Forging as a Viable Alternative to 3D Printing of Non-Ferrous Metal Parts

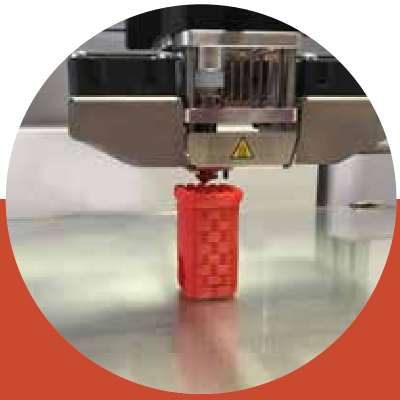
weldaloy

Introduction

3D printing is an additive manufacturing (AM) technology used to build objects layer-by-layer directly from digital data. It has surged in popularity in recent years because it enables fast and flexible product design and prototyping, and can be used to produce small numbers of parts cost-effectively, and create complex parts that are difficult or impossible to make otherwise.

The vast majority of 3D printing technologies are focused on making objects out of plastic, but 3D printing technologies are being developed to build metal objects, generally by laser-sintering powdered metal feedstock. The hope of the universities and corporations pursuing the technology is that the ability to print metal parts will bring about a revolution in industrial production by supplanting traditional metalworking methods like forging.

Are we on the threshold of such a revolution? Will 3D printing displace forging, especially for custom parts? Nobody can say for sure what will happen tomorrow, but one question that we can address today is this: Which would be the better choice for making parts for use in the aerospace, medical, and other industries? This paper will explore that question.



Know the Application

A good starting point is to carefully consider where and how the parts will be used. At present, there are many unknowns with 3D metal-printing technology, and while it's entirely possible the technology may make great inroads as time goes on, right now it seems best-suited for applications where the goals are:

- **to reduce the total number of parts in a system,**
- **to make parts that can't readily be made by another means (complex geometries with internal channels, for example), or**
- **to reduce weight.**

Forging, meanwhile, remains the best choice for applications where mechanical concerns such as strength and durability are key requirements. This is especially important with non-ferrous metals that include some of the softest and most ductile metals in the world. Forging allows engineers to use raw materials and special processes that address an application's specific requirements.

Forging allows engineers to use raw materials and special processes that address an application's specific requirements.

For example, for the highest-strength copper parts, it is imperative to start with a raw material that has the proper chemistry requirements needed in order to achieve particular grain size, hardness, or other mechanical characteristics needed in the application. The absence of raw material defects is critically important in many industries. This, along with an appropriate reduction ratio and grain orientation, results in the strongest part possible given its desired shape, size, and function.

Also, the use of particular alloys often is required to meet electrical or thermal conductivity specifications, to address welding or brazing considerations, or to meet governmen regulations or industry standards that may apply to the application. This is business as usual in the forging industry, but given the newness of 3D metal-printing technology and the variable characteristics of sintered metal powders, it isn't clear how users can always be assured of meeting such requirements

Production Speed

Speed is often touted as a major advantage of 3D printing technology, especially for small numbers of custom parts. This comes from the fact that designers are working directly from digital models, so fewer prototypes are required, and the prototypes that are required can be created quickly and relatively inexpensively with no need for special tooling, setup, or assembly.

But while this often may hold true for parts made from plastic resins, when it comes to metal parts, the issue of production speed has many other dimensions that are often left unmentioned. Anyone choosing between 3D printing or custom forging based simply on anticipated production speeds would do well to look at the issue from a broader perspective.

For the highest-strength copper parts, it is imperative to start with a raw material that has the proper chemistry requirements for the application.

Open die forging can produce custom prototypes faster than any other forging process.

The first consideration is the rated build speed of 3D printing equipment. Just because a car can travel at 120 MPH doesn't mean it will ever be driven that fast. Similarly, with 3D printers, output quality can go down at higher build speeds, and since many custom non-ferrous parts must meet exacting specifications, the printer may never actually be run at its rated build speed, and the production of parts may take longer than anticipated, particularly if they are large.

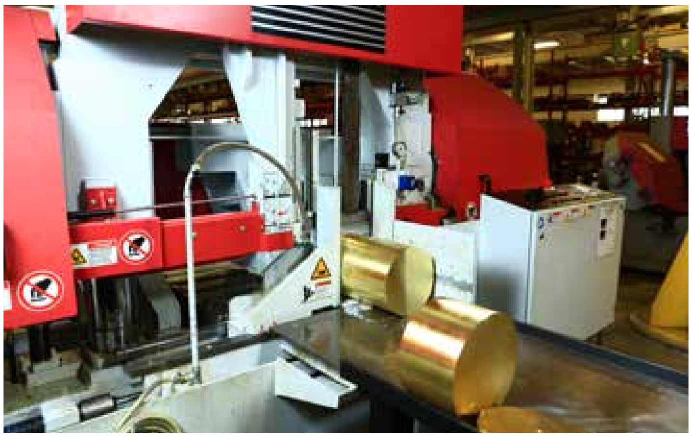
On the other hand, open die forging can produce custom prototypes not only faster than any other forging process, but fast in absolute terms. For example, while production speeds vary depending on the given part, custom prototypes can be fabricated in as little as 2 to 4 weeks.

For larger quantities of parts than just a few prototypes, some people envision "farms" of 3D printers to meet delivery requirements, but this remains to be seen. Another speed-related issue to consider is the common misconception that once a part comes out of a 3D printer, it is immediately ready for use. Post-production processes may be required with metal parts, delaying delivery to the customer. For example, take the support structures used during printing. These may be used to anchor a part to the build plate so it doesn't move during the printing process, or to provide a path for heat transfer so the metal powder isn't over-heated during laser-sintering. In any event, the support structures must be removed from the finished part. That not only takes time, but their removal can inadvertently create quality issues with some parts destined for critical applications, and time must be devoted to addressing them.

Heat treating is another potential post-production need, because some 3D-printed metal parts can deform or crack from residual stresses once they are built. These stresses may arise from factors such as the material used, or localized heating and cooling that may have taken place in certain areas of the part, given the varying thicknesses of its walls and other structures.

Availability of Technical Support

Another key issue to consider when weighing the tradeoffs of 3D printing versus forging is whether the supplier offers the needed engineering and technical support to help customers achieve desired levels of performance and quality.



Forging companies like Weldaloy that are vertically integrated (key functions under one roof) can provide better process control, higher quality, and lower costs.

For example, it isn't easy or straightforward to properly heat-treat many soft, ductile alloys. It requires specialized expertise. Time and temperature requirements must be precisely adhered to in order to achieve the optimum results, and the method of heating, furnace design, and furnace atmosphere all contribute to the success of achieving the desired properties. Specialized expertise may also be needed for testing, analysis, and other technical issues with certain alloys.

This raises the question of who would be doing the 3D printing. Would it be a service arm of the 3D printer manufacturer whose expertise probably lies more in printing technology than in metallurgy? Would it be an independent service bureau, which may or may not have the necessary expertise, depending on its background and specialization? Would it be the customer itself, who may be able to take care of all resulting technical issues?

Additional Considerations

Safety – Safety is a key concern in aerospace, medical, and other critical applications, and the ability to ensure high quality and to trace the pedigree of a part in the event of failure is an important capability.

3D printing of metal parts is in its early stages so the needed processes and procedures may not yet be fully developed. By contrast, a vertically integrated forging company like Weldaloy has a quality system registered to AS 9100C and ISO 9001:2008 that sets forth the production quality requirements for the aerospace industry.

Every part manufactured by Weldaloy is marked with a material ID to maintain traceability throughout the manufacturing process. Parts can also be serialized if the customer requires it, or if there is an internal need for a higher level of traceability. The pedigree of each part can be traced back through every operation and operator, all the way back to the raw material received at Weldaloy. The material supplier's chemical analysis of the raw material on file is maintained.

Time and temperature requirements must be precisely adhered to in order to achieve the optimum results.

Unique Alloys – It's said that an advantage to the use of 3D printing is that the powdered metals used can be custom-tailored so that parts can be made of specialized alloys. But that is hardly unique. Weldaloy works with suppliers to ensure an adequate flow of raw material, and carries inventory of alloys that are rarely produced to ensure supply on demand.

Moreover, customers can provide their own proprietary alloys, or metal they've happened to purchase at a discount, and Weldaloy will perform the forging processes needed to get the mechanical properties and performance required.

Conclusion

3D printing of metal parts has received much attention recently, and while its future is undoubtedly bright, it has limited applicability at present. It may best be viewed as a complement to the forging of non-ferrous metal parts, which remains the best choice for most applications.

About Weldaloy

For 70 years, Weldaloy has been a leading provider of custom copper, aluminum, and other non-ferrous forgings serving a variety of industries such as aerospace, electronics, oil and gas, and more. Weldaloy's goal is to create meaningful and lasting relationships with each customer by providing the highest level of service and quality. Weldaloy's vertical integration process offers its customers a single source for forged and machined non-ferrous metal products.

weldaloy

Interested in receiving a quote or talking with a representative?

Give us a call at 1-(888)-WELDALOY.

custom forging. customer focused.

Weldaloy.com | **P:** 888.935.3256 | **F:** 586.758.5049 | 24011 Hoover Road Warren, MI 48089