



OO/UC3M/43- DEVELOPMENT OF BINDER SYSTEM FOR MANUFACTURING METALLIC AND CERAMIC PARTS BY POWDER INJECTION MOLDING TECHNOLOGY

The research group "Synthesis and materials processing" of the Universidad Carlos III de Madrid have a large experience in Powder Injection Moulding (PIM). The main advantage of this technology is the manufacturing of small and complex shape parts that is no possible to obtain by conventional manufacturing technologies. The research group has developed in collaboration with different companies several binder systems to obtain ceramic and metallic parts from nano to micropowders.

We would like to establish collaborations with manufacturing companies of plastics, metals or ceramics from different industrial sectors (automotive, aeronautic, electronic...) that would like incorporate this manufacturing technology.

Description and special features

Powder Injection Moulding (PIM) is a development of polymer injection processes, which permit the production of large series of parts with highly complex shapes. This technology incorporates the advantages of plastic injection moulding, but can be applied to ceramic and metallic materials. The process has been developed both for ceramic and metallic powders and can be considered a hybrid between plastic injection moulding and conventional powder metallurgy forming.

In the PIM process a mix of a plastic material, which acts as binder, and a metallic or ceramic material in powder form is injected in a mould at the plastic injection temperature. This leads to the obtainment of a "green part", which is easy to handle and of larger dimensions than the finished part. Subsequently the polymeric material in the part, which acts as binder of the metallic or ceramic particles, is removed in a process known as "debinding", obtaining what is known as a "brown part" which is subsequently sintered, i.e. the particles are welded together at the sintering temperature of the metallic or ceramic material, as in the conventional powder metallurgy process.

Thus, in a PIM process the most important factors to be studied and optimised are:

- 1) Feedstock components: base powder and binder system.
- 2) Mixing and mix rheology.
- 3) Injection moulding process.
- 4) Debinding process.
- 5) Sintering.

The success of this processing method is dependent upon the use of an adequate binder.

From the point of view of industrial production, thermoplastic systems are those most widely used, and these systems include the majority of commercial polymers: polyethylene, polystyrene, polypropylene, etc. In addition to the main component (thermoplastic polymer) the system can contain additives to control lubrication, viscosity, binder adhesion to powder particles, and debinding

Mixing is the first stage in the preparation of the feedstock so that it can be injection moulded. The industrial process is carried out in mixers that can reach high shearing forces and can work in continuous (twin screw extruder) or discontinuous (blade mixer) production lines. It is important to control the mix homogeneity, and thus it is very useful to be able to record the torque generated during the mixing process. To this end it is recommended to use mixers that are capable of measuring torque, making it possible to determine critical loading and mixing times and to control the process temperature and possible degradation of the polymer being used as binder. It is vitally important to evaluate the viscosity of the mix, through an in-depth study of capillary rheology, as this is an extremely important factor to be taken into account in the material injection process.

The PIM companies have an important problem: they have to use a patented feedstock. This fact causes an increasing of the cost of final product. Nowadays our research group has enough technical capacity for developing binder systems to manufacturing different kind of parts.



Innovative aspects

Manufacturing industry is usually focused on cost and productivity. However this is not the unique objective in the aeronautical industry. Manufacturing process of high responsibility components should guarantee the safety of the component during its service life. On the other hand it is not possible to solve common problems in manufacturing industry with a multidisciplinary approach, taking into account technological aspects of the process, mechanical behaviour of the material and microstructure. Main goal of the team is solving problems in manufacturing industries with this global approach, giving competitive solutions with direct application in the industrial process.

Competitive advantages

The technology is used by manufacturing companies of metallic and ceramic parts. The PIM companies have an important problem: they have to use a patented feedstock. This fact causes an increasing of the cost of final product. Moreover sometimes is difficult to obtain parts from several materials because only exists few commercial feedstocks. We offer some innovative aspects, the possibility of development of feedstocks from different ceramic and metallic powders and different morphologic and surface characteristics.

Technology Keywords

Molding, injection Goulding, extrusion, sintering; Materials and ceramics powders (002007003)

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