Additive Manufacturing as spring of new materials

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ABSTRACT

Selective Laser Melting (SLM) of multimaterial has been increasing. The main targets are to improve the properties of the 3D objects resulting from SLM and to decrease secondary and post-processing treatments like coatings. Today, SLM plays a new role in reducing standard high-cost steel by improving the low-cost steel "surface" properties. For example, the "surface" should have properties suitable for high wear resistance /hardness/gloss in molds. Thus, low-cost steel, like H13 (AISI) applied in injection mold structure could be transformed into high alloy steel in the critical zones (molding surfaces and inserts). The addition of some powder particles to SLM feedstock (H13) could increase the hardness (small grain size and nanocarbides). However, the alloy elements must have a high affinity to carbon, like vanadium, creating carbides with appropriate dimensions during SLM technology. The present study selected vanadium powders (1-5 %wt.) and carbon allotropes (graphene) in suitable content. They should promote the highest carbide content without decreasing the properties of the H13 heat-treated matrix. They can guarantee surfaces with high hardness and an ultra-high gloss of a mold cavity /inserts.

INTRODUCTION

Additive manufacturing (AM) of metallic powder is becoming more and more significant for processing metallic 3D objects. The selection of AM versus replicative or subtractive processes is up to now mainly due to the new design potentials, which are either impossible or very costly with standard approaches. The AM must build products that are much more efficient, less dependent on the cost and availability of raw materials, and be able to quickly readapt to newly imposed boundary conditions. In the molds industry for injection molding of polymeric materials or other feedstocks enriched in inorganic powder (metallic and ceramic), the potential of AM is evident in optimized new geometries, e.g., cooling channels in inserts based on conformal[1–3] and recently in the new cooling inside systems, as the based on constructal cooling[4,5]. These systems, in particular, the common selective laser melting (SLM) (Figure 1, left), allow for improvement in the geometrical quality and the gloss of injected 3D objects. In SLM, different parameters must be considered, that are associated with the denominated VED (volumetric energy density) (Figure 1, right). Nevertheless, the brightness of the 3D object is also the result of the insert(s) hardness and the surface protection, which is common to be attained by the