Design & Modeling Compilation II
Theory & Equipment Related

A Collection of Technical Literature on Powder Metallurgy Design & Modeling

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ISBN 978-1-943694-08-2

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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 ~1000° 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