

**I/UCRC Executive Summary - Project Synopsis****Date:** September 13, 2018**Center/Site:** Center for Advanced Non-Ferrous Structural Alloys (CANFSA) / Colorado School of Mines**Tracking No.:** 22: Formation, High Temperature Stability, and Mechanical Properties of Microeutectics in Bulk Solidified Al-Fe-V-Si and Related 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. Finally, the solidification behavior with known processing conditions will be studied using autogenous 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) develop a model of the alpha-phase 2) determine the alloy system to examine solidification behavior in detail 3) develop parameters for a welding study to relate processing conditions to microstructural evolution 4) assess ability to produce favorable microstructures in a chill casting and 5) use DFT to develop compositional rules for the alpha-phase.

**Deliverables for the current proposed year:** Papers will be written on the crystallography of the h-phase in Al-Fe-V-Si, the alpha-phase crystallography as a function of composition, and the crystallography and electronic structure of alpha-AlMnSi. A final alloy composition will be selected to determine if the original goal of the project (the development of a low-cost, high temperature Al alloy) is achievable at the current level of understanding.

**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 alloy systems for future studies. Identification of undesirable alpha-phase with new crystal structure in Al-Fe-V-Si.

**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.**