

## PROJECT TITLE: *PVD Coatings to Aid Release for Permanent Mold Castings*

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**IMPACT:** PVD (Physical Vapor Deposition) coatings can be used to replace other less durable coatings that affect wear rates of die steels.

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### Technical Need

Aluminum often strongly solders to uncoated steel dies when cast in permanent metal molds. To address this problem, metalcasters use release coatings, which have to be continuously applied to the faces of the dies. For high-pressure diecasting, organic lubricants are sprayed onto the die prior to each shot, while for permanent mold casting, ceramic coatings and/or graphite are used. Although the application of coatings is necessary, they can cause various problems, such as reducing the quality of the castings and the creation of costly housekeeping issues. In addition, they add to the cost of the casting.

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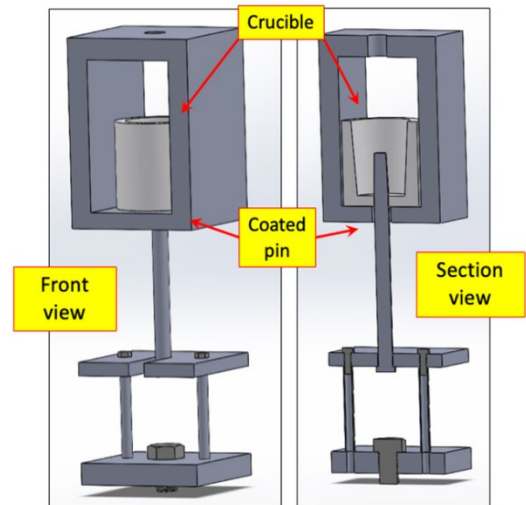
### Project Goal

To develop and utilize a laboratory test that can provide a quantitative measurement of the impact of different coatings on the level of adhesion and force required to extract long cores from aluminum castings.

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### Technical Approach

A testing apparatus has been designed and fabricated and was positioned in a tensile testing machine to provide a quantitative measurement of the load to extract a core pin from solidified A356 aluminum. Several different coating conditions were examined, including bare (un-coated) steel pins, sprayed graphite, a boron nitride coating, a silicon-doped DLC, and an AlCrN coating. To test the reproducibility of the apparatus, a crucible was purposely tilted to determine if the extraction load would increase significantly if the solidified aluminum was deformed during the pin extraction.



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### Findings and Conclusions

Pins coated with graphite and boron nitride exhibited the lowest extraction loads, while PVD-coated pins exhibited the highest. The molten aluminum appeared to chemically react with the silicon-doped DLC coating, resulting in extremely high extraction loads (nearly four times higher than un-coated). The high extraction load for the AlCrN coated pin was a surprise since this coating has performed well in high-pressure die-casting trials. A possibility is that the longer exposure time to liquid aluminum during permanent mold casting allows for an interaction to develop between the aluminum and coating.