Tech Article

How to Choose a Debinding Fluid for 3D Metal Printing

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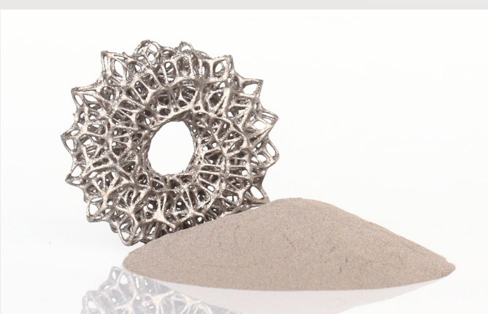

Finely powdered metals and binders mix to form complex parts.

Metal 3D printing, a subset of additive manufacturing is growing fast. It is a dynamic process that has changed tremendously over the past twenty years and continues to evolve with new technologies and techniques occurring every day.   It has gone from prototyping simple samples to making fully-finished, machine-grade metal parts.

Ideal for producing parts with complex geometries, metal 3D printing can help maximize production by creating parts that would be too expensive or time-consuming to make using traditional machining methods like lathing or turning. It only takes hours to produce 3D printed parts compared to days when using more conventional methods.

3D Printing Methods

There are many types of metal 3D printing methods in use today. However, two-methods in particular stand out for their speed, ease of use and cost-effectiveness. Binder Jetting and Feedstock Extrusion both use a combination of finely powdered metals and binders to form finished parts. Metals available include stainless steel, tool steel, and many other ferrous and nonferrous alloys. Common types of binders contain paraffin wax, carnauba wax, and specialty polyethylene waxes.

Binder Jetting creates green parts on a powder bed by depositing alternating layers of the metal powder and the binders to build the part. The Feedstock Extrusion method on the other hand, starts with an admixture of the metal powder and the binders and creates the green parts by extruding the mixture along a precise path, layer-by-layer directly onto a build plate.

Debinding Parts

In both processes, the binders serve a critical purpose in forming the metal powder into a specific shape. However, the binders are ultimately sacrificial and must be removed before the green parts are exposed to the high heat required for the next step of sintering. Debinding, or removal of the wax binders, is a balance of eliminating the binders in the shortest amount of time and with the least amount of damage to the structure. Because as you remove the binders, the parts become fragile.

Once the wax binders are fully removed from the green parts, the parts are sintered. Any remaining binders in the parts burn off while the parts compact at near melting temperatures. The metal powder bonds together and the finished parts reach their solid mass state. After that, the sintered parts can be post-processed using standard metal finishing techniques like grinding, cutting or coating.

Selective Debinding is Key

Debinding is an important step in the ultimate success of both the Binder Jetting and the Feedstock Extrusion 3D printing processes. Typically, a specialty fluid selectively removes some (typically up to 4%), but not all of the binders. The debinder fluid dissolves the binders and transports them out of the metal parts, creating pores and voids in the parts in preparation for the sintering furnace. The binders are progressively removed to avoid deformation

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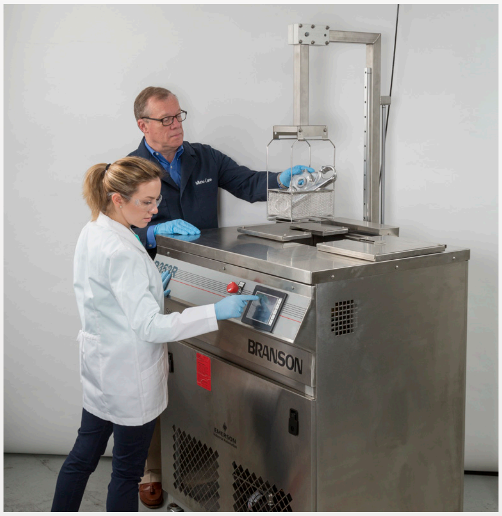
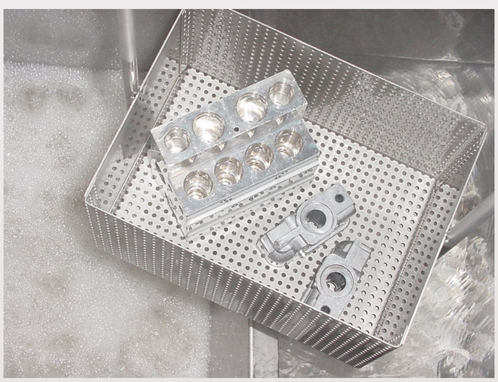


Fluid extraction of the binders can be easily done with a vapor degreaser.



Debinding may be performed in either the vapor or liquid phase in the vapor degreaser.

and cracking during sintering, while also allowing the parts to maintain their dimensional accuracy, compress uniformly and sinter evenly. The debinding process typically allows for faster sintering times resulting in shorter production runs.

Fluid extraction of the binders can be easily done with a vapor degreaser. The debinding may be performed in either the vapor or liquid phase in the vapor degreaser depending on the metals used and the binders to be removed. Both vapor degreasing phases rely on the fluid penetrating the parts to efficiently dissolve the wax from the full interior. This is where the physical properties of the debinding fluid become important and should be chosen carefully.

Good Materials Compatibility:
The debinding fluid should be safe to use on delicate uncured substrates. Use a fluid that is compatible with both the metal powders and the binders to safeguard the integrity of the formed parts.

Right Solvency or Strength:
Kb values typically indicate fluid strengths. The debinding fluid should be aggressive enough to selectively remove the right amount of binders yet still maintain the integrity of the parts. Too much binder left behind could result in cracking, deformation or part expansion during the sintering process.

Low Toxicity:
To protect workers and the environment, choose a fluid without n-propyl bromide, methyl pyrrolidone, heptane or trichloroethene which all carry health and or environmental baggage.

Low Boiling:
Low boiling fluids still melt the wax and additives but allow the vapor degreaser to run more efficiently, saving energy costs. The low boiling point also prevents damage to the non-soluble binder components.

Fast Evaporating:
Fluids with low latent heat of evaporation dry more quickly, translating into greater product throughput.

Low Surface Tension:
A fluid with a low surface tension allows the fluid to work its way into the parts structure. It penetrates the pores and internal channels to remove the binders more easily.

Low Viscosity:
Fluids with low viscosity flow around the parts more easily for more complete debinding and cleaning.

Nonflammability:
Nonflammable fluids are safer for workers and do not require specialty fire or explosion-proof equipment.

Maintenance-Free:
Debinding fluids should be stable and not require acid acceptance testing or stabilizer maintenance.

One Thing Always Remains the Same
Many industries continue to evolve with innovative parts design and manufacturing processes. However, one thing will always stay the same. Even state-of-the-art designs and manufacturing processes can benefit from unique chemistries that make these process advancements possible. It is essential to work with a critical cleaning partner that has specialized expertise in vapor degreasing and fluid debinding. Some fluid manufacturers have field engineers to conduct on-site audits to evaluate debinding methods. They may also perform comprehensive in-lab tests with sample parts to ensure cleaning and debinding success. They can recommend the debinding fluids and methods that will work best.

About the Author:
Venesia Hurtubise is a Technical Chemist at MicroCare which offers precision cleaning solutions. She has been in the industry more than 6 years and holds a MS in Green Chemistry from Imperial College. Hurtubise researches, develops and tests cleaning-related products that are used on a daily basis in precision cleaning and medical applications.
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