

**I/UCRC Executive Summary - Project Synopsis****Date:** October 2021**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 and unpredictable 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 this crack growth while accounting for microstructural influences on crack nucleation and propagation in Al 7085 samples.

**Milestones for the current proposed year:** SEM imaging of both cracked (from as-tested specimens) and base material will be paired with MIPAR quantification. 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:** SEM micrographs showing crack-microstructure behavior in as-tested specimens as a function of grain orientation. Fitting of Neely stress intensity data to SEM micrographs. EBSD analysis of texture, grain boundary character, and particle dispersion.

**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 microstructure and crack analyses. Spatially Resolved Acoustic Spectroscopy (SRAS), RoboMet serial sectioning for 3D analysis of microstructure and crack formation.

**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 of the Neely specimens were imaged optically at a macro scale and with stereomicroscopy. Stereomicrographs were combined into full fracture edge mosaics. All plate specimens were sent off site for EDM sectioning to excise fracture surface and base microstructure samples.

**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.**