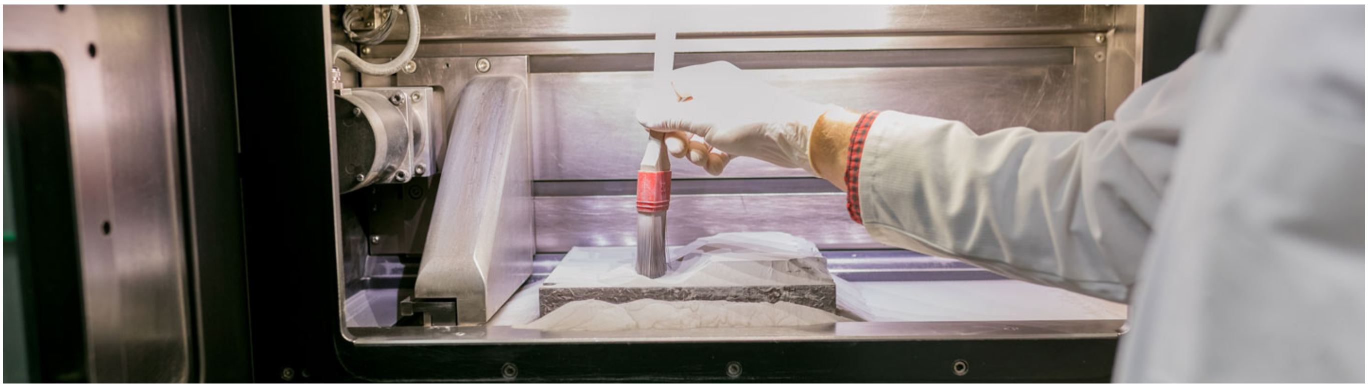

Additive Manufacturing

Is 3D Metal Extrusion the Next Wave in Additive?

Kip Hanson | Jul 24, 2018

3D additive metal extrusion manufacturing is beginning to establish itself in the market. With a more inviting price point than other 3D technologies, it has the potential to shake things up. We profile several major players in the space—and their claims to fame.

With all the news about 3D metal printing lately, chances are good you're at least interested if not actively investigating the available options. Manufacturers are using technologies such as direct metal laser sintering and electron beam melting to print everything from ***jet engine fuel nozzles*** to medical prostheses, so why wouldn't your shop want to leverage the technology for prototypes, tooling and low-volume production parts?

For one thing, printers used to produce these parts, and thousands of similar metal components can be costly. You can figure on $500,000 and up for a laser-based powder bed machine, plus the software, training and ancillary equipment to support it. The metal powder needed to actually build something is often proprietary, as are the lasers used to sinter it into useful products.

The New 3D Metal Extrusion Kids on the Block

Don't despair. A new breed of 3D metal printers has entered the market recently. These machines are much less costly, relatively easy to use and produce fully dense metal parts suitable for end-use applications. Several distinct technologies exist with roughly a dozen equipment manufacturers offering their own unique alternatives to traditional powder bed systems. Here are a few examples.

Is 3D additive manufacturing viable despite its hype? Read "The Case for 3D Printing in Manufacturing" to learn more.

3D Metal Extrusion Profiles: Markforged, Desktop Metal, Digital Metal

Markforged's Metal X printer uses a proprietary atomic diffusion additive manufacturing, or "ADAM" technology, to print parts out of 17-4 PH or 303 stainless steel with aluminum, Inconel, titanium and others that are planned.

The technology works by extruding rod-like cylinders of powdered metal previously blended with a plastic binder through a nozzle to create part layers 50 µm (0.002 in.) thick. When complete, the "green" part is sent through a wash station to remove some of the binder material and then placed in a furnace that burns away the remaining binder and fuses the metal particles together. With a price tag hovering around $100,000 for a complete system, manufacturing costs are reportedly up to 10 times less than alternative metal-additive technologies and up to 100 times less than machining.

3D Metal Extrusion Entry Point: Hobby-Grade Machines

Want to get your feet wet with 3D metal printing? A decent hobby-grade fused deposition modeling machine can be had for as little as $5,000. With the increasing availability of metal-infused filaments, parts that have the same look and feel as copper, bronze and even stainless steel are possible.

Granted, such a machine will deliver only hobby-grade accuracy, but it does give the user valuable experience with processing additively manufactured parts. Also, designing for 3D printing has long been one of the biggest obstacles to its effective use, so what better way to begin understanding the ins and outs of topology optimization, mesh design and organic structures than to model your latest part idea one day and see it become reality the next?

3D Metal Extrusion Profile: Desktop Metal, Digital Metal

Desktop Metal offers two 3D metal printers, the Studio System and the Production System. The Studio System is an "office-friendly" printer that employs an extrusion process not unlike the one used by Markforged. Its patented bound metal deposition process prints 17-4 PH, 316L, Inconel and other powders similar to those used in the decades-old metal injection molding but bound in a polymer mix. Layer thicknesses of 50 µm (0.002 in.) and build speeds of 16 cm^3/hr. (1 in^3/hr.) are possible. Here again, parts are washed in a debind station before being sintered in a furnace at temperatures up to 1400 degrees C (or 2552 F). Desktop Metal also lays claim to being 10 times less expensive than laser-based 3D metal printers.

With build speeds up to 8200 cm^3/hr. (500 in^3/hr.), Desktop Metal's Production System is said to be 100 times faster than laser-based metal printers and is clearly designed for mass production. Using 32,000 jets and a bidirectional powder spreader, its single pass jetting technology deposits millions of droplets per second of binder fluid on each layer of powder. It also has anti-sintering agents to make support structures easier to remove later. The "brown" parts are then fused in a furnace at just below the metal's melting temperature to produce a fully dense product.

Though not commercially available until 2019, the roughly $400,000 cost of the Production System is approaching laser-based powder bed printers but is said to offer a cost-per-part comparable to that of metal castings—at least up to 100,000 pieces.

Want to go deeper in 3D additive? Check out "The Unique Challenges and Solutions in Metal 3D Printing."

3D Metal Extrusion Profile: Digital Metal

Digital Metal's DM P2500 is another 3D metal printer that uses binder-jetting technology. As part of

Sweden's Höganäs Group, a leading supplier of metal powders, Digital Metal says its machines have produced more than 200,000 high-quality 3D-printed components for the ***aerospace***, automotive, medical and other industries. Layer thicknesses to 42 μm (0.0016 in.) are possible, as is feature resolution to 35 μm (0.0014 in.). Build speeds are close to that of Desktop Metal's Studio System at 100 cm^3/hr. (6 in^3/hr.), although the DM P2500 is said to achieve extremely fine detail and "medical grade" surface finishes.

There are plenty of other systems and technologies available. AM machine builder ExOne, for example, offers a variety of binder-jetting machines and materials ranging from bronze to tungsten. Vader Systems uses an electromagnetic field to build parts from liquified metals. Pollen AM's pellet additive manufacturing uses MIM feedstock that's up to 5 times less expensive than existing powder-based systems.

Though laser-based 3D metal printers have their place, these alternatives offer a number of advantages: Because there's none of the thermal stress as with laser-based systems, the support structures needed to hold parts in place during the build process can be simplified or even eliminated. This allows the entire build chamber to be filled, which means hundreds or even thousands of small parts can be processed in a single, unattended operation.

The support structures that are used are typically easier to remove, which can eliminate the need for secondary machining or hand-finishing operations. Since the metals are the same as those used with MIM, ***aerospace*** and medical oversight approvals are much easier to attain. There's no need for argon or nitrogen gases as there is with laser-based systems, nor are there any concerns over a laser beam sparking an explosion in an aluminum or titanium dust-filled atmosphere.

Have you ventured into additive manufacturing and 3D printing at all? What has your experience been like?

