What is FFF?

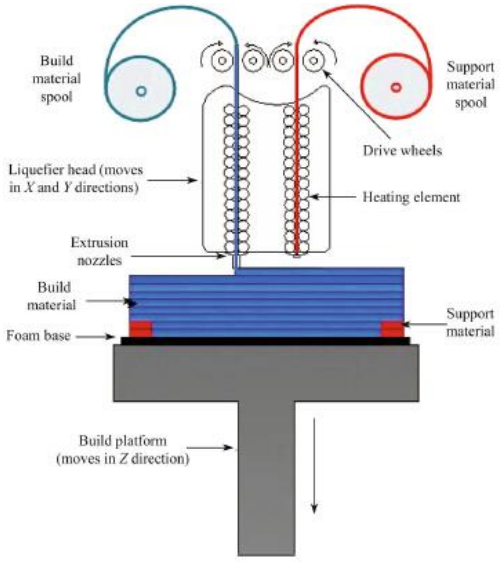
Fused Filament Fabrication (FFF), is an additive manufacturing process that belongs to the material extrusion family. In FFF, an object is built by selectively depositing melted material in a pre-determined path layer-by-layer. The materials used are thermoplastic polymers and come in a filament form. FFF is the most widely used 3D printing technology today. When designing keep in mind the capabilities and limitations of the technology when fabricating a part with the FFF process, as this will help achieve the best possible result.

How does FFF work?

A spool of thermoplastic filament is first loaded into the printer. Once the extrusion nozzle has reached the desired temperature, the filament is fed to the extrusion head and in the extrusion nozzle at a pre determine rate where it melts.

The extrusion head is mounted to a 3-axis Cartesian coordinate system that allows it to move in the X, Y and Z directions. The melted material is extruded in thin strands and is deposited layer-by-layer in predetermined locations, where it then cools and solidifies in place. Cooling of the material can be accelerated through the use of cooling fans attached on the extrusion head.

Multiple passes are required to fill an area. When a layer is finished, the build platform moves down (Z axis) and a new layer is deposited. This process is repeated until the part is complete.



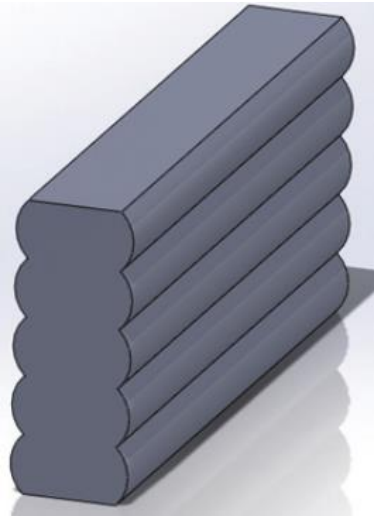
Characteristics of FFF

Build Volume

The build volume of the Pro series II 3D printer is 305 x 305 x 457 mm, the MAX printer is 457 x 457 x 457 mm. The layer height capabilities for the Pro Series II and the MAX printers range between 40 and 360 microns. A smaller layer height produces smoother parts and captures curved geometries more accurately, while a larger height produces parts faster and at lower cost. A layer height of 200 micron is most commonly used.

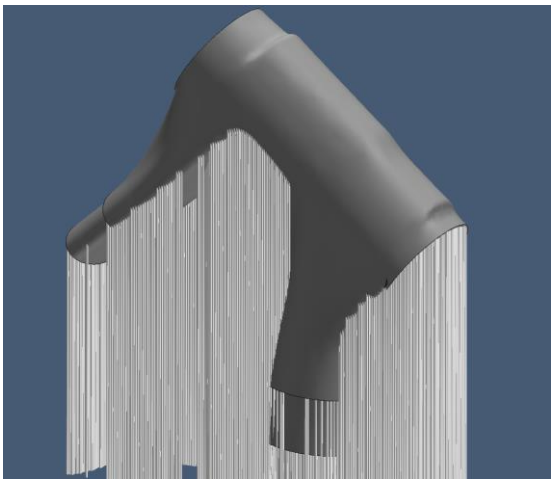
Layer Adhesion

Good adhesion between the deposited layers is very important for an FFF part. When the molten thermoplastic is extruded through the nozzle, it is pressed against the previous layer. The high temperature and the pressure re-melts the surface of the previous layer and enables the bonding of the new layer with the previously printed part. The bond strength between the different layers is always lower than the base strength of the material. This means that FFF parts are inherently anisotropic: their strength in the Z-axis is always smaller than their strength in the XY-plane. For this reason, it is important to keep part orientation mind when designing parts for FFF.
As the molten material is pressed against the previous layer, its shape is deformed to an oval. The FFF parts will have a wavy surface, a low layer height will produce a smoother surface. Small features, holes or threads may need post processed after printing.



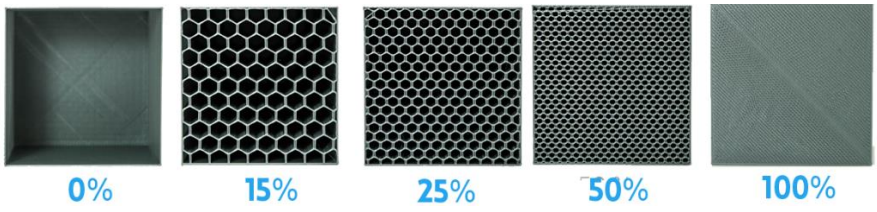
Support Structure

Support structure is essential for creating geometries with overhangs in FFF. The melted thermoplastic cannot be deposited on thin air. For this reason, complex geometries require support structure. Surfaces printed on support will generally be of a slightly lower surface quality than the rest of the part. For this reason, it is recommended that the part is designed in such a way to minimize the need of supports. Support can be printed with the same material as the part or in a dissolvable support material utilizing the secondary extruder on the Pro Series II and the MAX printers. Printing on dissolvable supports improves significantly the surface quality of the part. There are different types of support materials on the market. The support material must be compatible with the primary thermoplastic material being printed. The support team at 3d Printerworks can assist with compatible materials and printer settings.



Infill & Shell Thickness

FFF parts are usually not printed solid to reduce print time and save material. Instead, the outer perimeter “the shell” is traced using several passes, and the interior is filled with an internal structure “the infill”. Infill and shell thickness affect greatly the strength of a part. For FFF printing the default setting is 25% infill density and 1 mm shell thickness, which is a good compromise between strength and speed for quick prints.



Post Processing

FFF parts can be finished to a very high standard using various post processing methods, such as sanding and polishing, priming and painting, cold welding, vapor smoothing, epoxy coating and metal plating.

Benefits of FFF

The key advantages of FFF:

- FFF is the most cost-effective way of producing custom thermoplastic parts and prototypes.
- The lead times of FFF are short (as fast as next-day-delivery), due to the high availability of the technology.
- A wide range of thermoplastic materials is available, suitable for prototyping, tooling, fixtures, end use products and small to medium production runs.

To learn more about 3D printing and the capabilities of the CreatorBot and Pro Series printers Contact us at:

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