

I/UCRC Executive Summary - Project Synopsis		Date: April 2020
Center/Site: CANFSA/Colorado School of Mines		
Tracking No.: 31-L: Accumulative Roll Bonding of Al and Ti Sheets Toward Low Temperature Superplasticity		E-mail : bmcbride@mines.edu
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Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke		Type: (Continuing)
Project Leader: Brady McBride		Proposed Budget: \$240,000 Leveraged
<p>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.</p>		
<p>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.</p>		
<p>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.</p>		
<p>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.</p>		
<p>Milestones for the current proposed year: Bulk produce samples for future testing, develop strain rate jump test capabilities, draft design of experiments (DOE) for investigating optimal superplastic conditions.</p>		
<p>Deliverables for the current proposed year: Demonstrate superplasticity in ARBed 5XXX aluminum over a range of temperatures and strain rates. Show, through direct comparison, how ARBed material has superior superplastic properties compared to conventionally processed material. Identify variables, such as static annealing heat treatment and prior straining prior to tensile deformation, that may create an optimal microstructure for superplasticity.</p>		
<p>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.</p>		
<p>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.</p>		
<p>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.</p>		
<p>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. Preliminary tensile tests showing enhanced elongation in ARB processes Al 5083 over conventionally processing – e.g. 382% vs 169% at 377 °C with an initial strain rate of 10^{-3} s^{-1}.</p>		
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.