I/UCRC Executive Summary - Project Synopsis	**Date**: October 2021
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:31: Accumulative Roll Bonding of Al 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 CANFSA and Leveraged

Project Description: Accumulative roll bonding (ARB) is a severe plastic deformation technique used to produce ultra-fine grain materials with a conventional rolling mill. Materials subject to ARB exhibit enhanced 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: An ARB process will be developed at Colorado School of Mines within the capacity of current equipment. The development of microstructures in 5XXX aluminum using the ARB process will be investigated. After an understanding of the microstructural development that occurs with this process, samples will be tested for superplasticity, and optimization of parameters (temperature, strain rate, starting microstructure) for enhanced superplasticity will be investigated.

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 tensile testing parameters to optimize the superplastic response. Microstructural stability of a fine grain structure remains relatively unexplored.

Milestones for the current proposed year: Identify combinations of temperatures and strain rates that deliver an optimal low temperature superplastic response for the ARBed microstructure created. Use these parameters to establish a proof-of-concept for biaxial formability and evaluate strain uniformity.

Deliverables for the current proposed year: Identify temperature and strain rate limits for low-temperature superplasticity based on kinetics of deformation mechanisms that are realized in tensile tests and reported in literature. Report on superplastic forming strains that can be achieved in biaxial testing.

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, superplasticity, strain rate sensitivity) in 5XXX aluminum alloys. This will act as a detailed case study to showcase the potential of ARB as a novel processing method and its benefit to the sheet forming 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 decrease cycle time of forming operations while reducing costs. Retention of submicron grain size after forming can also lead to stronger parts without heat treatment.

Progress to Date: Completed tensile tests with three different starting microstructural conditions over a variety of temperatures and strain rates to identify a few parameters combinations to investigate in more detail. This detailed analysis will be used to identify mechanistically the limits of low temperature superplasticity. Proof-of-concept biaxial bulge tests have been conducted at and evaluation in terms of strain uniformity and microstructural evaluation are currently underway.

Estimated Start Date: Fall 2017	**Estimated Knowledge Transfer Date**: December 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.**