



Thermal and flow analysis of stainless steel and alumina feedstock used for 2C-PIM process

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ABSTRACT

Powder injection moulding (PIM) is a cost-effective manufacturing process aimed to establish complex near-net shapes of metals and ceramics involving four main steps; mixing, moulding, debinding and sintering. Two-component powder injection moulding (2C-PIM) is another alternative of PIM, a promising method which can integrate two different materials into one assembly. Generally, 2C-PIM can be achieved by injecting two different materials into mould cavity at the same time or in sequential order. The aim of this paper is to analyse the flow (rheology) and thermal properties of two component feedstocks based on ceramic and metallic powders. The rheological characteristics of the feedstocks, under various injection temperatures of 150, 160, 170 and 180°C were analysed using Shimadzu Capillary Rheometer. Differential scanning calorimeter (DSC) was used in this study to identify the melting temperature of both alumina and stainless steel feedstock while the thermogravimetric analysis (TGA) results can be used in determining the injection parameters. Results showed that both feedstocks indicate pseudoplastic behaviour with small shear sensitivity index (n) value, which is desirable in injection moulding process. The investigation concludes that the joining of two materials can be realized using several parameters of injection speed, pressure and temperature, measurement, and appearance.

Keywords: Powder injection molding; two components powder injection molding (2C-PIM); rheology; differential scanning calorimeter (DSC); thermogravimetric analysis (TGA)

Introduction

The conventional fabrication of small parts by mechanical machining such as turning and milling is very difficult, time consuming and costly. Thus, a time and cost effective near-net-shape process with the advantage of shape complexity, material utilization and high final density called powder injection molding (PIM) was introduced [1]. The process also allows mass production with low cost, high performance and complex geometries.

rheology, mechanical and processing parameters of the feedstock material [20], [21] and mould insert must be manufactured with high precision [21].

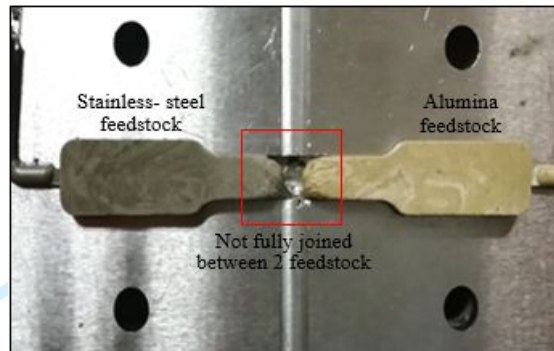


Figure 11 (a): Feedstock injected without heating the mold



Figure 11 (b): Mold were preheated at 50°C

It was difficult to identify the suitable temperature required considering the differences in moldability of the feedstock to flow in the mould cavity during injection process. Figure 11 (b) shows the green part which was successfully joined together at the temperature of 190 and 200°C for stainless steel and alumina feedstock. However, the position of the joining material resulted to part unsymmetrical balance of the surface area. According to Piotter et al. [7], suitable selection of the injection molding parameter such as injection speed will help to adjust the position of the joint line.

Conclusions

The present study concludes that both alumina and stainless steel feedstock indicate pseudoplastic behaviour since the viscosity reduces with the increase of shear rate and temperature which is suitable for flow-ability of the molten material into die cavity in injection molding process. Best injection temperature for both feedstock should be 180°C, since it has the lowest value of shear sensitivity index, n and highest value of mouldability index, α . However, the joining of stainless steel and

alumina feedstock can only be realized by setting the injection temperature up to 190 and 200°C. This is possibly due to the temperature gradient from the injector nozzle to the mould cavity during injection process which results to thermal reduction.

Acknowledgment

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