A MICROSTRUCTURAL MODEL FOR FEEDSTOCK HOMOGENEITY

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ABSTRACT

Mixture homogeneity affects the quality of components produced by binder-assisted processing techniques such as powder injection molding. However, quantitative methods for describing mixture homogeneity by relating powder and binder attributes to mixing conditions are currently not being used in the industry. As a result, obtaining a homogeneous feedstock for a given material system involves considerable trial-and-error. To rectify this situation the present study uses a microstructural model, which considers deagglomeration during mixing, to analyze feedstocks. Two powders were used to experimentally verify the model. One of the powders was coarse and spherical (stellite) while the other was fine and irregular (alumina). These powders represent limiting cases of particle characteristics. These powders were mixed into feedstocks at various solids loadings using a wax-polymer binder system. Differences were observed in the applicability of the microstructural model for the two powders when validation experiments were conducted by torque and capillary rheometry. These differences can be explained in terms of the feedstock microstructure.

INTRODUCTION

Mixing is a critical event during the binder-assisted processing of powders, such as in powder injection molding (PIM) since it controls the extent of homogeneity and hence the performance of the feedstock. Several molding defects such as jetting, flashing, powder-binder separation, and weld lines can at least partially be attributed to inhomogeneity introduced during mixing. Examples of some of these defects are shown in Figure 1. Insufficient mixing of the feedstock also results in increased green weight variations. Defects that became apparent after sintering, as well as variations in dimensions and properties have also been traced to errors introduced early in the processing cycle [1, 2]. Some of the barriers to reliably obtaining a uniformly mixed feedstock arise due to the significant diversity in material characteristics and mixing equipment. In this study, a generalized approach is presented to quantitatively relate the effects of various powder and binder attributes to the minimum mixing shear rate required to obtain a homogeneous feedstock.