Direct Metal Laser Sintering (DMLS)

Metal 3D Printing with Fathom Manufacturing

Fathom Manufacturing offers DMLS 3D printing services for complex metal parts, including functional metal prototypes and end-use parts, from a variety of alloys. **Contact us today to get started on your project!**

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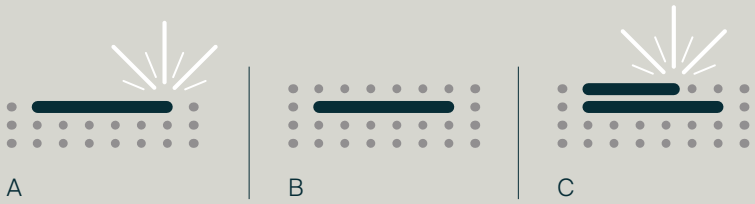
Overview //

What is DMLS?

Direct Metal Laser Sintering (DMLS) is the process of building or growing parts vertically from a build plate. In the simplest terms, DMLS is 3D printing with metal. A build plate is covered with metal powder. A fiber laser is then used to sinter, or fuse, the metal powder together, layer-by-layer. This allows for small, complex parts to be produced with a chosen metal. Parts that would otherwise be difficult or impossible to make with conventional machining methods can be created with DMLS. These parts are as strong as any that have been machined, formed, or stamped.



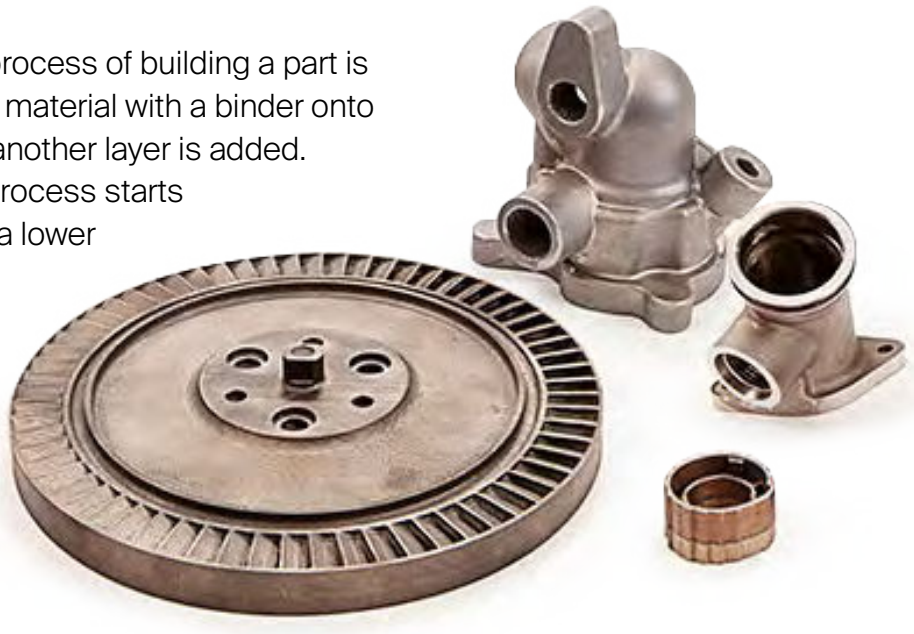
How Does DMLS Work?

A laser is directed into a bed of powdered metal as specified by the 3D design file. The laser sinters, or fuses, a layer of metal (A), more powdered metal is added on top (B), and the process is repeated (C). Layer by layer the object is built from the ground. This layer-by-layer process allows engineers to design parts that would be impossible or cost prohibitive to make by conventional means.

What is the Difference Between Other Methods of Metal 3D Printing vs. DMLS?

With other types of metal 3D printing, the process of building a part is done with a nozzle that extrudes a metallic material with a binder onto the build plate. The material solidifies and another layer is added. Once the first layer has been formed, the process starts over. Parts printed in this manner will have a lower overall density.

Fathom's DMLS process will produce 99% dense parts. This achieved by eliminating the use of polymer binders. Parts made with the DMLS process will have the same structural integrity as parts that are milled or formed, making them less prone to cracking and failure.



DMLS Specifications //

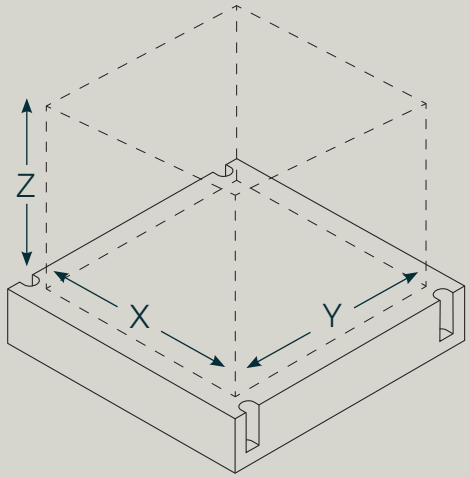
What are the **Tolerances**?

The DMLS process is ideal for making small, complex parts. Parts can be created to within .005 in. (.127 mm) of the design specifications. This means the finished part will measure +/- .005 in. of the original design. Five thousandths of an inch (.005 in.) is roughly the thickness of a coat of paint or a single human hair. Parts needing a higher degree of accuracy are machined in post processing.

What are the Available **Build Volumes**?

Fathom has several DMLS machines that offer varying build volumes. The build volumes determine the maximum size of the object and are designated along the X-, Y-, and Z-axis. The XYZ axis represents the length, width, and depth of an object. A square can be measured along its X and Y-axis, showing its height and width. Adding a third dimension turns the square into a cube. That third dimension is the Z-axis, showing an object's depth. The object is built from the build plate up in the Z direction.

250 x 250 x 310 mm (9.8 x 9.8 x 12.2 in)
280 x 280 x 325 mm (11.02 x 11.02 x 12.7 in)
300 x 300 x 390 mm (11.8 x 11.8 x 15.3 in)



Easy as X-Y-Z

Speak with a Fathom Expert to determine if the desired material is available and if the resolution will be compatible with the part design.

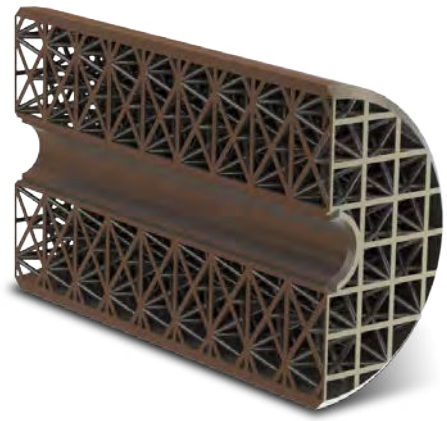
What is **Resolution**?

Resolution refers to the thickness of each layer that is fused after each pass of the laser. Resolution is measured in microns and can be 20-60 µm thick. Resolution is dependent on the DMLS machine and the material being used.

Why is Resolution Important?

Resolution, or layer thickness, can affect the final design, especially on parts with tight tolerances. Depending on the design of the part, a higher resolution may result in a stair-stepping effect on angled, outer surfaces. As each layer is fused into a place, the new layer will be slightly proud of the previous layer, resulting in a tiny ledge. Materials with a lower resolution will yield a smoother surface. Stair stepping can be easily removed in post processing when necessary. Stair stepping may not be an issue for prototypes or parts that do not require tight tolerances.

What **Materials** Can Be Used in DMLS?



- Stainless Steel (PH1)
- Stainless Steel (GP1)
- Cobalt Chrome (MP1)
- Maraging Steel (MS1)
- Aluminum AlSi10Mg
- Nickel Alloy IN718
- Stainless Steel (316L)
- Titanium Ti-64
- Titanium Ti-64 ELI

Data sheets are available for all materials used in the DMLS process. Contact a Fathom Engineer for data sheets on specific materials.

What are **Supports**?

Depending on the design, some parts may require temporary supports doing the building process. These supports are then removed during post-processing. Supports are used to anchor the part to the build plate and to ensure the part does not fail or tip during the building process. Any part with a downward-facing surface will require supports. This includes flat surfaces, some angled surfaces, and holes over 9mm (0.35 in.) in diameter.

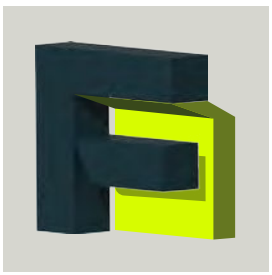
Why Use Supports?

Supports anchor the object to the build plate and aid in dispersing excess heat from the laser. The supports will allow any excess energy a place to disperse with out causing burn, or disfiguration to the part. The supports will keep the part from moving during the building process. A part that moves during the build process will be compromised and often leads to build failure.

Fill

Lattice

Gusset



Offset

Supports also help reduce part failure. The supports will reinforce the object during the building process and reduce the risk of warping as each new layer is added.

Supports keep everything in place. The supports will hold up any overhang during the build process. Supports are needed for some angled surfaces, all downward facing flat surfaces, large holes, and arches.

A Note On Angles

Supports may not be need if a downward-facing surface has an angle of 45° or more. Any angle below 45° will require supports. Surfaces with an angle between 45° and 60° may show some signs of burn if no supports are used.

What is **Burn**?

Burn refers to the texture of an unsupported downward-facing surface. DMLS uses a powerful laser to fuse metal powder. This laser is so powerful that it will “burn” the metal. As each layer is added, the new layer is fused to the layer below it. If there is nothing below the layer being fused, the laser’s heat will distort the bottom layer of the unsupported surface. This distortion will continue until enough material has been built up to absorb the laser’s energy. One way to avoid burn is to replace downward-facing surfaces; both flat and arched, with an angle where possible. Supports can also be used to reduce burn. Supports and any burn are then removed in post processing.

Avoiding Burn

Unsure how to avoid burn? Contact a Fathom Expert if you have questions about designing parts with angles.

What are **Self-Supporting Designs**?

Designing for additive manufacturing (DfAM) can present unique opportunities and challenges. Unlike conventional machining where material is removed from a solid block, DMLS parts are built layer by layer. As the machines builds the part, it is simply told to fuse or not to fuse the metal powder in certain places, layer after layer, one on top of the next.

DfAM can seem a bit counterintuitive for designers until they understand the DMLS building process and its limitations. A good example would be a part with a large hole. The hole is specified for weight reduction or airflow. During the conventional CNC process, the hole would simply be drilled out during the machining. With DMLS, it is easier and faster if supports are added to the design, leaving a vent-like structure where the design calls for a large hole. The supports will increase structural integrity if left in place or can removed in post-processing. Lattice designs are often incorporated into the part design in order to reduce weight, cut production costs, and maintain structural integrity.

Post Processing

After the part has been built using a DMLS machine it will typically be sent to post processing. The most common type of post processing is support removal. Any unwanted supports are removed from the part. This is usually done by hand since each part is unique. CNC secondary machining is available if applicable. Additional design features, such as holes, keyways, and threads, are added in post processing.

Post processing includes media blasting to smooth a surface and remove discoloration or stress relief, age hardening, coatings and passivation, anodizing and polishing.

- Support Removal
- CNC Secondary Machining (Critical Dimension Re-Qualification)
- Tapping, Threading and Helicoils
- Vibratory Polishing and Surface Treatment
- Annealing and Age Hardening
- Painting and Finishing

What Are My Options?

Fathom Experts can help you with any questions you might have about post processing requirements.

Is DMLS a Good Fit for Your Project?

- ✓ Does the part need to be made of metal?
- ✓ Is the part small enough?
- ✓ Is the part too small?
- ✓ Does the part contain complex geometries that cannot be made by conventional machining?
- ✓ DMLS is ideal for metal prototyping.

Is DMLS a good fit for your project? **Speak with a Fathom Engineer now to learn more about the benefits of DMLS.**

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