I/UCRC Executive Summary - Project Synopsis	**Date**: March 24, 2018

Center/Site: CANFSA/Colorado School of Mines

Tracking No.: 33-L: In-situ Studies of Strain Rate Effects on Phase Transformations and Microstructural Evolution in β-Titanium Alloys	**Phone:** (720)272 -9125	**E-mail : :** bellyson@mymail.mines.edu

Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Benjamin Ellyson	**Proposed Budget**: $240-320K, Leveraged

Project Description: Investigate the deformation mechanisms and microstructure evolution in metastable β-titanium (Ti) alloys as a function of composition, processing, and strain rate to develop alloy design strategies. Specifically, understanding transformation- and twinning-induced plasticity (TRIP/TWIP) are the main focus of this project, as they allow for high work-hardening and uniform elongation, without compromising strength. These alloys hold potential for blast and crash resistant applications.

Experimental plan: Multiple alloys of varying compositions will be mechanically tested in different microstructural states. Characterization of the samples will occur before, during, and after deformation to understand the dependencies of TRIP/TWIP on intrinsic and extrinsic factors. This understanding will be used to inform possible alloying, microstructure, and property design strategies.

Related work elsewhere: High strain rate compressive and tensile mechanical behavior of metastable β-titanium alloys is sparse to non-existent in the literature. Limited studies have started to explore the role of strain rate on microstructure evolution during compression, but high strain rates or deformation in tension have not been explored.

How this project is different: This project aims to fundamentally understand TRIP/TWIP deformation mechanisms to provide insights into possible alloying and microstructure design strategies to tailor properties for specific applications, such as blast/crash resistance.

Milestones for the current proposed year: TRIP/TWIP in Ti-1023 and Ti-15Mo has been studied during high strain rate deformation with in-situ imaging and diffraction at the Advanced Photon Source at Argonne National Laboratory. Experiments were performed in February 2019 and 2020. Complementary microstructure characterization will also be performed.

Deliverables for the current proposed year: The strain rate dependence of TRIP/TWIP and microstructure evolution in Ti-1023 and Ti-15Mo as a function of heat-treatment and deformation conditions will be summarized. First principles calculations will be used to understand the effect of chemistry on chemical stability, elastic anisotropy, and deformation mechanisms, which will help to inform alloy design.

How the project may be transformative and/or benefit society: This project will aid in the development of lightweight, blast resistant armor and crash-resistant structural components for defense applications.

Research areas of expertise needed for project success: Mechanical testing and microstructure characterization (optical, advanced electron microscopy, x-ray diffraction), in-situ studies during deformation at national user facilities, analytical and numerical material modeling, alloy design and materials processing.

Potential Member Company Benefits: This work will enable alloying and TRIP/TWIP mechanism and microstructure design to control the mechanical behavior of novel β-Ti alloys for specific applications. These results will be relevant for aerospace and defense applications.

Progress to Date: Quasi-static and intermediate strain rate tensile and compression testing and high strain rate tensile testing of TRIP Ti-1023 and TWIP Ti-15Mo have been performed. The role of low-temperature aging on TRIP Ti-1023 has also been explored, which promises novel microstructure design strategies for TRIP/TWIP Ti alloys for crash and blast resistant applications.

Estimated Start Date: Fall 2017	**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.**