

**I/UCRC Executive Summary - Project Synopsis****Date:** 2-April 2018**Center/Site:** CANFSA/Iowa State University**Tracking No.:****15****Phone :** (515) 294 - 5127**E-mail :** pcollins@iastate.edu**Center/Site Director:** M. Kaufman/P. Collins/A. Clarke**Type:** (New or Continuing)**Project Leader:** Collins**Proposed Budget:** \$ 60k

**Project Description:** Linear Friction Welding (LFW) is a solid phase bonding process, which is particularly appropriate for titanium alloys. Due to the titanium's great affinity for oxygen, nitrogen and hydrogen, protective atmospheres must be used not to contaminate the welded material. LFW avoids the formation of a liquid phase during the welding process, and can therefore be carried out in air. The typical defects caused by melting and solidification during traditional welding process such as pores, pinholes, shrinkage cracks and grain coarsening are therefore avoided. However, due to the LFW process, a narrow and extensively deformed region forms adjacent to the bond line. *This region has significant variations in microstructure that can influence performance of the components.* Understanding the variations in microstructure in this region is far from mature. In addition, high frequency oscillation during the weld can result in textured structures along the bond line. *The influence of these textured regions on cold dwell fatigue have not been explored.*

**Experimental plan:** The proposed project would focus on understanding microstructural evolution during LFW and explore the effect of these structures on mechanical properties including cold dwell fatigue. The student would assess the microstructure evolution as a result of varying weld parameters (Upset, load, frequency). The student would assess the effect of any texture zones on mechanical properties, especially cold dwell fatigue.

**Related work elsewhere:** Very little work has been conducted to understand the formation of texture and its influence on properties and performance.

**How this project is different:** This project seeks to provide quantified microstructural information and preliminary assessments of strength and fatigue behavior.

**Milestones for the current proposed year:** To characterize the microstructure and texture of the LFW materials. To make preliminary estimations of yield strength, and propose methods to test the fatigue behavior of the material.

**Deliverables for the current proposed year:** Characterized material. Properties. Literature review.

**How the project may be transformative and/or benefit society:** Titanium alloys are widely used in Aerospace applications for their high strength to weight ratio, good corrosion resistance and metallurgical stability. In recent years, the drive towards reduction in energy consumption has put emphasis on use of lighter weight materials and more titanium hardware is being used in Aerospace applications. At the same time cost reduction and conservation of resources have driven towards more cost-effective production methods requiring less machining and less material waste. New joining methods are being implemented that allows a more near-net component shape, reducing the amount of post machining required.

**Research areas of expertise needed for project success:** Microstructural characterization. Understanding of composition-microstructure-property relationships. Ability to analyze texture. Fatigue.

**Potential Member Company Benefits:** Understanding of new process.

**Progress to Date:** Preliminary microstructural investigation. Preliminary design of testing geometries to assess properties.

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