I/UCRC Executive Summary - Project Synopsis	**Date**: April 2020

Center/Site: CANFSA/Colorado School of Mines

Tracking No.: 36A-L: Microstructural Evolution in Titanium Alloys Under Additive Manufacturing Conditions	**Phone:** (303)-990-0939	**E-mail:** asaville@mymail.mines.edu

Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Alec Saville	**Proposed Budget**: $240,000, Leveraged

Project Description: This project will focus on observing changes to crystallographic texture of electron beam melted (EBM) Ti-6Al-4V as a function of build scan strategy and build height. Three different scan strategies are employed to produce Ti-6Al-4V with different thermal histories and thus give rise to different conditions within each specimen. Neutron diffraction is used to evaluate texture profiles for each specimen both on a bulk scale and locally. With processing completed using the Material Analysis Using Diffraction (MAUD) software package and MATLAB-MTEX plugin, the goal of this project is to quantify differences in texture components between scan strategies and with build height. Large scale electron backscatter diffraction (EBSD) maps will be used to correlate texture components determined via neutron diffraction to aspects of AM Ti-6Al-4V microstructure. This will build a better understanding of processing-property relationships for additively manufactured (AM) titanium alloys and give insight into controlling anisotropic behavior and microstructural evolution in titanium AM builds. Development of a standard operating procedure for processing neutron diffraction data will also be developed, along with documentation and instructional materials.

Experimental plan: Texture data will be collected via bulk and local neutron diffraction experiments at Los Alamos National Laboratory and subsequently processed using the MAUD software package and MATLAB-MTEX plugin. Quantification of texture components for all experiments will be completed, enabling a numerical comparison of crystallographic texture as a function of scan strategy and build height. EBSD maps will be collected in 4 x 4 mm areas to collect and correlate texture to microstructural features.

Related work elsewhere: Experiments will be carried out at the HIPPO (High-Pressure-Preferred-Orientation) TOF neutron diffraction beamline at Los Alamos National Laboratory (LANL) to collect texture information. Training on MAUD and MATLAB-MTEX software will also occur at LANL and potentially at NIST-Maryland as the project evolves. EBSD work will occur offsite at NIST-Boulder due to their unique microscopy capabilities.

How this project is different: This project aims to develop a direct understanding of crystallographic texture evolution with varying scan strategies not seen in literature, probe how texture changes as a function of build height, and relate this to microstructural evolution. Texture is a poorly understood aspect of AM materials and is needed for effective control of anisotropic properties and desired material properties.

Milestones for the current proposed year: Correlation of texture components to microstructural features is the immediate primary objective. Reconstruction of prior β-Ti grains is a secondary objective enabled by the correlative EBSD analysis previously described.

Deliverables for the current proposed year: Deliverables for the current year include: publication of a journal paper summarizing results, video and document instructional materials detailing a standard operating procedure for processing neutron diffraction data, and summary reports to the project sponsor, the Office of Naval Research.

How the project may be transformative and/or benefit society: By understanding crystallographic texture evolution within AM builds, models and predicative capabilities can be updated for future AM efforts. This will increase general confidence in AM parts, enable new levels of control in material performance, and increase the deployment of AM into higher impact functional and structural applications.

Research areas of expertise needed for project success: Rietveld refinement, neutron diffraction, crystallographic texture, crystallography, and titanium metallurgy.

Potential Member Company Benefits: This project is of direct interest to LANL due to their involvement in completing neutron diffraction experiments. Results from this work can also give insight into anisotropic behavior of AM titanium components produced by member companies, helping to inform new predictive capabilities and troubleshoot present production issues encountered by several sponsors.

Progress to Date: Literature review for AM titanium and crystallographic texture has been completed. Neutron diffraction experiments and MAUD processing and texture component quantification are complete. Correlation of texture to microstructure and texture reconstructions is ongoing.

Estimated Start Date: Fall 2018	**Estimated Knowledge Transfer Date**: Spring 2022

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.**