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Ana Romero, Gemma Herranz

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Ana Romero [a], Gemma Herranz [a,*]

[a] Institute of Energy Research and Industrial Applications, PIM Research Laboratory, Universidad de Castilla-La Mancha, Campus universitario de Ciudad Real E-13071, Spain. E-mail addresses: ana.rgutierrez@uclm.es (A. Romero), gemma.herranz@uclm.es (G. Herranz).

*Corresponding author at: Institute of Energy Research and Industrial Applications, PIM Research Laboratory, Universidad de Castilla-La Mancha, Campus universitario de Ciudad Real E-13071, Spain. E-mail address: gemma.herranz@uclm.es (G. Herranz).

Abstract

Feedstock behaviour during processing via powder injection moulding (PIM) has a critical influence on the properties of the final parts. The objective of the present study is to analyse the effect of vanadium carbide (VC) addition (1, 3, 6, 10 and 14 wt.% VC) on the rheological response and stability of AISI M2 high speed steel PIM feedstocks. A binder system consisting of high density polyethylene (HDPE) and paraffin wax (PW) is proposed. The effects of VC concentration, powder loading, apparent viscosity and temperature have been investigated via capillary rheometer. The feedstocks with a 14 wt.% of VC, which exhibited a variable flow behaviour was discarded. The rest of the feedstocks showed a pseudoplastic behaviour which is suitable for injection moulding and in particular, those reinforced with 6 and 10 wt.% of VC exhibited the best rheological responses. In order to maximize the powder loading and ensure safety conditions, the feedstocks reinforced with 6 wt.% (5.9 vol.%) and 10 wt.% (9.8 vol.%) of VC with 68 vol.% of powder loading and 3 wt.% (2.8 vol.%) of VC with 62 vol.% of powder loading were selected to continue the rheological analysis. Rheological parameters such as flow behaviour index (n), yield stress (σ_y) flow activation energy (E_a) and the general mouldability index (α_{stv}) have been analyzed for the above mentioned feedstocks and showed suitable values for the injection moulding. The green parts produced using the three feedstocks have constant weights and dimensions, good mouldability, density, shape retention and stiffness. Therefore, the developed feedstocks are suitable for PIM.

Keywords: Rheology, Powder injection moulding, High speed steel, Metal matrix composite.

1. Introduction

It is well known that high speed steels (HSSs) are excellent tool cutting and wear resistant materials due to their good properties of toughness and hot hardness [1]. HSSs are characterized as highly alloyed materials which present good behaviour in service due to their alloying elements, such as W, Mo, Cr and V, and to their particular microstructure consisting of a ferritic matrix with many carbides precipitated (M_2C-type and M_6C-type among others) [2]. The addition of a reinforcement to a metal matrix