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Powder Metallurgy Technique for Production and Utilization of Metal Powders

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Brief Report

Powder metallurgy (PM) is the production and utilization of metal powders. Powders are defined as particles that are usually less than 1000 nm (1 mm) in size. Most of the metal particles used in PM are in the range of 5 to 200 mm (0.2 to 7.9 mils). Powder mixing (pulverisation), die compaction, and sintering are the three essential phases in the powder metallurgy press and sinter process. Compaction is normally done at room temperature, and the elevated-temperature sintering process is usually done at atmospheric pressure and with a carefully controlled atmosphere composition. Secondary processing, such as coining or heat treatment, is frequently used to obtain unique features or increased precision.

Powders have a high surface area to volume ratio, which is exploited in the use of metal powders as catalysts or in different chemical and metallurgical reactions. While this article focuses on the use of powders to create functional engineering components, many metal powders are utilised in particle form as well. This element of PM is described in this Volume's article "Specialty Applications of Metal Powders." Powder technologies pique the interest of engineers since processing choices allow for the selective placement of phases or pores to adapt the component to the application. Design engineers are drawn to the capabilities of press and sinter processing or metal injection moulding (MIM) manufacturing to copy parts in large quantities. Powder metallurgy processing has numerous advantages. When compared to alternative metal forming technologies, the PM process is both material and energy efficient. Powder metallurgy is a low-cost method for producing complex-shaped objects that eliminates the need for machining. A wide range of engineered materials are available, and the needed microstructure in the material can be generated by suitable material and method choices. Parts made using powder metallurgy have a superior surface polish and can be heat treated to boost strength or wear resistance.

Compaction in rigid dies is used for high-volume manufacture of PM parts. Most metallic powders are combined with a lubricant (e.g., ethylene bisstearamide) to reduce interparticle friction during compaction and to allow ejection of compacted pieces by reducing friction at the die-wall and core-rod interfaces. Metal powders can be elemental powders, mixes of elemental powders, or mixtures of elemental powders and master alloys or ferroalloys, prealloys, diffusion alloys, or hybrid alloys. The majority of PM parts include holes, which is advantageous when using metal powders to build self-lubricating bearings in which the surfaceconnected pores of the parts are saturated with oil. Oil is discharged from the pores when the bearing surface heats up due to frictional heat. When the bearing cools, capillary action draws the oil back into the pore channels. The porosity of PM components affects their physical, mechanical, magnetic, thermal, wear, and corrosion properties. Atomization is possible with any fusible substance. Several approaches have been developed that allow for high production rates of powdered particles, generally with significant control over the final grain population size ranges. Crushing, grinding, chemical reactions, and electrolytic deposition can all be used to create powders. Copper- and iron-based powders are the most often utilised materials. High-temperature reduction of the matching nitrides and carbides yielded powders of titanium, vanadium, thorium, niobium, tantalum, calcium, and uranium. Submicrometre powders of iron, nickel, uranium, and beryllium are produced by reducing metallic oxalates and formates. Excessively tiny particles have also been created by atomizing a stream of molten metal with a high-temperature plasma jet or flame. Various chemical and flame-associated powdering techniques are used, in part, to prevent significant oxidation of particle surfaces caused by ambient oxygen.

Powder compaction is the technique of compacting metal powder in a die using high pressures. The tools are typically held vertically, with the punch tool creating the bottom of the hollow. After that, the powder is compacted into a form and discharged out the die cavity. In a number of these applications, the parts may require relatively little extra effort for their intended usage, resulting in very cost-effective manufacture. Isostatic powder compacting is a mass-saving shaping technique. In contrast to the direct pressure applied by the die faces of a die pressing process, fine metal particles are inserted into a flexible mould and then subjected to high fluid pressure. The finished product is then sintered in a furnace, which strengthens the part by fusing the metal particles together.

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