I/UCRC Executive Summary - Project Synopsis	**Date**: March 24, 2018	
Center/Site: CANFSA/Colorado School of Mines		
Tracking No.: 29 L Identification of Deformation Mechanisms of Thermally Stable Cast Al-Cu Alloys via Neutron Diffraction	**Phone :** (906) 370-9057	**E-mail :** bmilliga@mymail.mines.edu
Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**	
Project Leader: Brian Milligan	**Proposed Budget**: $240,000 Leveraged	

Project Description: Cast Al-Cu alloys have long been an area of study, due to their high strength and low cost. In order to better understand the behavior of these alloys, this project aims to use advanced characterization techniques such as neutron diffraction to qualify and quantify *in situ* the mechanical deformation mechanisms in various Al-Cu alloys. Of particular interest is the high temperature mechanical properties of commercial alloys compared to thermally stable alloys. In order to properly study this thermal stability, precipitation during aging will be studied *in situ* using advanced characterization techniques. Relevant creep testing will also be performed.

Experimental plan: In order to separate the variables of temperature and microstructure, testing has been performed at Oak Ridge National Laboratory's (ORNL) Spallation Neutron Source (SNS) VULCAN beamline at room temperature that varies microstructure and temperature in Al-Cu alloys of interest. *In situ* studies of precipitate evolution will be performed by advanced characterization techniques. Microstructural characterization by transmission electron microscopy (TEM) is also underway.

Related work elsewhere: Study of phase transformations/microstructural development and mechanical behavior has been performed by Shyam's group at ORNL.

How this project is different: In this project, microstructural evolution over a wide range of temperatures will be examined and linked to deformation mechanisms. In situ time of flight neutron diffraction during deformation will obtained, in addition to state-of-the-art characterization of precipitation evolution at national user facilities.

Milestones for the current proposed year:
- Develop quantitative model for the amount of precipitate shearing and make correlations with in-situ neutron diffraction experiments;
- Perform TEM on post-tension tested conditions;
- Continued creep testing at ORNL;
- Pursue in-situ studies of precipitate evolution with advanced characterization techniques to link microstructural condition with mechanical property evolution

Deliverables for the current proposed year:
- Submit the journal paper entitled "The Effect of Microstructural Stability on the Creep Behavior of Cast Al-Cu Alloys at 300 °C";
- Prepare and submit a journal paper on microstructural effects on room-temperature mechanical properties in 206 Al alloy implementing neutron diffraction;
- Give talks at MS&T 2018 and TMS 2019;
- Give CANFSA talks and submit CANFSA reports

How the project may be transformative and/or benefit society: Deep understanding of mechanical behavior and phase transitions in Al-Cu alloy systems can be used to improve the high temperature behavior, allowing for more efficient, higher temperature internal combustion engines.

Research areas of expertise needed for project success: Mechanical metallurgy, including dislocation dynamics and strengthening mechanisms; phase transformations, particularly with respect to metastable phases and transformation kinetics; characterization techniques, such as neutron diffraction and advanced microscopy techniques.

Potential Member Company Benefits: This work is important to advanced vehicle technologies, particularly transmission applications. This project will help to seed new sponsor development in the automotive sector. CANFSA's aerospace members (e.g. Boeing and Honeywell) are also generally interested in lightweight Al alloys.

Progress to Date: Creep testing at 300 and 350 °C of various alloys; in-situ tensile neutron diffraction tests at various temperatures, aging conditions on a range of alloys; TEM of microstructural conditions tested during neutron diffraction experiments.

Estimated Start Date: Fall 2017	**Estimated Knowledge Transfer Date**: Spring 2021