I/UCRC Executive Summary - Project Synopsis	**Date**: October 2020
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:36E: In-Situ Characterization of Microstructural Evolution During Simulated Additive Manufacturing in Model Alloys	**E-mail :** brodgers@mines.edu **Phone :** (720) 413–4542
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Brian Rodgers	**Proposed Budget**: $240-320K, Leveraged
Project Description: Conduct spot melts and rasters of Al-Ag and Ni-Al-Mo samples at the Advanced Photon Source (APS) with in-situ radiography imaging. This will be coupled with ex-situ simulations of the melt pools correlated to the APS melts pools for verification of solid-liquid interface velocities and to obtain information about thermal gradients. Solidification velocities from APS radiography and thermal gradients obtained from simulations will be combined with microstructural characterization to assess solidification behavior of materials under different conditions.	
Experimental plan: As-solidified samples of Al-Ag and Ni-Al-Mo melts from the APS will be imaged from the top-down via SEM before sectioning. Once sectioned, samples will be polished into the centerline and then imaged via SEM and EBSD. Simulation work will be conducted using the FLOW-3D software package.	
Related work elsewhere: This project is a part of a MURI, so similar work is being conducted at other university sites, mainly on alloys from the INCONEL series and Ti-6Al-4V. These other projects also focus on electron beam additive manufacturing, while also using complementary APS experiments.	
How this project is different: Other studies emphasize the analysis of built parts in industrial alloy systems, while this project is centered around model alloys. The goal is to understand fundamental solidification behavior, rather than analyzing the performance of a single alloy under specific conditions.	
Milestones for the current proposed year: Top-down microstructural analysis of APS samples is underway, in addition to radiography analysis for solidification velocities and FLOW-3D simulations.	
Deliverables for the current proposed year: Top-down images of microstructures in Al-Ag and Ni-Al-Mo APS samples, determination of solidification velocities by analyzing APS radiography data, FLOW-3D simulations to determine thermal gradients in APS melt pools, and correlation of simulations to real melt pool shape to ensure accuracy.	
How the project may be transformative and/or benefit society: Most solidification research has been performed on slow solidification velocity scenarios such as casting. A deeper understanding of the phenomena uniquely seen at high velocities and gradients will facilitate advanced technologies, such as additive manufacturing, to expand into more alloy systems. These results may also facilitate concepts for alloy design for additive manufacturing. Control of solidification conditions may lead to opportunities for producing unique microstructures, such as additive manufacturing of highly textured, or 'single crystal', parts.	
Research areas of expertise needed for project success: Beamline access for *in-situ* experiments. SEM with EBSD and post-processing to evaluate microstructure. FLOW-3D software for simulation work.	
Potential Member Company Benefits: Enhanced understanding and control of metallurgical behavior under rapid solidification conditions, with applications in additive manufacturing and laser welding.	
Progress to Date: A matrix of Al-Ag and Ni-Al-Mo alloys during simulated additive manufacturing experiments with processing parameter variations have been completed at the APS. Analysis of APS radiography is underway with code developed by students within CANFSA. Top-down imaging of APS samples has started. Initial simulations of APS melt pools using analytical equations and melt pool shape comparisons to evaluate the relative effect of heat transfer phenomena has been performed.	
Estimated Start Date: Fall 2019	**Estimated Knowledge Transfer Date**: Spring 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.**