

I/UCRC Executive Summary - Project Synopsis

Date: April 2022

Center/Site: CANFSA/Colorado School of Mines**Tracking No.:** Project 37: Advanced Engineered Coatings with Extended Die Life for Tooling**E-mail:** ndelfino@mines.edu**Phone:** (720) 774-1233**Center/Site Director:** CANFSA/M. Kaufman/P. Collins/A. Clarke**Type: (Continuing)****Project Leader:** Nelson Delfino de Campos Neto**Proposed Budget:** \$360,000 Leveraged

Project Description: PVD coatings applied to steel die casting dies help prevent aluminum from soldering to the die surface, allowing a reduction, or even elimination, of the lubricants applied to the die prior to each shot. Elimination of lubricants can significantly improve the quality of the die castings, allowing them to be used in new, higher performance applications. In addition, production costs can be decreased, resulting in lower per-part costs, as well as die life being significantly extended. Advanced PVD coatings will be identified, laboratory tested to determine the best coatings to avoid soldering, and attempts to perform lube-free die casting will be conducted. In addition, the mechanisms controlling the adhesion of molten aluminum to the die faces will be evaluated.

Experimental plan: Laboratory tests have been developed to test the level of adhesion between molten aluminum alloys and a range of coatings. Various coatings are being examined to determine those that exhibit no reaction, and ideally no wetting, against the molten aluminum alloy. Laboratory die casting experiments and industry in-plant trials have been conducted.

Related work elsewhere: Bo Wang, "An Investigation of the Adhesion Behavior of Aluminum on Various PVD Coatings Applied to H13 Tool Steel to Minimize or Eliminate Lubrication During High Pressure Die Casting", PhD thesis, CSM, 2016.

How this project is different: The previous project performed by Wang was able to reduce lubrication by 85% - the objective of this work is to totally eliminate the need for conventional lubrication. To achieve this, the mechanisms controlling adhesion of molten aluminum to dies need to be identified and addressed.

Milestones for the current proposed year: Continue performing die casting in-plant trials to identify the best PVD coatings. Characterization of the PVD coatings and the soldering mechanisms between molten aluminum and coatings are being performed.

Deliverables for the current proposed year: (1) In-plant die casting trial; (2) Results from the tests on the PVD coated samples; (3) Characterization of the tested samples.

How the project may be transformative and/or benefit society: This project can lead to a significant improvement in the quality of die castings, allowing them to be used in higher performance applications, which is significant as die casting is normally the lowest cost approach to produce complex aluminum shapes. In addition, production costs can be further reduced, resulting in lower per-part costs.

Research areas of expertise needed for project success: Metallurgical and mechanical engineering, PVD coatings, die casting, die manufacturing, laboratory testing and characterization, microscopy.

Potential Member Company Benefits: Die casting is typically the lowest cost approach for making complex-shaped aluminum components. By increasing the quality of die castings and reducing their cost, the improved castings can meet the requirements of member needs.

Progress to Date: Literature review has been performed to: (1) develop an improved adhesion test; (2) identify mechanisms involved in adhesion; and (3) identify the best PVD coatings candidates. An improved aluminum adhesion test has been developed and tests have been performed. Controlled laboratory die casting tests have been performed. In-plant die casting trials are being conducted on a number of PVD coated samples with two different surface finishes. Initial characterization was performed.

Estimated Start Date: Fall 2018**Estimated Knowledge Transfer Date:** Spring 2023

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.