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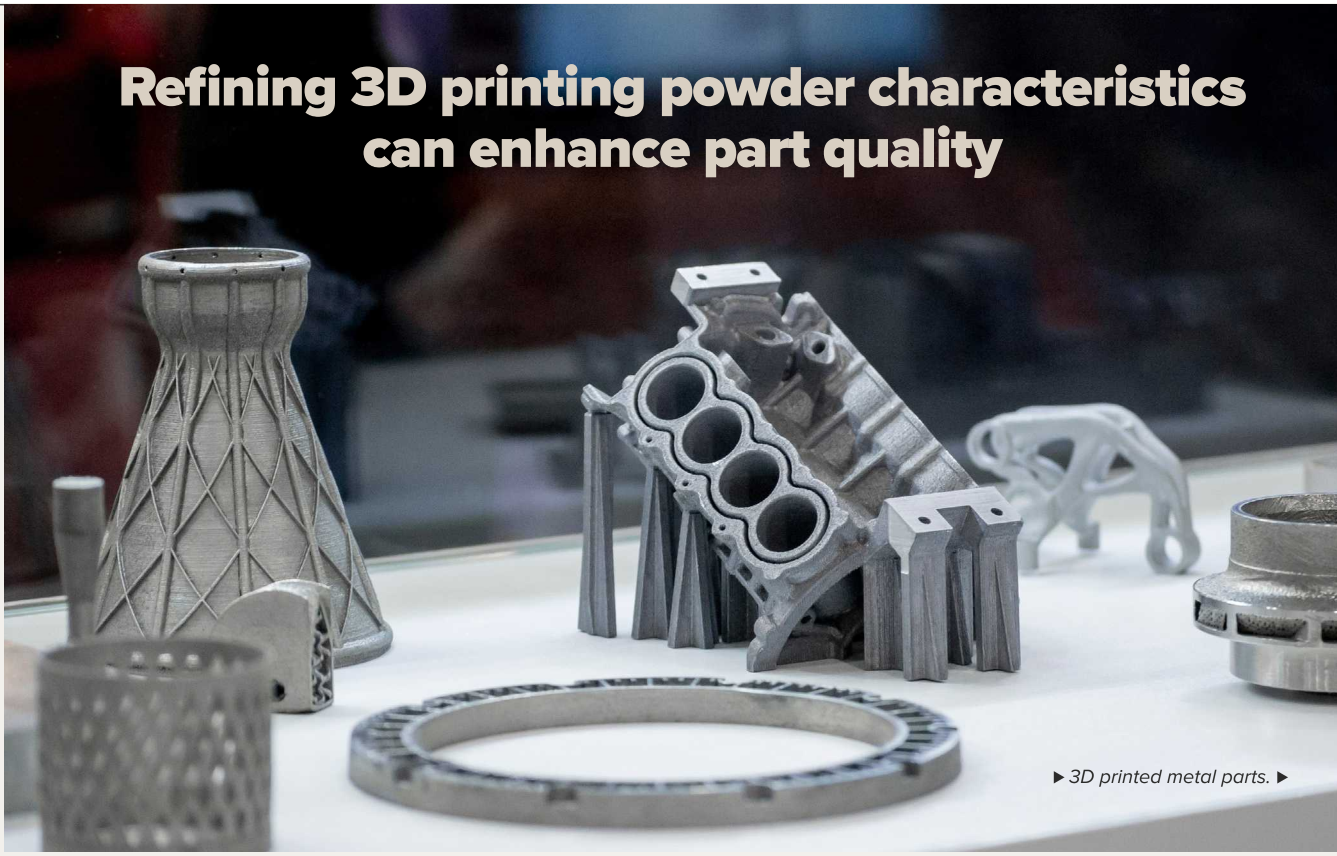
Refining 3D printing powder characteristics can enhance part quality



▶ 3D printed metal parts. ▶

GEORGE PAFFENDORF, DIRECTOR OF OPERATIONS, ADVANCED POWDER SOLUTIONS (APS), GEMCO

According to a report by Grand View Research, the global 3D printing metal market is growing and expected to reach US$3.05 billion by 2025[1]. However, to take full advantage of this growth and efficiently produce high-quality parts, powder manufacturers, 3D printer manufacturers and others need to ensure the consistent, repeatable quality of the metal powders used in the process.

Metal 3D printing applications are exploited by industries such as aerospace, automotive, defence, jewellery and medical. The metals involved include aluminium, chrome, copper, cobalt, iron, nickel, stainless steel and titanium alloys, as well as precious metals such as gold, palladium, platinum and silver.

The 3D printing process involves putting down layer on layer of metal powder and simultaneously fusing the particles of these layers until the component is complete. The powder used must afford extremely fine, sub-micron particle sizes.

Industry is increasingly turning to contract powder manufacturers that offer sophisticated heat treatments for improving powder quality. As 3D printing techniques and equipment continue to advance, optimising the powders using such heat treatments can improve powder flowability to prevent clogging, speed the process and produce a higher-quality part.

Optimising powder quality

Most metal 3D printing powders—such as aluminium, cobalt, iron, nickel and titanium alloys—are produced via gas atomisation. In this process, a feedstock is melted in a crucible before it is ejected from a nozzle into a high-pressure gas stream. This breaks the molten metal into fine particles, typically under 50–150 µm in size.

The particles produced by this process are typically spherical in shape, but it is important to address their surface porosity to improve flowability. Otherwise, the powder can clog or slow during the process, affecting the speed and quality of printing.

The powder must flow continuously and smoothly in order to achieve efficient and reliable production. The attractive force between tiny, sub-micron sized particles also increases as the particles become smaller, so finer powders are typically less free flowing. Uniform powder flow is further inhibited if the particles are porous or rough, as these characteristics create friction.

Furthermore, high particle porosity can reduce the load bearing, fracture toughness and fatigue properties of finished parts, leading to, for example, cracks and failure in cyclic stress conditions.

A growing number of contract powder manufacturers and 3D printer manufacturers are introducing a vacuum tumble-drying step in the manufacturing process to eliminate porosity and enhance flowability for a more consistent, high-quality product.

Advanced Powder Solutions (APS)—a contract powder manufacturer and in-house testing/engineering arm of the blending and drying equipment manufacturer GEMCO—uses vacuum tumble dryers that perform sparging (gas injection). This involves a perforated tube positioned under the bed of material distributing a flow of inert gas such as nitrogen and thus helping to circulate heat evenly amid the powder.

The heat in the vacuum tumble dryers closes the pores of raw metal powder particles so that they become more spherical and flow more smoothly. Furthermore, sparging protects oxygen-sensitive or volatile powders that might otherwise compromise certain alloy chemistries.

A blanket of inert gas over the material bed acts as a protective barrier, preventing the powder from being exposed to atmospheric oxygen. It also improves operator safety, as some metals such as nickel can be dangerous in powder form and their containment may be necessary to eliminate the risk of explosion or fire.

> “As 3D printing techniques and equipment continue to advance, optimising the powders using such heat treatments can improve powder flowability to prevent clogging, speed the process and produce a higher-quality part.”

Reconditioning powder

From a 3D printer end-user’s point of view, it is important to use any unused metal powder at the bottom of the tray for the next print job since it is costly. When this is necessary, vacuum tumble blenders can be used to re-blend the unused powder with new powder. Advanced vacuum tumble blenders are designed to apply even turbulence in all corners of the mix. This is accomplished through a combination of simultaneous macroblending and microblending, which allows for improved distribution.

▶ A GEMCO vacuum tumble dryer. ▶

▶ Metal 3D printing powder. ▶

Macroblending is achieved through rotation of the shaped vessel, enabling the material bed to fall away from its walls. The blender moves at a precise speed, with the vessel wall at a precise angle so that the material cascades over itself. There is no additional force from paddles, ploughs or spiral ribbons, only gravity.

Microblending (if needed) is performed via agitator blades located in the blending zone centre of the vessel, which is where fine processing of the material occurs.

Together, the two blending methods evenly expose each particle to six times more active blending per revolution than traditional mixers.

The industrial 3D printing market primarily uses metal powders, however the addition of a heat treatment step also improves part quality and manufacturing productivity if plastic or resin-based powders are used. ●

Advanced Powder Solutions (APS)
www.advancedpowdersolutions.com

GEMCO
www.okgemco.com

Reference

[1]*3D printing metal market size, share & trends analysis report by form (filament, powder), by product (steel, titanium, nickel), by application (medical, aerospace & defense) and segment forecasts, 2019–2025* [report]. January, 2019. Grand View Research.
Available at: https://bit.ly/3eTnBhr