A comparison of plastic and visco-plastic constitutive models for accurate predictions in PM-HIP

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Abstract

Powder metallurgy hot isostatic pressing (PM-HIP) is an advanced manufacturing process that can efficiently produce near net shape parts with high material utilization and uniform microstructures. While the PM-HIP process is used frequently to produce small-scale components, its application to large-scale components is still limited due to inadequate understanding of its complex processes that cause unpredictable post-HIP shape distortions. A computational model can be a cost-effective alternative to exhaustive experimentation required to understand the PM-HIP process fully. Therefore, we present a comparison of plastic and visco-plastic models that are frequently used to model the PM-HIP process. We show that the predictions of powder densification behavior and shape distortions obtained from both the models are similar under most conditions and agree well with experimental observations.

Keywords: PM-HIP, Powder metallurgy, Isostatic pressing, Visco-plasticity, Plasticity, Powder densification

1. Introduction

The powder metallurgy hot isostatic pressing (PM-HIP) is an advanced manufacturing process that can yield near net shape (NNS) parts with uniform microstructures and reduce material wastage. PM-HIP process typically involves: (1) Filling a canister with metal powder, (2) out gassing and sealing the canister, and (3) subjecting the sealed canister to a high pressure and temperature environment for several hours. An inert gas atmosphere is normally used to avoid oxidation at high temperatures of about 1100 °C with pressures

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