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Powder metallurgy: Advanced techniques and applications

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ABSTRACT

In this paper, a brief review about the advancement in powder metallurgy process along with their applications as well as problems faced during the research is discussed. The main objective of this paper is to accentuate the applications of advanced powder metallurgy technology in various fields and also to encourage the readers to understand and write more papers on such issues. Advanced Powder Metallurgy is also known as metal injection moulding (MIM) technology helpful for forging complex shaped components with a low investment of money. Therefore, a forming technology applied to form new materials by diffusion of different metals as well as ceramic powders as raw ingredients through sintering (temperature below the melting point) is known as powder metallurgy. The most advantageous thing of this process is that the powder can easily be shaped directly into the end product and also possesses a significant degree of freedom in the composition of materials, properties, microstructure and thermal processing. Powder Metallurgy provides such properties that cannot be achieved by the melting process. Advancement in Powder Metallurgy technique is a standard allusion for the engineers in the metal forming industries that use powder metallurgy with a research interest in the field.

Keywords— *Metal injection moulding, Diffusion of metals, Sintering, Complex shaped components, Thermal processing*

1. INTRODUCTION

Powder metallurgy is a general metal forming technique applied to produce dense and precision components. It is regarded with the production of metal powders and commensurates them to the desired shape. In this kind of technique, the particulate materials are bonded to semi-finished and finished products. On the other hand, direct laser forming (DLF) technique is another advanced powder processing technique. Steps in the process of powder metallurgy are shown in the following given figure:

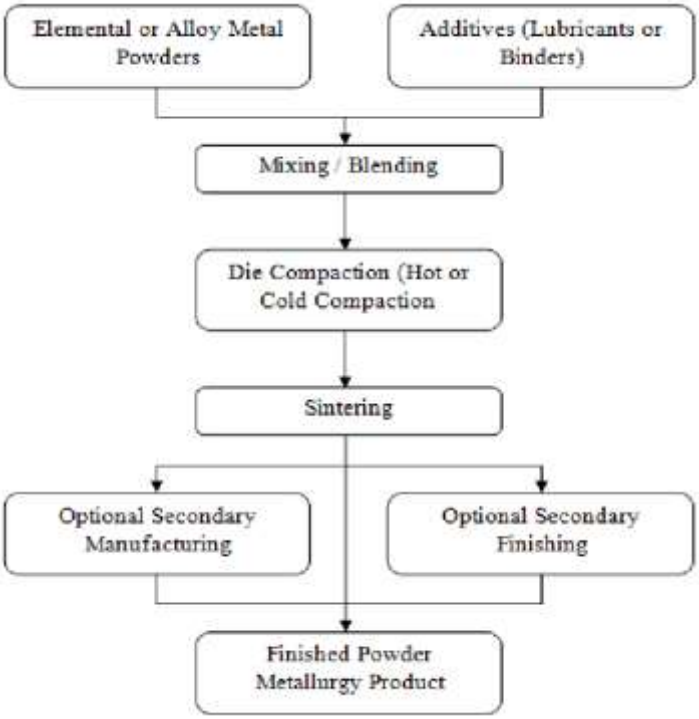

Fig. 1: Powder metallurgy process

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2. PRINCIPLES OF POWDER METALLURGY

The long-established powder metallurgy process involves the blending of the metal powders and other constituents by compaction and sintering to obtain desired size and shape. The two stages of compaction are fused into a single step in hot pressing. Some of the problems occurred during die-compaction and compaction of sintering in traditional powder metallurgy technique can be overcome by newly developed isostatic compaction method.

3. MATERIALS AND PROCESSES IN POWDER METALLURGY

3.1 Titanium:- Hot Isostatic pressing (HIP), Injection moulding
3.2 Superalloy and steel:- Spray Forming
3.3 Aluminide, Nickel:- Reaction sintering and Extrusion
3.4 Iron alloy:- Powder Forging
3.5 Stainless steel:- Cold isostatic pressing (CIP)
3.6 Solidified aluminum alloy:- Complete densification method

4. APPLICATIONS OF POWDER METALLURGY

4.1 Gears, bearings and connecting rods (for automobiles)
4.2 Produce cutting/abrasion resistant tooling materials such as cemented carbide tip and moulding
4.3 Porous materials such as filters and implants for living bodies
4.4 Materials for pantograph contact strips
4.5 Sensor rings
4.6 Aircraft structuring
4.7 Fine jewellery/accessories
4.8 Cutting Tools and Dies
4.9 Anticorrosive component
4.10 Dynamic membranel filter

5. FUTURE DEVELOPMENTS

5.1 **Structural parts:** To enhance the strength of sintered materials, nickel and molybdenum have been mixed to achieve the high hardness. As the chromium is the most effective element for the improvement of hardness and strength of steel and because Cr is not so expensive, we can obtain high-strength materials at very low cost.

5.2 **Magnetic parts:** Recently, we are seeking to initiate the new applications of magnetic materials to support the enhancement in the demand for electric cars. This will be done by improving magnetic properties and advancing the techniques for development of net shaping methods in order to produce cores that are more difficult to be formed.

5.3 **Next-Generation High-Performance parts:** For the continuous advancement of Powder Metallurgy industry, the trend towards reaching higher relative density levels should be emphasized. There has been an increasing trend in the usage of high-density Powder Metallurgy steels over the last decades. To maintain the future development of Powder Metallurgy and competitiveness with the other manufacturing processes, reaching full or near-full density is a key factor.

5.4 **Powder Lamination 3D:-** Ti powder laser forming is now an advanced method to improve the relative density and accuracy of the product.

6. CONCLUSION

After studying the whole research paper, in the end, we come to the conclusion that, in recent, metal injection moulding (MIM) and powder lamination 3-D printing are brought as new powder forming techniques. Producing large products is still difficult because of deformation due to their own weight during the debinding process and long processing time. If these problems are resolved then the scope of application is expected to be greatly expanded. Contrarily, metallic powder lamination 3D printing has just come into the trend with the efficiency of forming complicated structures and shapes on the outer as well as the inner side. The roughness of the side surfaces and entire dimensional accuracy need to be improved. Some of the problems are associated with the volume production but this powder metallurgy technique is different and unique from a manufacturing point of view. Now, at last, based on the whole study the further advancement and development is needed to be very much upgraded

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