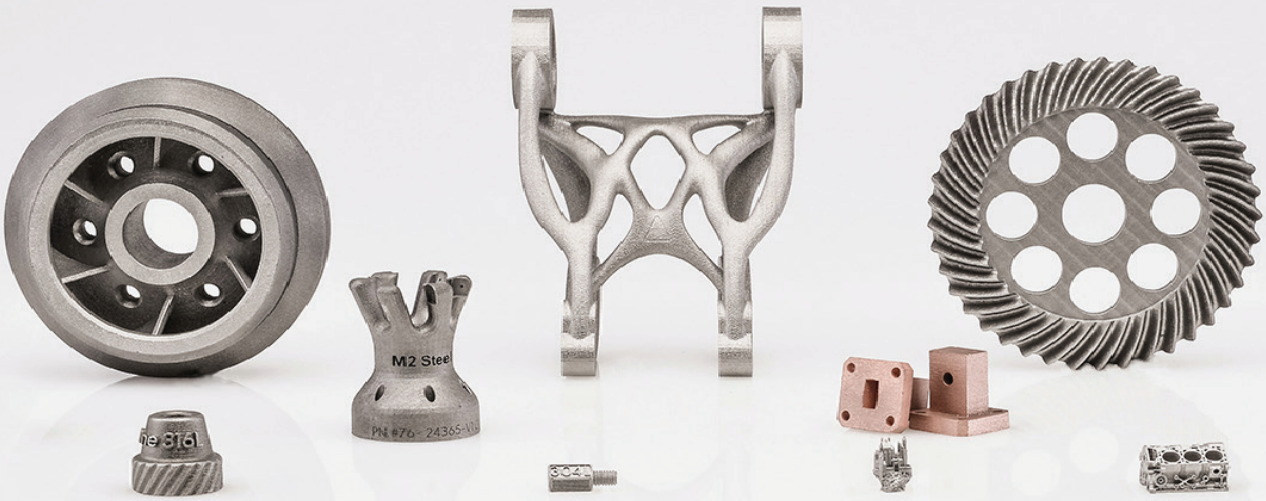

Q1 2020 MATERIALS UPDATE

Metal 3D Printer Materials

ExOne metal binder jetting systems now print 21 metal, ceramic and composite materials. Three levels of qualification now offered for different market needs.

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Perspective on ExOne's Metal Materials Announcement

A Message from John F. Hartner, Chief Executive Officer of The ExOne Company

February 25, 2020

Today, ExOne announced its metal 3D printers could now binder jet a total of 21 powders into metal, ceramic and composite precision parts -- with even more materials approved for controlled R&D printing.

From the outside, it may look like ExOne's metal printers jumped from six to 21 qualified materials overnight.

In reality, ExOne's engineering team and our customers have been moving so fast to print new materials since 2013 -- the breakthrough year when we began printing dense single-alloy metals -- that we haven't slowed down to update the market on our progress.

When we took the time to re-evaluate where we were over the last few months, the numbers surprised even us. ExOne customers were printing an astonishing number of materials -- 14 -- that had not yet worked all the way through ExOne's rigorous qualification process. That included six single alloys, six ceramics, and two ceramic-metal composites.

At the same time, we were ready to announce new materials, such as M2 Tool Steel, had achieved our highest qualified status, and other materials, such as aluminum and titanium, were qualified for controlled R&D printing. So, a major reset was needed.

ExOne's Rigorous Qualification Process

ExOne's top-tier qualification process is deliberately very tough - it's meant to designate that customers can buy a metal printer and, essentially, have standardized 3D printing with repeatable results out of the box. We also get these results certified by a third party, which is why we call this our "Third-Party Qualification" level.

Binder jetting uses an industrial printhead to quickly deposit a liquid bonding agent onto a thin layer of powdered particles, either metal, sand, ceramics or composites. The process is repeated, layer by layer, until the object is complete. Depending on the material being printed, additional post-processing may be necessary.

Overall, the binder jetting process is simple. But optimizing the machines, binders, powders and post-processing steps to work together to deliver the precise densities, material properties and metallurgy the market wants with every powder is serious engineering work. At ExOne, we won't third-party qualify a material until we've truly achieved top-tier results repeatedly.

For example, even before we made this announcement, our team was debating whether Inconel 718 should receive our top-tier qualification. We routinely print this material in R&D, and we're very close to where we want to be with the material. But for now, we've decided it still belongs on our list of qualified R&D materials until we've fully optimized the end-to-end process.

Customer-Qualified Materials

In the meantime, many of ExOne's customers have been printing the powder they needed because it meets their own standards, which are different than ExOne's broad commercial-readiness standard. Usually, these requirements are very specific to a certain application and not general to the overall marketplace.

Really, that's the beauty of binder jet 3D printing: you can print almost any powder if it works with a binder and delivers the final material properties required.

So, with our announcement today, ExOne is launching a new qualification category called "Customer-Qualified." This means the material is printable on our machines and that customers are successfully printing it today for their own applications.

We felt this was necessary to let the market know all the materials that are printable, so others might take advantage of the sustainability and design benefits of binder jet 3D printing for their parts and products.

Exciting materials are on this list, such as cobalt chrome, copper, H13 Tool Steel, Inconel 625, titanium and tungsten heavy alloy.
Cutomers are also printing ceramics such as alumina, carbon, natural and synthetic sands, silicon carbide, alone or infiltrated with silicon, tungsten carbide-cobalt. We've also previously announced our work with Oak Ridge National Laboratory on boron carbide infiltrated with aluminum.

Copper is a good example of the work our customers have been doing. Virginia Tech Prof. Chris Williams, Ph.D., has been 3D printing copper on ExOne machines since 2015, starting with the ExOne R2 machine, launched in 2003, and now also with an Innovent+, a machine launched in 2018 for high-density metals printing.

Prof. Williams' work on the subject of copper printing with ExOne binder jet printers has been published in at least three peer-reviewed journals, including Design & Materials, Additive Manufacturing, and Procedia Manufacturing.

So, while ExOne hasn't fully qualified copper for our top-tier status, it will likely work for many customer applications - depending on the specific requirements needed.

The Benefits of Binder Jetting

We're excited about today's change in material classifications -- not because it results in an impressive number of printable materials -- but because it showcases the great diversity that binder jetting offers in terms of material and design flexibility, and sustainability.

Binder jet 3D printing is a sustainable method of metal part production because it fabricates objects with little to no waste, and, at the same time, enables all-new lightweight designs that were not previously manufacturable. What's more, binder jetting is capable of 3D printing parts at high speeds and volumes that can truly make a difference.

At ExOne, where we've always been proud to be green, more binder jetting materials will eventually mean more sustainable manufacturing and products for all.

Metal 3D Printer Systems — Materials & Binders

ExOne metal 3D printers transform more than 20 powders into metal, ceramic and composite parts and products. Our metal printing technology creates dense and functional precision parts used for automotive, aerospace, defense, energy, and consumer applications.

To ensure customers will have reliable, repeatable and predictable parts, from 3D printing to final sintering, we have a comprehensive qualification process. ExOne's R&D teams work continuously to qualify new materials for use in our machines. What's more, we routinely partner with companies to develop specific materials for binder jet 3D printing with our technology.

ExOne has three qualification levels that recognize different degrees of readiness for customers with different application needs.

1. Third-Party Qualified Materials

These materials have passed ExOne's rigorous testing for uniformity, dimensional tolerance, sintering characteristics, and other features over multiple builds. Please see the attached data sheets for third-party testing results based on MPIF standards.

Single Alloy Metals

1. 17-4PH SS
2. 304L SS
3. 316L SS
4. M2 Tool Steel

Metal Composites

1. 316 SS i/w Bronze
2. 420 SS i/w Bronze
3. Tungsten i/w Bronze

2. Customer-Qualified Materials

The materials below have been qualified for use by ExOne customers, using standards for their own applications, and are being successfully printed today. Additionally, a number of ExOne customers also print proprietary powdered materials on our machines that are not listed below. If you have a question about 3D printing the materials below, please **contact us**.

Single Alloy Metal

1. 17-4PH SS*
2. 304L SS*
3. 316L SS*
4. Cobalt Chrome
5. Copper
6. H13 Tool Steel
7. Inconel 625
8. Titanium
9. Tungsten Heavy Alloy

Ceramics

1. Alumina
2. Carbon
3. Natural Sands
4. Synthetic Sands
5. Silicon Carbide
6. Tungsten Carbide Cobalt

Ceramic-Metal Composites

1. Boron Carbide i/w Aluminum
2. Silicon Carbide w/Silicon

Metal Composites

1. 316 SS i/w Bronze*
2. 420 SS i/w Bronze*
3. Tungsten w/w Bronze*

**This material is also a third-party qualified material*

3. Research & Development Materials

These materials have been deemed printable by ExOne and our customers after preliminary analysis. Our R&D work for these materials is ongoing and involves engineering work with the materials, as well as our printers and processes, to ensure successful printing. If you are interested in collaborating on development of these or any unlisted materials, please **contact us**.

Single Alloy Metals

1. 17-4PH SS**
2. 304L SS**
3. 316L SS**
4. 4140
5. 420
6. 4340
7. 4605
8. Aluminum
9. Bronze
10. Cobalt Chrome**
11. Copper*
12. H11 Tool Steel
13. H13 Tool Steel**
14. Hastelloy
15. Haynes 230
16. Inconel 625**
17. Inconel 718
18. Iron-Chrome-Aluminum
19. M2 Tool Steel**

Single Alloy Metals (continued)

20. Panacea
21. Titanium**
22. Tungsten (bonded or green)
23. Tungsten Heavy Alloy**
24. TZM Molybdenum

Ceramics

1. Alumina**
2. Aluminum Nitride
3. Barium Titanate
4. Boron Carbide
5. Carbon**
6. Glass
7. Lead Zirconate Titanate (PZT)
8. Natural Sands**
9. Silicon Carbide**
10. Silicon Nitride
11. Synthetic Sands**

Ceramics (continued)

12. Tungsten Carbide
13. Tungsten Carbide-Cobalt**
14. Zirconia
15. Zirconium Carbide

Ceramic-Metal Composites

1. Boron Carbide i/w Aluminum**
2. Silicon Carbide w/Silicon**

Metal Composites

1. 316 SS i/w Bronze**
2. 420 SS i/w Bronze**
3. Iron i/w Bronze
4. Tungsten i/w Bronze**
5. Tungsten i/w Copper
6. Tungsten i/w Invar

***This material has also been qualified by customers or received our rigorous third-party qualification status.*

ExOne Fuse Binders

One of the reasons ExOne metal binder jet systems can print such a diversity of powdered materials is our portfolio of specialty Fuse binders, which deliver unique benefits for the material being 3D printed.

Binders must deliver certain characteristics that work harmoniously with the powder material being printed. Considerations include viscosity, saturation, bleeding in X and Y, as well as debinding characteristics. ExOne binders continue to be optimized to provide improved green strengths and other beneficial properties based on the material being printed.

- CleanFuse – A premium, clean-burning binder that leaves behind no carbon residue and works well with metallic materials negatively affected by carbon, such as Inconel powders
- FluidFuse – A versatile solvent-based binder with low viscosity that works well with a variety of metallic and non-metallic materials, including ceramics
- AquaFuse – A water-based binder that works well with a variety of metallic material
- PhenolFuse – A phenolic binder best suited for printing high-temperature materials, including non-metallics such as carbon, tungsten carbide (WC), silicon carbide (SiC), and other ceramics

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