I/UCRC Executive Summary - Project Synopsis	**Date**: October 2020
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 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 optimal ARBed microstructures, strain rates and temperatures for future testing to achieve optimized superplastic responses	
Deliverables for the current proposed year: Demonstrate superplasticity in ARBed 5XXX aluminum over a range of temperatures and strain rates. Correlate tensile data (total elongation, strain rate sensitivities) with microstructural analysis to determine deformation mechanisms that lead to enhanced superplasticity for given temperatures and strain rates.	
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 increase 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: Characterization of grain structure and morphology showing the progression of grain refinement for Al 5083 that has been processed up to five consecutive ARB cycles. First round of tensile tests completed, thus giving a general idea of temperatures, strain rates and microstructural conditions to further investigate for enhanced superplasticity. Algorithms developed to obtain strain rate sensitivity and activation volume values as a function of strain during tensile tests.	
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.**