I/UCRC Executive Summary - Project Synopsis	**Date**: April 2022
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:58: Understanding Microstructure Evolution of High Temperature Ni Alloys Across Additive Manufacturing Processes	**E-mail :** jfgonzalez@mines.edu **Phone :** (910) 552–7526
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Juan Gonzalez	**Proposed Budget**: $100,000

Project Description: Additive manufacturing (AM) processes provide different benefits related to high deposition rates and geometric complexity. Understanding the annealing behavior on the microstructure of Ni based alloys (IN 625 and H 282) across AM processes is envisioned to open doors to improve the quality of manufactured power generation components.

Experimental plan: As-built and annealed samples were taken from IN625 and H282 metallic walls built with laser powder bed fusion (LPBF) and wire arc additive manufacturing (WAAM). Two extra set of IN625 samples were made to study how the number of weld beads (one single bead, and four weld beads) used on the manufacturing process would affect the annealing behavior of the alloy. Electron backscatter Diffraction (EBSD) was performed to compare the microstructural changes between as-built condition and the other specimens annealed during one hour at temperatures of 1000, 1100, and 1200 ºC. Microhardness testing was performed to correlate microstructure changes with mechanical properties.

Related work elsewhere: There is very little work in the literature evaluating the effects of AM process on annealing behavior of Ni-based alloys.

How this project is different: Previous work suggest that it is necessary to reach the highest carbide solvus temperature to get recrystallization, assuming that these precipitates strongly affect boundary mobility. However, the amount of stored energy in the as-built condition should significantly affect the driving force or recrystallization.

Milestones for the current proposed year: Identify the effect of annealing temperatures on final microstructure and hardness of Nickel alloys, as an assessment of the stored energy left by AM processes on the annealing behavior of Nickel alloys.

Deliverables for the current proposed year: Correlate the annealing temperatures (1000, 1100 and 1200ºC) with additive manufacture processes performed on this project (WAAM and LPBF) to determine what drives recrystallization and other annealing phenomena.

How the project may be transformative and/or benefit society: Understanding the annealing behavior of Nickel alloys will open doors to improve the quality of additively manufactured power industry components, clarifying the criteria for the selection of the AM processes that provides the best deposition rate vs properties relationship.

Research areas of expertise needed for project success: Operate a collaborative robot (cobot) controlled Fronius CMT GMAW; EBSD to compare as-built samples with annealed specimens; automated microhardness indenter to aid in data analysis to support conclusions about the annealing behavior of both alloys which cannot be easily appreciated on the EBSD analysis .

Progress to Date: Preparation, testing and analysis of IN625 and H282 samples have been done, allowing to identify the mechanism that drive recrystallization and other annealing phenomena regarding the AM process used on the production of the studied specimens.

Estimated Start Date: Fall 2021	**Estimated Knowledge Transfer Date**: August 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.**