Mathematical And Computational Analysis On Sintering Densification Of Binder Jet Printed Valvebody

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Abstract

Binder jet printing (BJP) is one of the additive manufacturing methods that are being widely implemented as an efficient alternative for casting and machining in the automotive industry. Sintering densification of the as-printed part (green part) adds uncertainty and possible undesirable side effects to the final product. The purpose of the research is to perform theoretical analysis on densification mechanisms and provide an applicable shrinkage model in preparation for accurate additive manufacturing redesign. The paper presents a melting-solidification mathematical model and a COMSOL Multiphysics® simulation of the sintering densification process for binder jet printed valvebody. In the COMSOL® simulation, a 3D model was generated based on the valvebody design. The melting-solidification mathematical model was analyzed through the heat transfer and fluid flow modules to monitor the temperature increase and phase change during the sintering process. By implementing a previous solution operator, temperature solution at the previous time step was stored to determine whether volumetric shrinkage would occur. Geometric evolutions of valvebody channels, bridges as well as bulk surfaces were simulated through the deformed geometry module, which could be back-traced to obtain the green part design for binder jet printing. The model can be potentially implemented to help analyze the effect of sintering parameters to achieve an optimal binder jet printed product, both geometrically and metallurgically.

Figures used in the abstract

Figure 1 : Isothermal contour and geometric evolution of valvebody with channel cavities during sintering process at (a) 0 min, (b) 5 min, (c) 10 min, (d) 15 min