



Additive Manufacturing Overview

METAL SOLID & POROUS 3D PRINTING OVERVIEW

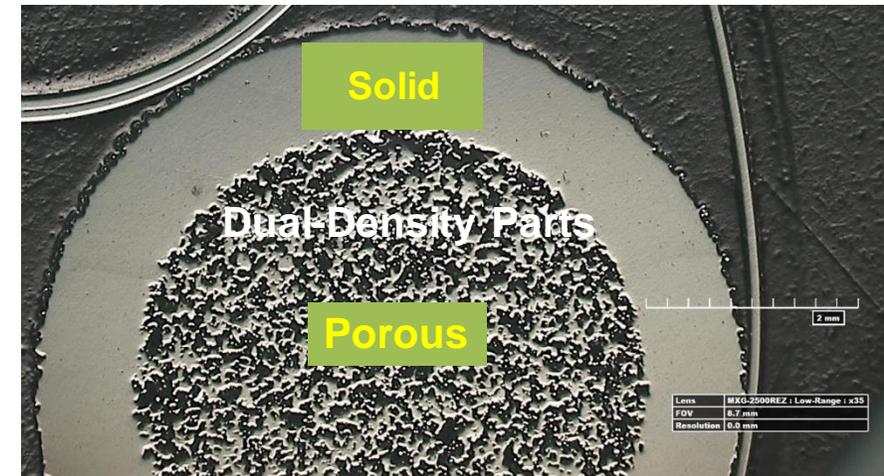
Lack of density gradients in 3DP parts can provide more uniform flow throughout the surface of a part

Consistent pore size distribution with 3DP parts

Ability to **print geometries that are not practical with conventional** pressing or have prohibitively expensive tooling

Print solid and porous media in one part (avoiding secondary operations such as welding, sinter-bonding, press- fitting)

Print multiple porosities in one part (i.e. 60micron pre-filter + 2micron diffuser)



Avoids secondary operations such as assembly, welding, press-fitting and sinter-bonding

BUILD FEATURES & TOLERANCES - METAL

Build volume: 9.7" x 9.7" x 11.0" (L x W x H)

Build materials: 316L Stainless Steel, Titanium, other alloys
consult engineering

Solid feature size resolution: +/- 0.01"

Porous feature size resolution: +/- 0.02"

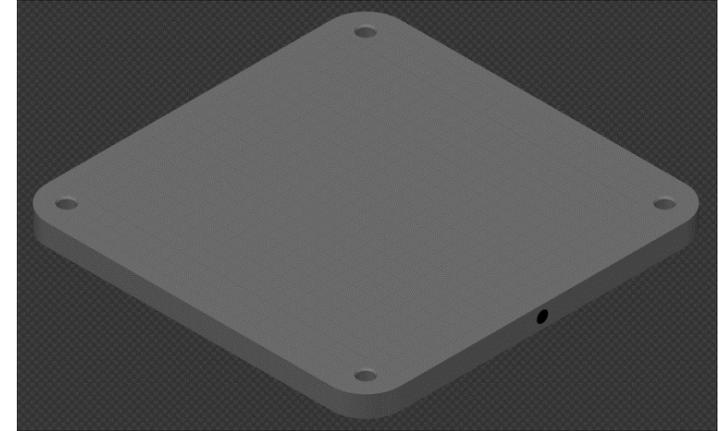
Porosity range: 1 to 100+ micron pore size (for custom porosity consult engineering)

Part-part dimensional consistency: +/- 0.001-0.002"

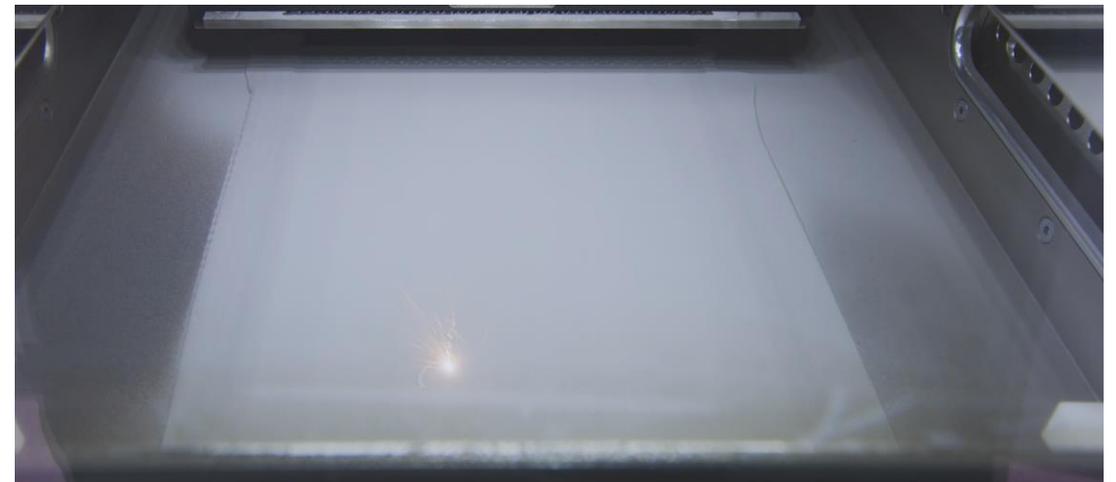
Density consistency: +/- 0.07-0.1 g/cc

Solid printed surface finish: 350 Ra μ in

Machined surface finish: 5 to 32 Ra μ in
(same as typical hardware)



Build plate



Laser Powder Bed Fusion

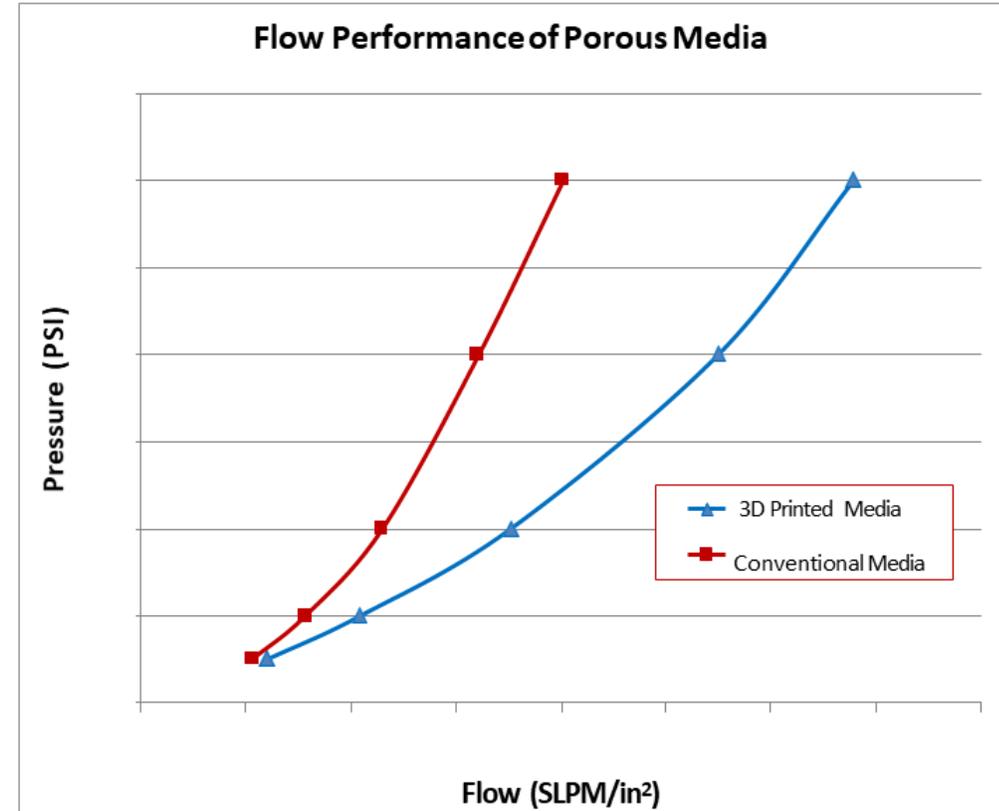
FLOW-DP PERFORMANCE

When density gradients mess up your product specs, think 3DP!



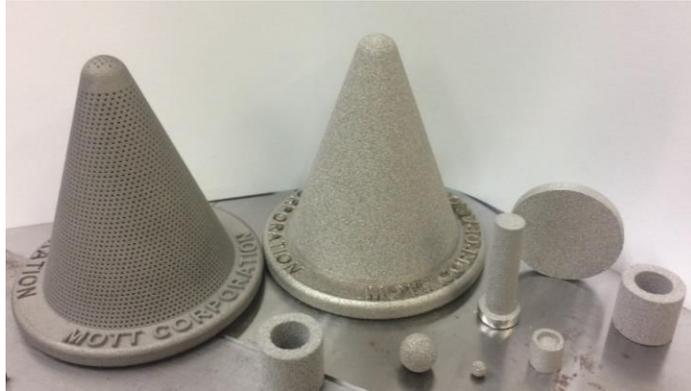
Conventional

Solid-Porous
3DP



Higher flow for 3DP media is likely the result of the lack of density gradients

EXAMPLE UNIQUE DESIGNS MADE CAPABLE BY ADDITIVE



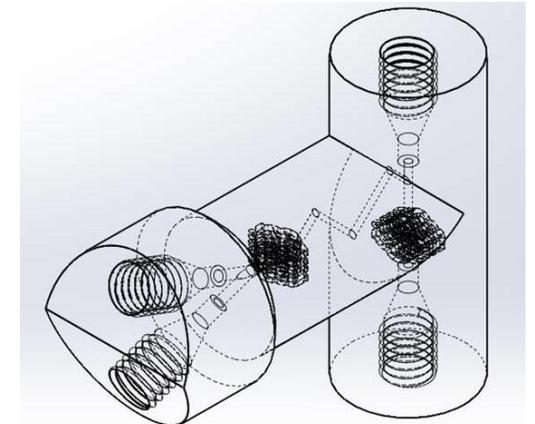
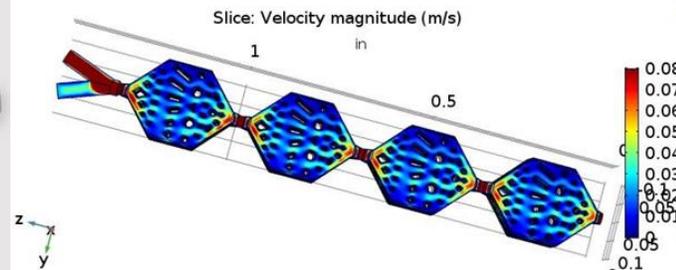
Example integrated filter hardware & complex porous shapes (ie spheres)



Complex solid-porous filtration structures



Example multi-dense porous used for thermal management application



Complete fully 3D printed products with unique internal fluidics for new applications (ie Integrated Valves, Mixing and Flow Reaction)

BUILD FEATURES & TOLERANCES - POLYMER

Build volume:

- Prototypes: 15.7" W x 11.8" D x 11.8" H (400mm x 300mm x 300mm)
- Production: 18.0" W x 18.0" D x 32.0" H (457mm x 457mm x 813mm)

Build materials: PEEK, PEKK, PEI, Nylon, ABS, Polyethylene, and more

Porosity range: 100 microns and larger; for custom porosity integration, consult engineering

Pore shape:

- Lattice: Rectangular, Hexagonal, Triangular
- Random: Under Development

Solid feature size resolution and dimensional consistency*

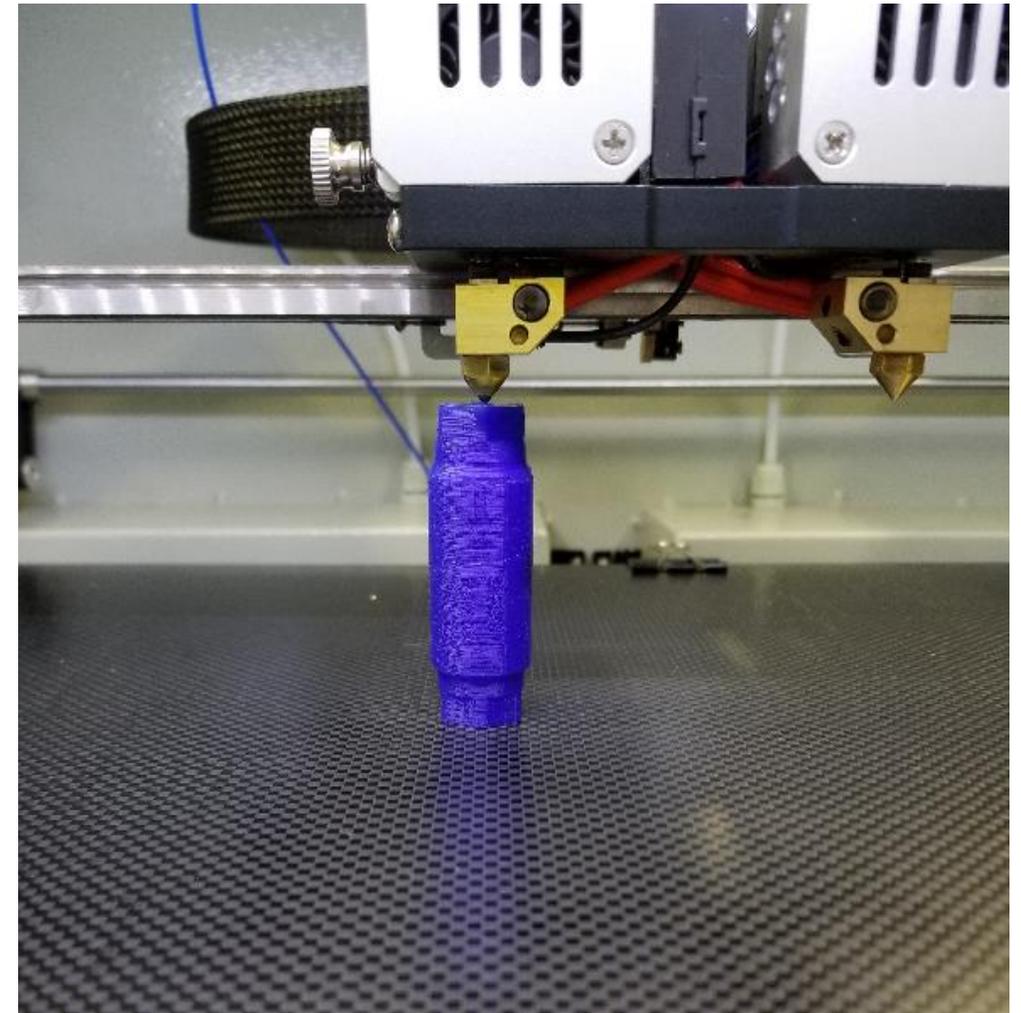
- As Printed: +/- 0.010"
- Machined: +/- 0.002"

Part density: Up to 100% depending on polymer

Surface finish

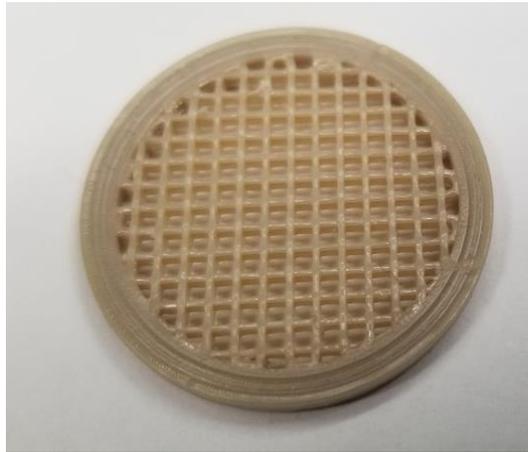
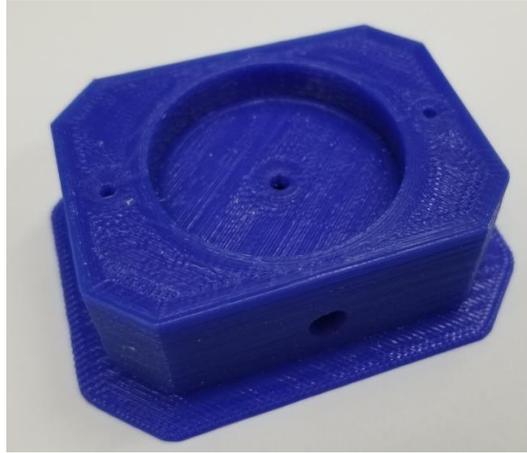
- As printed: 200 to 600 Ra μ in
- Machined: 5 to 32 Ra μ in

** Dimensions and tolerances are subject to the polymer chosen and overall part dimensions. Values presented are typical for small parts, < 1" (25mm) cross section printed in PEEK with a medium resolution extrusion nozzle.*



Fused Deposition Modeling (FDM)

EARLY STAGE DEVELOPMENTS: POLYMERS AND CERAMICS



PEEK Static Mixer, Tooling, Filter



Alumina Flow Control Components

ABOUT US

WHO WE ARE: THE GOLD STANDARD FOR HIGH PERFORMANCE FILTRATION AND FLOW CONTROL APPLICATIONS

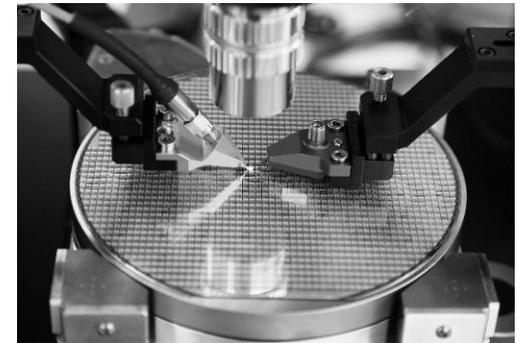
60 year track record of making products used by the most demanding customers such as NASA, Samsung, and Medtronic

Largest installed base of porous metal filters/fluid controls in the world across every major industry ranging from the Mars rover to implantable medical devices

Most extensive metal alloy selection for the toughest operating conditions such as temps from -437°F to 3336°F

Customer Innovation Center (CIC) becoming a hub for industry leader collaboration, with the latest lab equipment and new technologies like additive porous manufacturing and materials development.

Manufacturing and CIC based in Farmington, CT.



CAPABILITY SPANS BREADTH OF APPLICATIONS

**Large Scale
Process Systems**



**Point of Use
Equipment**



**Integrated
Components**



WIDE RANGE OF APPLICATION EXPERTISE

**GAS & LIQUID
FILTRATION**

**FLOW
CONTROL**

MIXING

DIFFUSION

**HEAT
EXCHANGE**

**WICKING &
PHASE
SEPARATION**

FLUIDIZING

**FLAME
ARRESTING**

SPARGING

STRUCTURAL

**CONTROLLED
RELEASE**

**SOUND
DAMPENING**

COLLABORATION MODEL

