Computational Designed Printable Die Steel for GigaCasting

Scaling up high-pressure die casting components to a “Giga-size” of up to 150 kg leads to significantly leaner and more sustainable car production. For example, Tesla’s Model Y uses two large aluminum casting parts instead of approximately 170 smaller parts that are spot-welded, clinched, or riveted. The reduced number of parts correlates with a decreased number of alloys in the car, minimizing cross-contamination and thereby enhancing sustainability. Given the limited heat dissipation in conventional die inserts based on traditional manufacturing techniques, their lifespan for Giga-Casting applications can be reduced to 5% to 10% compared to standard high-pressure die casting (10 to 20 thousand shots versus 150 to 200 thousand shots).

Conformal cooled die inserts reduce hot spots by promoting uniform cooling across the surface of the die insert. In the context of additive manufacturing, it is essential to develop advanced printable die steels with high thermal conductivity. In my talk, I will present a rigorous mechanistic systems approach that integrates processing, structure, property, and performance, leading to a die steel with excellent printability, high thermal conductivity, and sufficient hardness. In addition to a systematic CALPHAD-design approach, experimental results encompass APT and TEM investigations that demonstrate the hybrid co-precipitation concept of B2, Ni2AlMn, M2C, and Cu.