Sintering Simulation of Metal AM and MIM Parts Using Growth-Based Generative Design

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ABSTRACT

Development of a novel Live Sinter™ technique enables the simulation of shrinkage, creep, frictional drag, gravity, and distortion that occurs during sintering, and then automatically produces a negatively distorted part to compensate for the distortion to yield a near net shaped component at the end. Live Sinter™ builds off of Live Parts™ that utilizes dynamic physics simulation to grow parts similar to how living organisms grow in nature enabling designers to control shrinkage and distortion, reduce support structures, and produce consistent parts. The technology combines a particle model using position-based dynamics and static finite element analysis (FEA) to simulate the sintering behavior, and then tunes the process to match scanned sintered part dimensions. Once tuned to furnace and material properties, the technology may be used to simulate and negatively distort parts and supports for subsequent designs, thereby avoiding "trial and error" guesswork to sinter the next-generation of complex part geometries.

INTRODUCTION

Live Sinter™ is an application for simulating the sintering process of powder metallurgy parts produced via additive manufacturing or Metal Injection Molding (MIM). The importance of this type of sintering simulation has grown due to the commercialization of metal and ceramic injection molding (MIM and CIM) of complex near-net shaped parts in high volumes [1-3]. The recent proliferation of several non-melt-based Additive Manufacturing (AM) or 3D printing technologies [4-8] have also resulted in the design of extremely complex shaped parts whose final consolidation and attainment of mechanical properties are also dependent on the sintering process. Fabrication of such complex shaped parts requires the use of fairly complex shaped support structures. Mass production of these complex shaped sintering support structures is expensive and often requires special tooling. Coupled with the expense of the