

How to Engineer Precision Miniature Components



As technology advances, electronic and automated devices continue to shrink. Miniature precision components support this development, enabling devices to function within tiny assemblies. Examples include the miniscule gears, pinions, cams, and sprockets that comprise devices in the medical, automotive, and motion control industries.

Crafting products at this scale requires precision manufacturing processes that can produce intricate shapes with tight tolerances and high repeatability. One of the best methods to create these parts is powder metallurgy, which uses a variety of powdered materials to compress and Sintered for strength (heat).

As a leading manufacturer of miniature metal parts, Allied Sinterings Inc. uses powder metallurgy to produce diverse, precise components at high volumes.

DESIGN CONSIDERATIONS FOR MINIATURE METAL PARTS

While application requirements largely dictate the component's size, shape, and material, powder metallurgy also imposes certain constraints. Take the following design factors into consideration:

Size

Powder metallurgy is the ideal process for crafting very small components. Allied Sinterings creates precision gears and structural components with a maximum outer diameter of 1.5 in. and a maximum height of 1 in.

Shape

This process can accommodate highly complex 3D geometries limited only by the die shape. Combining powder metallurgy with micromachining removes even this constraint, as secondary processes can add features that cannot be modeled with a die.

Material

Powder metallurgy can form a variety of metals, including alloys of stainless steel, brass, copper, iron, and bronze.

Precision

Allied Sinterings can achieve tolerances of ± 0.001 in. for miniature metal components.

Finishing

Finishing processes such as heat treatments may improve a sintered component's performance and appearance.

Your powder metallurgy provider can help you decide on these features for a successful production run.

The Importance of Precision Miniature Metal Parts

Miniature metal parts often have diameters well under 1 inch. At this scale, tolerances must be extremely small to ensure components fit together properly. Precision manufacturing techniques such as powder metallurgy help manufacturers meet these requirements.

Mass Production with Powder Metallurgy

With powder metallurgy, clients do not need to sacrifice speed for precision. Depending on flow rate—how fast dies can be filled—throughput can range from 300 to 600 parts per hour for complex components or more than 3,500 per hour for simple components. Your manufacturing partner can provide a more accurate estimate based on part complexity and required secondary processes.



ADVANTAGES OF THE POWDER COMPACTING AND SINTERING PROCESS FOR MINIATURE METAL PARTS

Powder metallurgy offers a number of advantages over other processes, especially when producing with small and precise components. These benefits include:



Complex Geometries: Powder compacting and sintering can create components with intricate design features such as custom gears, gearboxes, and sprockets.



Low Weight: Because of their lower density, powdered metal components are lighter than those formed from solid metal. This benefit is key to reducing overall product weight.



Cost Effectiveness: Although powder metallurgy requires a small initial investment in tooling design, the process is extremely cost-effective in the long run.



Tight Tolerances: Powder metallurgy maintains extremely tight tolerances of ± 0.001 in. for even complex shapes.



Minimal Waste: Powder metallurgy is a net shape process, which means that it produces parts in their final shape. This produces nearly zero material waste.



Speed: It's possible to produce hundreds of parts per hour, even when those parts have intricate design features. This is beneficial for rapid, high-volume production. The speed of powder metallurgy also allows for rapid prototyping.



High Quality: Powder metallurgy produces high-quality, durable parts with metal components that are up to 92% dense.

Secondary Finishing for Miniature Part Production

Although powder metallurgy creates net or near net components, some applications may require secondary processing. Precision micromachining uses lasers or extremely fine cutting tools to achieve features such as undercuts and threads, which are difficult to create using powder metallurgy alone. Other finishing processes include electrode machining, and precision stamping.



APPLICATIONS OF MINIATURE METAL PARTS

Miniature metal parts can be used in a variety of applications across diverse industries, such as:

Medical Devices

We specialize in producing parts for some of the largest medical device companies in the world. Our processes support gears and components for surgical robots, prostheses, respirators, medicine dispensing robots, and other medical applications.

Automotive

The automotive industry relies on many miniature parts, including fine-pitch gears, rotors, pinions, and gaskets. Miniature metal part manufacturing has become more relevant especially with manufacturing electric vehicles (EVs). Powder metallurgy creates EV pumps, motor stators, and batteries with optimal magnetic properties and better electrical performance than traditionally forged parts.

Industrial

Precision miniature gears and connectors are essential for industrial machinery, from lifts to packaging equipment.

Robotics & Motion Control

Sintered metal gears and gearboxes are ideal for reducing weight and improving electrical performance in robotics and motion control applications.

In general, if an application would benefit from a smaller or lighter design, miniature metal components are an attractive solution.



BENEFITS OF WORKING WITH ALLIED SINTERINGS, INC.

Allied Sinterings Inc. is a global leader in the manufacture of custom powdered metal parts, including miniature gears, assemblies, and structural components for medical devices and other consumer and industrial products. Our team applies over 50 years of experience and cutting-edge equipment to create highly precise, near net components. All of our processes are subject to strict quality controls, and we work within environmentally-controlled facilities to minimize defects.

We implement the principles of lean manufacturing and on-time delivery to keep costs down while maintaining short lead times. Whatever your component complexity or production volume, Allied Sinterings will develop a manufacturing plan to suit your needs.

To learn more about how Allied Sinterings can serve you, [contact our team](#) today.

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