components helps to inform design and processing considerations for components made from 7085.

Progress to Date: All Neely specimens have been metallographically prepared and imaged with optical microscopy. EBSD scans were taken of areas of interest on all specimens. Data analysis for secondary crack number, length, and length-density has been completed for key specimens. EBSD data analysis has been streamlined by the use of MTEX, and inverse pole figures, Kernel average misorientation, and grain boundary misorientation maps have been generated from the data.

Estimated Start Date: Spring 2021	**Estimated Knowledge Transfer Date**: Spring 2022

The Executive Summary is used by corporate stakeholders in evaluating the value of their leveraged investment in the center and its projects. It also enables stakeholders to discuss and decide on the projects that provide value to their respective organizations. **Ideally, the tool is completed and shared in advance of IAB meetings to help enable rational decision making.**