

Design & Modeling Compilation II

Theory & Equipment Related

A Collection of Technical Literature on Powder Metallurgy Design & Modeling



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TABLE OF CONTENTS

Extrusion

Modeling PM Extrusion of Rods

Jane W. Adams, Chian F. Yen and Brandon McWilliams
Advances in Powder Metallurgy & Particulate Materials—2008

Finite Element Analysis

FEM Analysis of Stress and Deformation States of Shelf Dies for Metal Powder Compaction

E. Armentani, G. F. Bocchini, A. Cortigiano, G. Cricri, R. Esposito
Advances in Powder Metallurgy & Particulate Materials—2008

FE Simulation of Die Compaction of Cylindrical Sample and Subsequent Diametrical Compression Test

Wenhai Wang, Antonios Zavaliangos
Advances in Powder Metallurgy & Particulate Materials—2006

Numerical Investigations of Mixing for Powder Injection Molding Feedstock

T.G. Kang, S. Ahn, S.J. Park, Randall. M. German, and S.V. Atre
Advances in Powder Metallurgy & Particulate Materials—2007

General Processing

Self-Similar Aspects of Particulate Materials Processing

Randall M. German
Advances in Powder Metallurgy & Particulate Materials—2007

Hot Isostatic Pressing

Application of Finite Element Analysis in the Capsule Design Process During Manufacturing of HIP PM Components

Virendra Warke*, Tero Taipale, and Susan Davies
Advances in Powder Metallurgy & Particulate Materials—2014

Elasto-Plastic-Viscoplastic Modeling of HIP with Hardening Effects of Density and Equivalent Plastic Strain

G. Aryanpour, and M. Farzaneh
Advances in Powder Metallurgy & Particulate Materials—2011

HIPing of Large Near Net Complex Shape PM Parts Without an Experimental Iteration: Design, Modeling, Methodology

V.Samarov, D.Seliverstov, G.Raisson, B.Picque
Advances in Powder Metallurgy & Particulate Materials—2014

Technological Principles and Tools for the Control of Near Net Shape HIP of Metal Powders

V. Samarov, C. Barre, D. Seliverstov, E Khomyakov, R. Haykin,
Advances in Powder Metallurgy & Particulate Materials—2011

Mathematical Modeling

Empirical Method to Model a Part's Thermal Response in an Existing Furnace

Steven K. Smith
Advances in Powder Metallurgy & Particulate Materials—2011

From Experimental Data an Analytical Model Of Powder Behavior During Uniaxial Cold Compaction

Ilaria Cristofolini, and Alberto Molinari
Advances in Powder Metallurgy & Particulate Materials—2015

Mathematical Modelling of the Die Wall Lubrication Process Using the “Confining Block” Technique

Patrick Lemieux, Kinnor Chattopadhyay, Roderick Guthrie, Mihaiela Isac, and Mainul Hasan
Advances in Powder Metallurgy & Particulate Materials—2010

Modeling for Powder Metallurgy Component Design and Life-Cycle Prediction

Tonya W. Stone, Youssef Hammi, Ricolindo L. Carino, and Mark F. Horstemeyer
Advances in Powder Metallurgy & Particulate Materials—2009

Process Modeling: Use of Uncertainty, Sensitivity and Optimization Techniques for Improved Understanding of Compaction Model Outputs

T.W. Stone, H.I. Sanderow, H. Grewal, E. Acar, Y. Hammi, P. Allison, K. Solanki, and M.F. Horstemeyer
Advances in Powder Metallurgy & Particulate Materials—2009

Microstructure

Determination of Microstructure-Property Relations for Performance and Design Optimization of the PM Process

Paul G. Allison, Youssef Hammi and Mark F. Horstemeyer
Advances in Powder Metallurgy & Particulate Materials—2007

Particle Size

Particle Size Effect on the Rheological Behavior of Magnetic Feedstock for Magnetic Powder Injection Molding

Im Doo Jung, Jang Min Park, Ji-Hun Yu, Tae Gon Kang, See Jo Kim, Seong Jin Park
Advances in Powder Metallurgy & Particulate Materials—2014

Design of Experiments (DOE) Study to Achieve Higher Mechanical Properties by Optimizing Particle Size Distribution and Processing Parameters of 17-4PH Stainless Steel Powder for Metal Injection Molding (MIM)

Jessu Joys, Bo Li, and Bing Wang
Advances in Powder Metallurgy & Particulate Materials—2013

Modeling PM Extrusion of Rods

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ABSTRACT

Modeling was used to simulate extrusion of tungsten (W) particulate/ glassy metal matrix composite rods from powders and give insights to the can design and process parameters. The configuration consisted of a cylindrical copper (Cu) cup and liner filled with metal powder extruded through a 5:1 reducing die orifice. Fluid-structure interactions were modeled using LSDYNA-ALE code where the copper liner, cup and simulated metal powders were the fluid components and the die and ram were rigid body structures. Simulated fluid-structure interactions indicated that steady-state streamlined plastic flow was not established within the cup and powder region, which agrees with experimental results. Redesigning the extrusion system initial can configuration, die angle and reduction ratio is required to eliminate the inward Cu flow at die-exit that interrupts powder flow to prevent forming of a continuous rod.

INTRODUCTION

The U.S. Army is continuously investigating new material systems for a variety of reasons, including improved equipment performance, reduced manufacturing time and costs, as well as to reduce or eliminate environmental contamination. Ongoing research [1] to develop new materials for projectiles brings material/process development, analytical modeling, special manufacturing processing, performance testing, and end users together to develop a material system based on tungsten particulate, bulk metallic glass matrix composites. Metallic glass systems exhibit high strength and favorable plastic deformation characteristics [2, 3], but lack the desired high density required for a penetrator. Early work to increase density using tungsten wire showed the desired mechanical behavior, but due to packing limitations, could not achieve the target density, so a particulate composite approach was taken [4-6].

Developmental studies of hafnium (Hf) -based metallic glass (MG) and up to 75% by volume particulate tungsten metal composite system using hot isostatic press forming at $\sim 1000^{\circ}\text{C}$ (1832°F) have shown that the composite material can be made fully dense [1]. A powder metal extrusion process would be a more rapid and economical method to produce long composite cylinders. The composite system that prompted the extrusion models consisted of mixed particulates of Hf-based MG and up to 75% by volume