I/UCRC Executive Summary - Project Synopsis	**Date**: October 2021
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:54: Lubricious PVD coating for forging dies	**E-mail:** jvazquez@mines.edu
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Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Jesus Vazquez	**Proposed Budget**: $

Project Description: The objective of this project is to reduce or eliminate the need for conventional lubricants during the forging process through modification of the die surface, by applying permanent thin-film lubricious coatings applied to the faces of the forging die or using surface texturing.

Experimental plan: Use the Ring Forge Test to obtain quantitative values for friction of the coated dies using an Al 6061 ring with and OD:ID:height ratio of 6:3:2 to try to understand the mechanism under which some coatings or surface texturing reduce the coefficient of friction during forging.

Related work elsewhere: This research leverages the knowledge base developed during recent related coating research performed at the Colorado School of Mines, which includes successful projects to minimize conventional lubricants for die casting, and an exploratory project funded by the Foundry Industry Educational and Research Foundation (FIERF) to examine coatings for forging dies that showed certain coatings have the capability to considerably reduce friction between the die and workpiece, and potentially dramatically reduce the amount of conventional lubrication required.

How this project is different: Most studies have concentrated the studies of forging coated dies in the reduction of wear to improve die lifetime. This project concentrates on the reduction of friction coefficient to reduce or eliminate the use of lubricants which may also bring a lifetime extension to the dies.

Milestones for the current proposed year: Create a baseline for the uncoated dies, test current available coatings and do their microstructural characterization to try to understand their friction reducing mechanisms when forging.

Deliverables for the current proposed year: Continue the literature review to determine which type of coatings and/or surface modification techniques show promise to reduce the coefficient of friction in forging dies. Use analytically derived graphs to determine the friction factor with assumptions that closely resemble the ring forge testing being conducted at CSM.

How the project may be transformative and/or benefit society: By modifying the surface of forging dies with permanent coatings and/or texturing, there is an opportunity to significantly reduce or eliminate the amount of traditional die lubricant that is sprayed during the conventional forging process, resulting in cycle time reductions and material savings. In addition, such surface modifications have the potential to increase die life by reducing wear and the thermal fatigue that results from spraying lubricant on a hot die. Both the cycle time reduction and longer die life will result in lower part costs. In addition to cost savings, these surface modifications could increase part quality, improve productivity, and reduce environmental hazards.

Research areas of expertise needed for project success: Access to different type of commercially available lubricious coatings, test equipment that simulates actual forging parameters, ability to characterize the coatings that have the best performance to understand the friction reduction mechanism that they provide.

Potential Member Company Benefits: Lower friction translate to smaller forces needed to forge, lower cycle times, and longer die lifetime, and lead to lower part costs. The elimination of lubricants has environmental benefits.

Progress to Date: Established the parameters of the Ring forge testing, obtained coated dies and initiated testing, producing samples with a homogeneous surface roughness to test.

Estimated Start Date: Spring 2021	**Estimated Knowledge Transfer Date**: December 2024