I/UCRC Executive Summary - Project Synopsis	**Date**: April 2022
Center/Site: CANFSA/Iowa State University	
Tracking No.: Project 36B-L: Rationalization of Liquid/Solid and Solid/Solid Interface Instabilities During Thermal-Mechanical Transients of Metal Additive Manufacturing	**E-mail :** pcollins@iastate.edu **Phone :** (515) 294 - 5127
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Katie O'Donnell	**Proposed Budget**: N/A

Project Description: The length and time scales in additive manufacturing, as compared to other manufacturing techniques such as welding, casting, powder metallurgy, etc., create unique relationships between the resulting thermal gradients and microstructure. The goal of this project is to understand the science behind the relation between thermal gradients in AM builds, as a function of different scan strategies, and the microstructure and texture evolution, using Ti-6Al-4V, Inconel 738, and Haynes 282.

Experimental plan: Ti-6Al-4V, Inconel 738, and Haynes 282 samples were made using a powder bed, electron beam, additive manufacturing system, using 3 different scanning strategies (raster, Dehoff and random). ISU has been working on the characterization of these samples across different length scales. The latest observations have been about different types of defects present in the titanium samples and how they influence the texture and grain growth, as well as act as stress concentrators, as well as more recent work on the characterization of the Inconel and Haynes samples.

Related work elsewhere: The majority of previous work has been focused on changing build parameters to improve individual build operations without a basic science study on the effects of AM on microstructural development.

How this project is different: The MURI project is focused on understanding and expanding the basic science and phenomena through the thermomechanical gyrations materials experience during the AM processes.

Milestones for the current proposed year: Comprehensive understanding of defects present in titanium AM parts, with an emphasis on finite element modeling of the effect of thermal stresses on gas pores, as well as the influence of compositional variations on local properties. Preliminary microstructural characterization and comparison of Inconel 738 samples and Haynes 282 samples.

Deliverables for the current proposed year: A draft of a paper on the Inconel samples, as well as the submission of one to two more papers on the titanium samples.

How the project may be transformative and/or benefit society: Optimization of the final cost and mechanical properties of AM components as well as reducing the trial and error phase of AM design and manufacture curve. Fill in knowledge gaps in AM.

Research areas of expertise needed for project success: Microstructural characterization. Understanding of composition-microstructure-property relationships. Ability to analyze texture. Phase transformation behavior during solidification. Sources of defects in AM builds.

Potential Member Company Benefits: Deeper understanding of AM processes.

Progress to Date: ISU team has worked on characterization (2D and 3D) that has been translated into papers. One paper on texture in the titanium samples was published in the Metallurgical and Materials Transactions A journal. Two additional defect-focused papers have been published as well, in Scripta Materialia and Advanced Materials & Processes. Two talks were presented at MS&T 2021, with a third talk presented at TMS 2022 and a fourth at AeroMat 2022.

Estimated Start Date: Fall 2018	**Estimated Knowledge Transfer Date**: Fall 2023

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.**