I/UCRC Executive Summary - Project Synopsis	**Date**: October 2019
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:31: Accumulative Roll Bonding of Al and Ti Sheets Toward Low Temperature Superplasticity	**E-mail :** bmcbride@mines.edu **Phone :** (503)866–6530
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Brady McBride	**Proposed Budget**: $240,000 Leveraged
Project Description: Accumulative roll bonding (ARB) is a severe plastic deformation technique used to produce ultrafine grained materials with a convention rolling mill. This processing technique has shown significant Hall-Petch strengthening behavior and enhanced superplastic formability. Materials subject to ARB exhibit typical superplastic behavior at reduced temperatures and increased strain rates, which has the potential to significantly impact the cost and processing time of superplastic sheet forming.	
Experimental plan: After an ARB process is developed at Colorado School of Mines, 5XXX series aluminum will be investigated to see how composition and initial microstructure effect grain refinement in the ARB process. Elevated temperature mechanical properties, as well as microstructural evolution, crystallographic texture and bonding interface development will also be studied. Titanium alloys can be studied in the future as an extension of this project.	
Related work elsewhere: The majority of previous work has been focused on proof-of-concept studies pertaining to ARB. Research has been conducted for the past decade at Osaka University of Japan on the development of the ARB process and processing parameters that affect grain refinement.	
How this project is different: Few studies have examined the superplastic behavior of ultrafine grained materials produced by ARB. Recent developments have proven the enhancement of superplastic behavior in specific alloys, such as Al 5083, but have not comprehensively studied alloy composition or starting microstructure to optimize superplastic response.	
Milestones for the current proposed year: Investigate the effect of alloying elements on dispersoid size and distribution, which is speculated to influence the amount of dynamic grain refinement and, by extension, superplasticity. Begin to characterize the nature of superplastic deformation with regards to grain boundary sliding, microstructural stability and void formation.	
Deliverables for the current proposed year: Demonstrate superplasticity in ARBed 5XXX aluminum over a range of temperatures. Show, through direct comparison, how ARBed material has superior superplastic properties compared to conventionally processed material. Identify alloy compositions within 5XXX aluminum that are best suited to enhance superplasticity through ARB processing.	
How the project may be transformative and/or benefit society: An in-depth understanding of ARB will be developed with respect to multiple aspects (microstructural refinement, texture development, strengthening, superplasticity, strain rate sensitivity) in select alloys. This will act as a detailed case study to showcase the full potential of ARB as a novel processing method and its benefit to industry.	
Research areas of expertise needed for project success: Access to a high capacity rolling mill (>50 tons) to roll-bond wider samples; EDAX's EBSD post-processing software NPAR to aid in data analysis of grain size and grain boundary misorientation of severely deformed grains.	
Potential Member Company Benefits: Enhanced superplasticity by means of reduced temperature or increased strain rate has the potential to increase cycle time of forming operations while reducing costs.	
Progress to Date: Preliminary tensile tests on 5-cycle ARBed Al 5083 (grain size 1 μm x 250 nm x 250 nm) have demonstrated superplastic behaviour – an elongation of 382% – at 377 °C with an initial strain rate of 10^{-3} s^{-1}. In the same testing conditions conventionally processed material, with an average grain size of ~15 μm, only showed 169% elongation.	
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.**