

I/UCRC Executive Summary - Project Synopsis**Date:** March 2019**Center/Site:** Center for Advanced Non-Ferrous Structural Alloys (CANFSA) / Colorado School of Mines**Tracking No.:** 22: Development of Novel High Temperature Aluminum Alloys**Phone:** (925) 864-1543**E-mail:** jjankows@mines.edu**Center/Site Director:** CANFSA / M. Kaufman/P. Collins/A. Clarke**Type: (Continuing)****Project Leader:** Joseph Jankowski**Proposed Budget:** \$200,000

Project Description: The goal of this project is to develop a low-cost aluminum structural alloy for high temperature service and performance in extreme environments. This will be done by utilizing the microeutectic microstructure formed between Al and the alpha-phase intermetallic. In order to accomplish this, modifications to the baseline alloy 8009 (Al-Fe-V-Si) are proposed on the basis of density functional theory (DFT) calculations and experimental validation. If successful, the alloy could have a service temperature as high as 400 degrees Celsius, at low cost, without the need for rapid solidification. This will be done utilizing conventional processing routes, unlike currently available high temperature Al alloys.

Experimental plan: In order to assess the value of the Al + alpha microeutectic, several experiments are underway. First, a crystallographic study of the alpha phase combined with DFT analysis will be performed. Second, the ability to produce desirable structures in a chill casting will be assessed. Third, mechanical properties of the alloys produced will be assessed. Finally, the solidification behavior with known processing conditions will be studied using autogenous GTAW welds.

Related work elsewhere: There is an ongoing project similar to this one being performed at Oak Ridge National Laboratory on Al-Ce eutectic alloys.

How this project is different: This project is expected to yield an alloy with better high temperature stability and potentially higher strength, since the volume fraction of the reinforcing phase appears to be relatively easy to change compared to most conventional eutectics.

Milestones for the current proposed year: The milestones are as follows: 1) Validate prior DFT modeling using new knowledge of alpha phase crystallography 2) Characterize as-cast, heat-treated, and deformed microstructures 3) Perform additional compression tests to verify initial results 4) Use autogenous GTAW welding to develop general knowledge of solidification behavior.

Deliverables for the current proposed year: Papers will be written on the crystallography and electronic structure of alpha-AlMnSi, mechanical properties of the alloy and processing conditions that were selected for final testing, solidification behavior of the Al-alpha pseudo-binary system in Al-Fe-Mn-Cr-Si alloys, and the alloying approach used to develop this class of alloys.

How the project may be transformative and/or benefit society: The development of a low-cost Al alloy with high service temperatures will allow for steel and titanium parts to be replaced with Al. This will help improve fuel efficiency and reduce cost, especially in the automotive industry.

Research areas of expertise needed for project success: Crystallography, Solid State Physics (Electronic Structure), Physical Metallurgy, Characterization, Casting

Potential Member Company Benefits: Pre-competitive research to develop an innovative alloy system that can be refined to meet the specific needs of member companies.

Progress to Date: Development of rough compositional guidelines on producing Al + alpha microeutectic systems outside of the baseline Al-Fe-V-Si system. Identification of promising alloys and processing conditions with corresponding mechanical properties. Potential identification of an additional strengthening mechanism intrinsic to Al-alpha pseudo-binary alloys.

Estimated Start Date: Fall 2015**Estimated Knowledge Transfer Date:** Spring 2019

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.**