Five Emerging Metal 3D Printing Technologies at AMUG

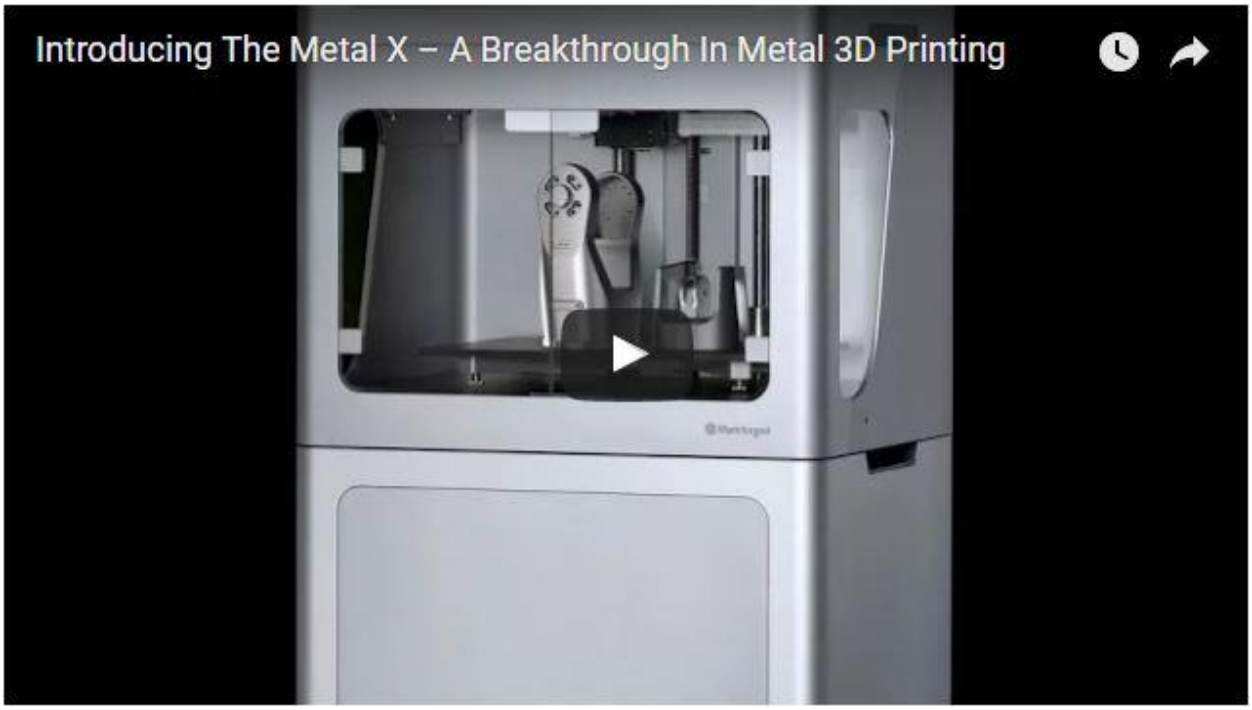
With its emphasis on presentations and discussions over shiny objects on the showroom floor, AMUG provides a unique experience for its additive manufacturing (AM)-experienced attendees. Although the event's presentation on new metal 3D printing technologies could have easily become lost amidst the marketing fluff at any other conference, at AMUG, the talk was focused on the practical aspects of metal AM.

During this talk, three important start-ups chatted with attendees about their technologies: Markforged, Voxel8 and Vader Systems. They were not the only metal AM companies at the event with exciting new processes, however. XJet and Admatec were also present at AMUG, showcasing their takes on metal AM.

The sheer novelty of these processes is interesting, but how do they contribute to metal AM as a whole? Well, each technology addresses existing problems with metal 3D printing in a way that may make them attractive to potential users.

Markforged

At CES this year, Markforged unveiled its new Metal X 3D printer, which takes the company's carbon fiber 3D printing technology to the next level. Rather than laying down continuous strands of fiber reinforcement within plastic parts, the Metal X actually prints with metal encased in a thermoplastic matrix in a process referred to by Markforged as atomic diffusion additive manufacturing (ADAM).



Link: https://www.youtube.com/watch?v=InYfu5hoV7c

The parts are printed in a method similar to standard fused deposition modeling, but, once complete, they are thrown into a traditional sintering furnace, which burns out the thermoplastic and fuses the metal together, creating a 95 to 99 percent dense metal part.

For less than $100,000, the Metal X is much more affordable than powder bed or directed energy deposition technologies. Throw in the fact that the bound-powder rods are completely safe to handle, and the ADAM process seems appealing from a safety standpoint because machine technicians will not have to wear ventilators or

hazmat suits to handle the material. The process does not use a powder bed, so it's possible to create sealed complex geometries without worrying how some encased powder would be removed.

A 3D-printed brake lever demonstrating that a lattice infill can be printed using ADAM without worrying about powder escape cavities. (Image courtesy of the author.)

At the moment, ADAM works with 17-4 and 303 stainless steel, but other metals like A-2, D-2 and M-2 tooling steel for injection molding, as well as 6061 and 7075 Aluminum and 6AL 4V Titanium are in development.

Vader Systems

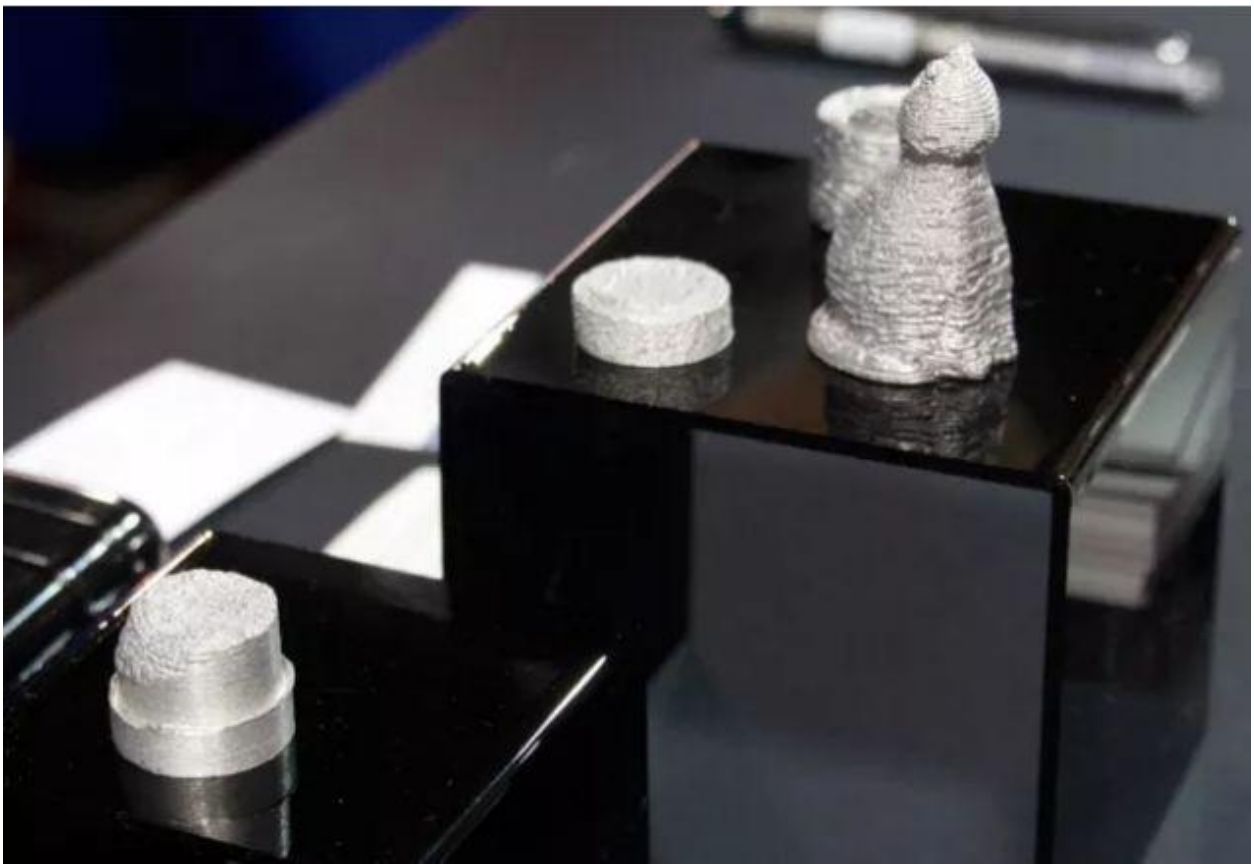
Founded by a father-and-son team, Scott and Zachary Vader, Vader Systems has developed a process dubbed MagnetoJet, which jets liquefied metal from a 1200 °C (2192 °F) chamber encased in an electromagnetic field through inkjet nozzles.

This makes it possible to 3D print objects at an impeccable speed of 1,000 droplets per second or 1 lb per hour based on a 500-micron droplet size.

Link: https://www.youtube.com/watch?v=cfoXKtl26Hg

The system also uses standard aluminum wire as its feedstock, dropping down the cost of materials significantly from powder bed systems. Although the materials may save a user some costs in the long run, the printers themselves aren't cheap. At $400,000 per printer, this puts the technology in line with powder bed systems.

The start-up has so far sold its first machine, the MK1, to the Rochester Institute of Technology. While the MK1 is targeted at research institutions and development labs, Vader is working on a production machine, the MK2, on which Vader aims to have 10 printheads for 30 times the speed. This system will also be able to process more materials, including bronze and copper.



Prints demonstrating experiments with cool beds (right) and heated beds (left). The print on the left has been post-processed for a smoother finish. (Image courtesy of the author.)

The parts displayed by Vader at AMUG were not the most refined, but post-processing will eliminate surface finish issues, and the company is working to develop software solutions for maintaining speed while increasing resolution.

XJet

At AMUG 2016, XJet showcased its nanoparticle jetting (NPJ) technology. The company was back at AMUG again this year. So far, there hasn't been any new developments from the company, except that its NPJ process can be used for ceramic 3D printing, in addition to metal. For a more complete description of the process, read our interview with the company from last year.

What's relevant for our discussion here are the advantages and disadvantages of NPJ. Like ADAM from Markforged, there are no dangerous powders to deal with, as the nanoparticle inks are housed in cartridges meant to be easily fed into the machine.

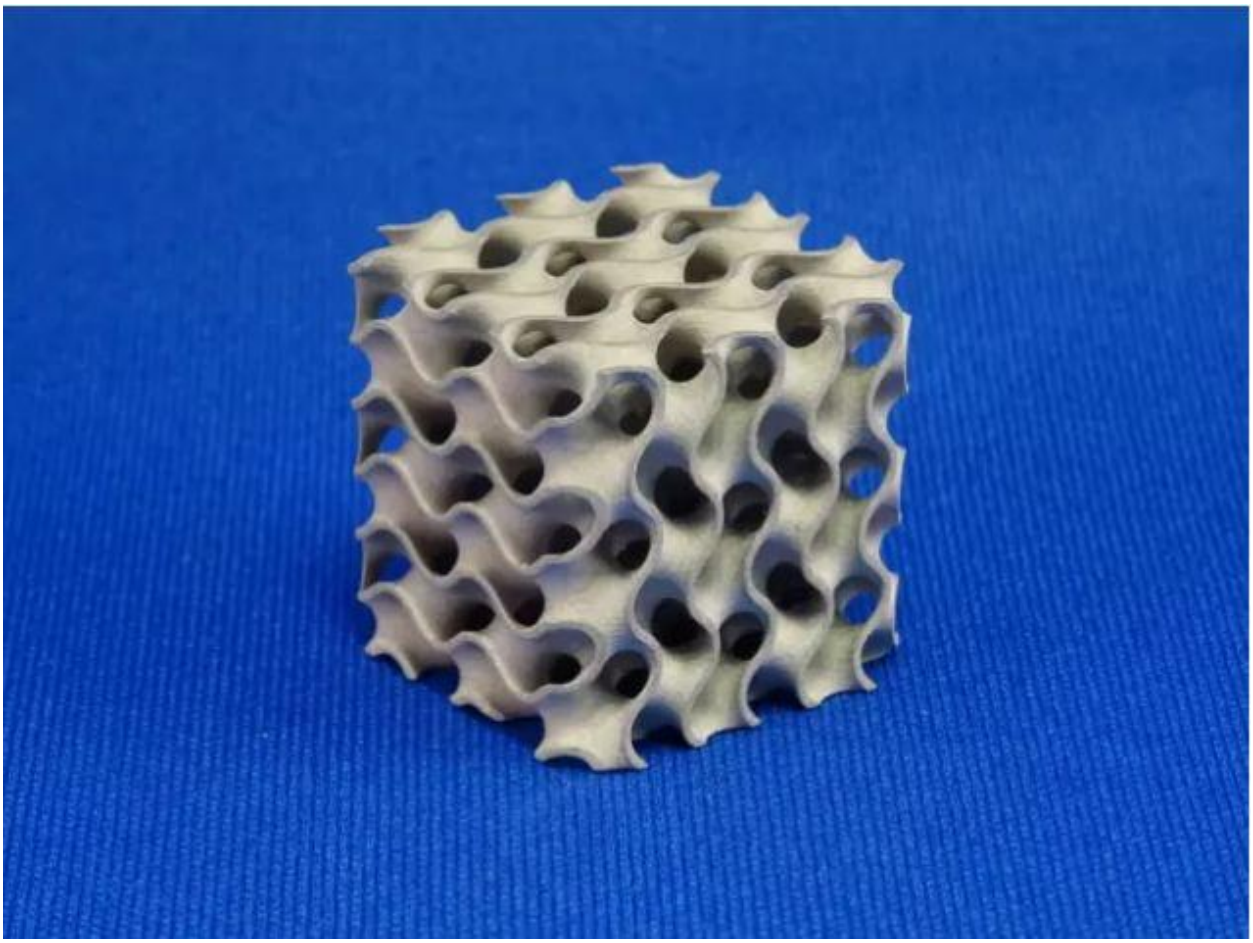
On display at AMUG, a collection of stainless steel, silver and ceramic parts. (Image courtesy of the author.)

Because parts are printed with support material that can be burned out during the necessary sintering process, it's possible to create unique geometries, moving parts and voids without worrying about powder removal or machining support structures.

Perhaps most importantly, NPJ's print resolution is unmatched at one micron layer thicknesses. The system should be available for purchase sometime soon and, when it is, users should be able to print with silver and stainless steel.

ADMATEC

At AMUG this year, Admatec unveiled its ADMETALFLEX 3D printer, developed with ECN, which takes a familiar technology and throws in a unique twist. After already unveiling a ceramics 3D printer, the digital light projection (DLP) 3D printer manufacturer has now adapted its DLP platform for metals.



A stainless steel print made with the ADMETALFLEX. (Image courtesy of ADMATEC.)

The principle behind the two systems is similar: load photopolymer resin with either ceramic or metal particles and expose it to light from a DLP projector layer by layer. Once the parts are complete, sinter them in an oven, burn out the photopolymer binder and you've got either a dense metal or ceramic part.

The system is meant to be a low-cost solution to 3D printing metal parts. So far, the ADMETALFLEX machine can 3D print 98 percent dense parts from 316L stainless steel. Like all parts that require post-sintering, there is some shrinkage

with those made by this printer, as the oven needs to burn out about 50 percent of the material.

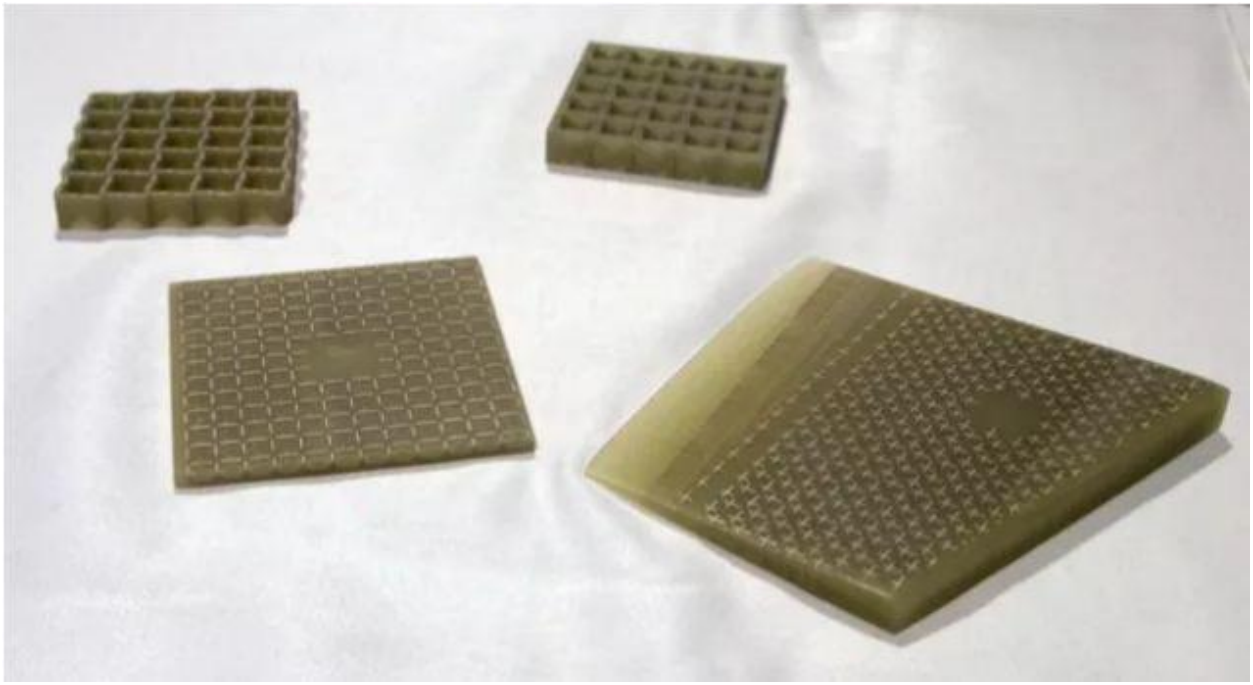
Voxel8

Although Voxel8 presented alongside other metal 3D printer manufacturers, the company's multi-material digital manufacturing platform does not print with metal exclusively. In fact, the metal it does print with is a silver nanoparticle ink used to apply conductive circuits to parts as they are being printed.

Since the company initially launched its developer's kit at CES in 2015, Voxel8 has taken some of the technology developed at its founders' Harvard lab and commercialized it through an industrial platform. Whereas the developer's kit could apply conductive ink to PLA plastic parts, the industrial platform uses multiple nozzles to print with rigid and soft materials, while adding electronic inks to the mix.

Altogether, this means the ability to print flexible circuits, geometrically complex antennas, footwear and transducers. In the works from Voxel8 is lithium ion battery 3D printing, which was also developed by Voxel8 Founder Jennifer Lewis.

Systems are sold on a case-by-case basis and are tailored specifically to the end application of a given customer. Obviously, the immediate goal with Voxel8's technology is not the 3D printing of metal parts, like the rest of the companies listed here, but the 3D printing of functional parts.



Uniquely shaped antennas 3D printed by Voxel8 for the MITRE corporation. By altering the geometry of an antennae, it's possible to increase its power without expanding its size. (Image courtesy of the author.)

All of the processes listed here are extremely new. Although some advantages and disadvantages are immediately easy to check out, many of them will be discovered once products have been on the market for an extended period of time. At next year's AMUG, this list may look completely different.

http://www.engineering.com/3DPrinting/3DPrintingArticles/ArticleID/14594/Five-Emerging-Metal-3D-Printing-Technologies-at-AMUG.aspx