AMC
AMERICAN METALCASTING CONSORTIUM

USING ADVANCED ENGINEERED COATINGS TO ACHIEVE PRODUCTIVITY IMPROVEMENTS IN HIGH PRESSURE DIE CASTING

Introduction: The Innovative Casting Technologies (ICT) Program Advanced Engineered Coatings with Extended Die Life for Tooling project, sponsored by the Defense Logistics Agency is a collaboration between the American Metalcasting Consortium (AMC) , the North American Die Casting Association (NADCA), Colorado School of Mines (Mines) and Stellantis. This project is a process of coating die cast tooling to reduce adhesion of molten aluminum to the tooling.

SUCCESS STORY

Problem: NADCA in collaboration with Mines, Stellantis and Phygen sought to extend the results from the ICT work, to place protective coatings onto copper-alloy tooling instead of conventional steel, for die cast tooling applications. Copper-alloys offer significantly higher thermal conductivity than steel, providing much better heat extraction during casting, and so superior thermal control of the die. The challenge with using un-coated copper tooling in the high pressure die casting process is that the copper will rapidly dissolve when in contact with molten aluminum.

Solution: With advanced coatings, copper tooling can be protected during the injection phase of the aluminum die cast process. However, placing advanced coatings onto copper-alloy substrates is not trivial, and Phygen addressed this problem by developing an adhesion layer that can first be applied to copper, allowing the protective coating to adhere to the copper tooling (Figure 1). Copper test samples were selected, and trials were run with and without coatings in a molten aluminum bath, demonstrating the protective nature of the advanced coating (Figures 2 & 3).

Figure 1

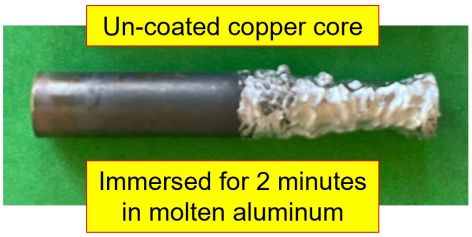

Figure 2

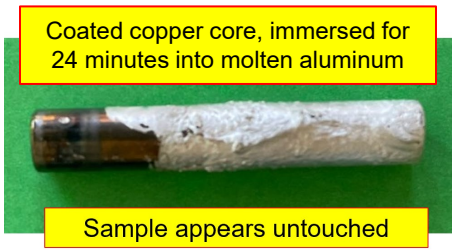

Figure 3

Benefits: The coating chosen for this application was CrN, applied using the Physical Vapor Deposition (PVD) process. In laboratory testing, the coated copper cores performed extremely well without any degradation for up to 40 minutes of continued exposure to molten aluminum (Table 1). The next step in this effort will be to place this coating onto production tooling fabricated from the copper alloy. As the chosen copper alloy has a thermal conductivity seven-times greater than steel, the improved thermal transfer allows for quality improvements, advancements in operational efficiency, increase in die life, and cycle time reductions.

Insertion	Furnace Temp (°C)	Time of Insertion (mins)	Sample Condition
1	675	5	OK
2	629	10	OK
3	608	10	OK
4	600	15	OK
5	596	20	OK
6	599	40	OK

Table 1: Up to 40 minutes of continued exposure

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This coating will make high thermal conductivity die cast tooling more economical and have many positive results on the high pressure die cast process - Dr. Corey Vian, Stellantis Casting Plant

For more information about AMC go to: amc.ati.org

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