I/UCRC Executive Summary - Project Synopsis	**Date**: October 2019

Center/Site: CANFSA/Colorado School of Mines

Tracking No.: 36c Combining In-Situ and Ex-Situ Characterization to Understand Crystallographic Texture Development in Metal Additive Manufacturing	**Phone:** (352) 281-5752	**E-mail:** jklemmto@mines.edu

Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Jonah Klemm-Toole	**Proposed Budget**: $100000, Leveraged

Project Description: The emergence of metal additive manufacturing (MAM) has unlocked the possibility to create complex geometries with location and orientation specific properties. The vast parameter space available in MAM provides the opportunity to create unique microstructures that are not possible with conventional processing. Recent reviews by the National Academy of Sciences, the Federal Aviation Administration, and National Institute for Standards and Technology have identified anisotropic mechanical properties as a characteristic of MAM that limits the broad implementation. Crystallographic texture is expected to be a major contributor to anisotropic mechanical properties observed in MAM. In this project we aim to combine in-situ characterization, e.g. radiography during laser melting to simulate laser-based MAM, with ex-situ characterization such as scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD) in order obtain a deeper understanding of crystallographic texture development in MAM. It is expected that the outcome of this project with contribute to a deeper understanding of processing-microstructure relationships and enable the broader implementation of MAM.

Experimental plan: Single crystal samples with specific crystallographic orientations made from two model Ni-based superalloys will be laser melted at the Advanced Photon Source (APS) while obtaining in-situ radiography to measure the velocity of the solid liquid interface. Ex-situ EBSD and SEM will be used to characterize the solidification microstructure. Combining in-situ and ex-situ characterization will allow for the estimation of dendrite/cell tip velocity that will be used to calibrate Phase Field models to better understand the columnar to equiaxed transition in Ni-based superalloys.

Related work elsewhere: Similar work is being performed by Tresa Pollock's group in University of California Santa Barbara (UCSB), in collaboration with CANFSA through an Office of Naval Research (ONR) Multi-Disciplinary University Research Initiative (MURI).

How this project is different: This project is focused specifically on crystallographic texture and the disruption of texture through the columnar to equiaxed transition in model Ni-based superalloys. The UCSB group is focus on more industrially-based Ni-Co alloys.

Milestones for the current proposed year: In the current proposed year, the first set of experiments were conducted at APS, and the results will be presented at MS&T.

Deliverables for the current proposed year: A journal publication documenting the findings of the first set of experiments at APS is planned in the current year.

How the project may be transformative and/or benefit society: It is expected that the outcome of this project with contribute to deeper understanding of processing-microstructure relationships and enable the broader implementation of MAM to high value, failure critical components such as gas turbine airfoils.

Research areas of expertise needed for project success: Radiography, image processing, EBSD, SEM, computational modeling.

Potential Member Company Benefits: Increasing the depth of understanding of processing-microstructure relationships is expected to help industry expand MAM into demanding applications.

Progress to Date: The first set of experiments is complete, radiography analysis is in progress, EBSD and SEM is in progress, MS&T presentation is in progress.

Estimated Start Date: Spring 2019	**Estimated Knowledge Transfer Date**: Spring 2021

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.**