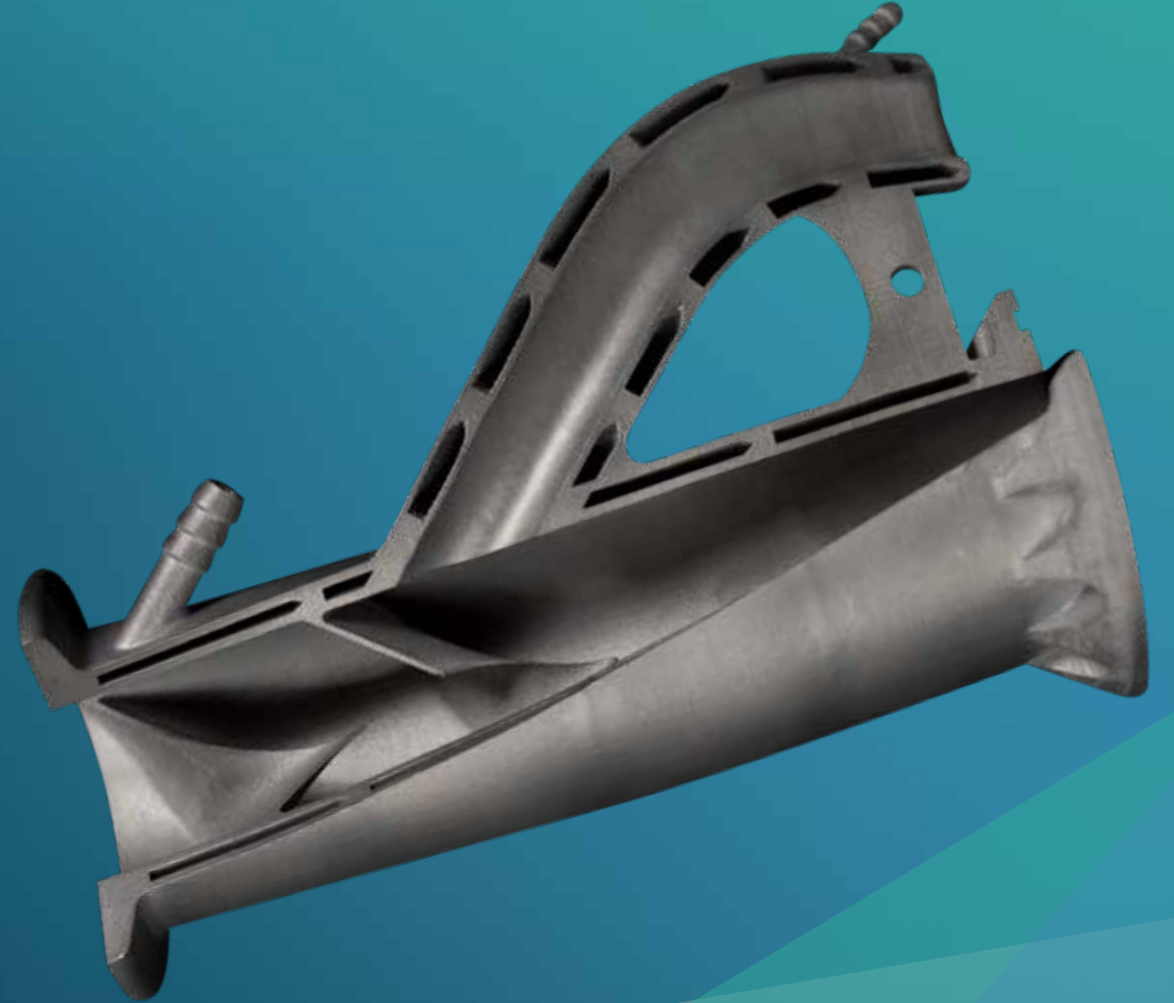


Design Guide

Strategies for Reducing Supports in Metal Additive Manufacturing



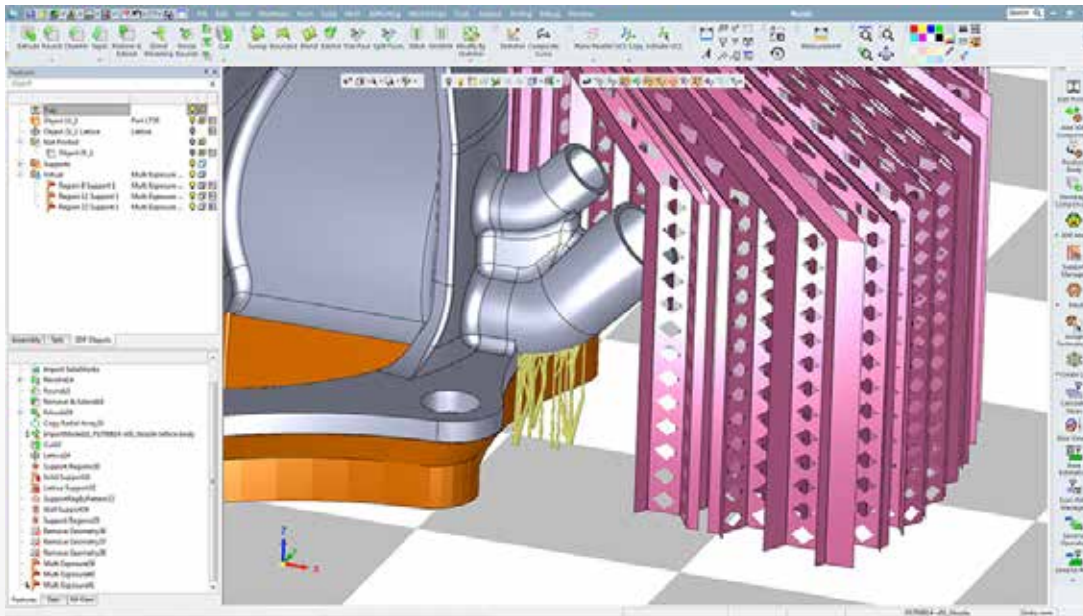
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Support structures

When printing with metal, proper support is needed for heat transfer, to prevent warping, minimize cross formation and reduce shrink lines.



There are a multitude of possible support structures.

Here are some examples:



Wall
Support



Solid
Support



Lattice
Support



Solid
Wall



Cone
Support



Manual
Cone



Skirt
Support



Multi
Exposure

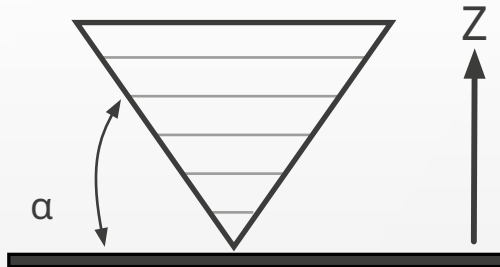
What can be built without support?

Steel, stainless steel, Inconel

- Large* downfacing areas $\alpha > 60^\circ$
- Medium* downfacing areas $\alpha > 50-55^\circ$
- Small* downfacing areas $\alpha > 45^\circ$

Titanium, aluminum

- Large* downfacing areas $\alpha > 50^\circ$
- Medium* downfacing areas $\alpha > 40-45^\circ$
- Small* downfacing areas $\alpha > 35^\circ$

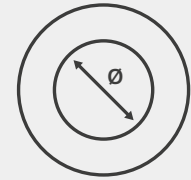


*These values are experience-based for DMP Flex 350 printers and are subject to change based on printer model, specific geometries, and improved build styles.

*The size of these areas is dependent on part geometry.

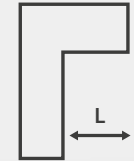
Horizontal circular holes

- Supportless $\varnothing\text{mm} < 10\text{mm}$
- Support needed $\varnothing\text{mm} > 10\text{mm}$



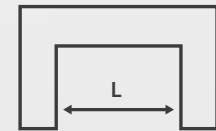
Horizontal bridges

- Supportless $L < 1.2\text{mm}$
- Support needed $L > 1.5\text{mm}$

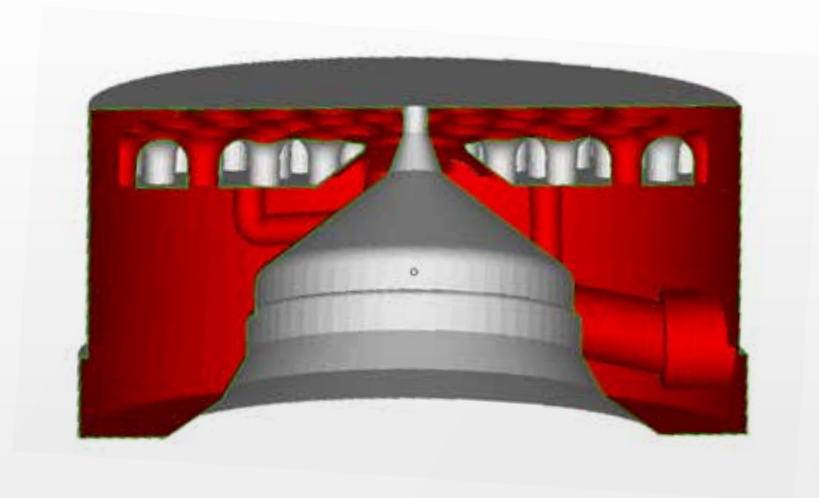
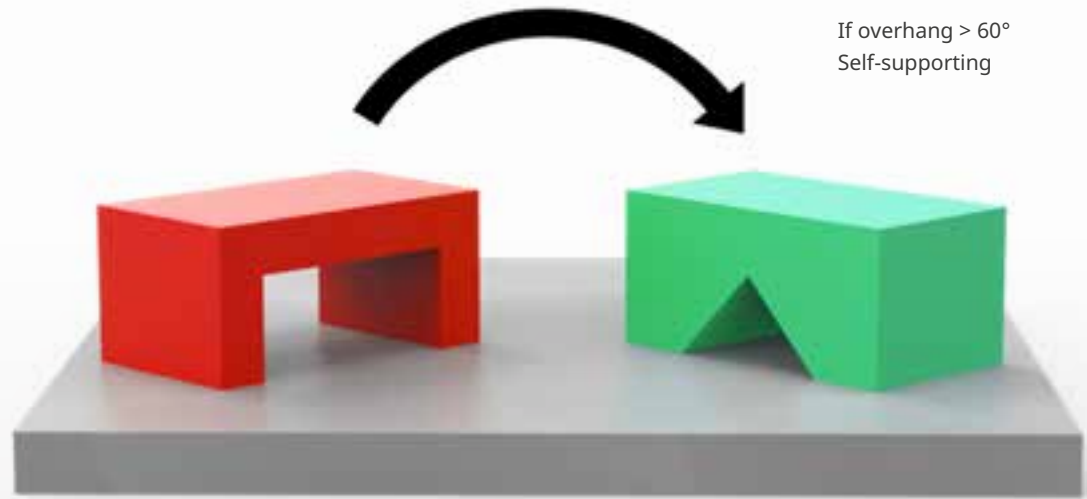


Horizontal bridges

- Supportless $L < 2\text{mm}$
- Support needed $L > 2\text{mm}$



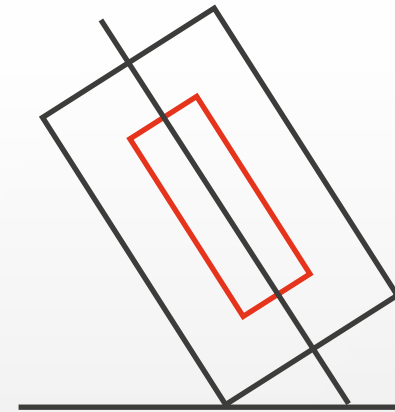
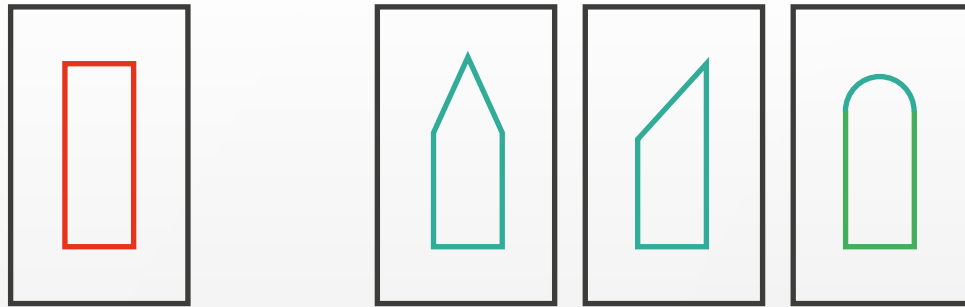
Avoid downfacing surfaces and create self-supporting geometries



Channel design

Large (internal) overhangs are not feasible to print

- Change design of internal channels (closing at $> 45^\circ$)
- Angle part at a self-supporting angle (45°)
- Extra support structure possibly needed on the outside of the part



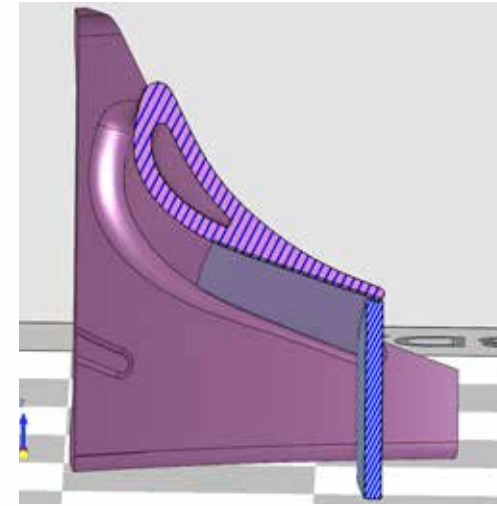
NoSupports™ with 3DXpert®

Strategies powered by 3DXpert® software enable metal 3D printing without supports

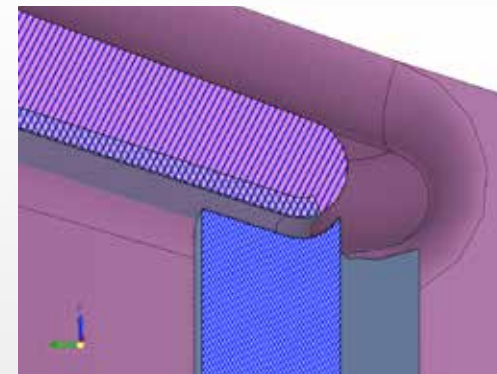
Together with 3D Systems' leading expertise and machine platforms, the 3DXpert software package has advanced metal AM capabilities to help expand your design envelope with features such as multi-exposure and thermal blades to help you realize the goal of no supports.

3DXpert is an all-in-one integrated software for the entire AM workflow. It provides the ultimate combination of automation and full user control.

- Parametric and history-based hybrid (b-rep and mesh) CAD tools
- History-based approach facilitates changes at any stage
- Built-in simulation speeds up design verification
- Optimize print strategies to ensure quality at reduced printing time



Thermal blade
Contactless support



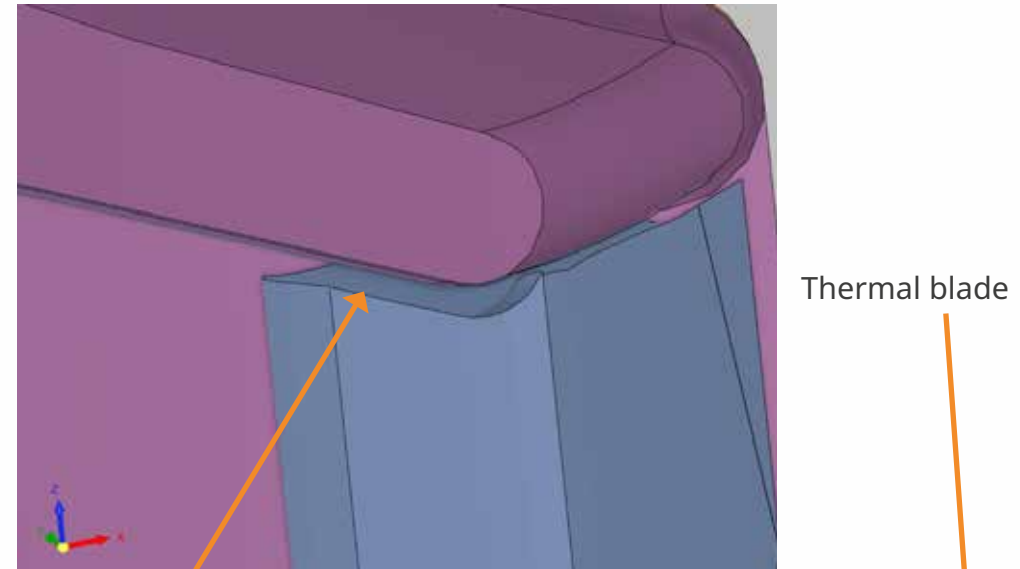
Multi-exposure
Downfacing multi-hatching parameters

Thermal blades

Contactless support

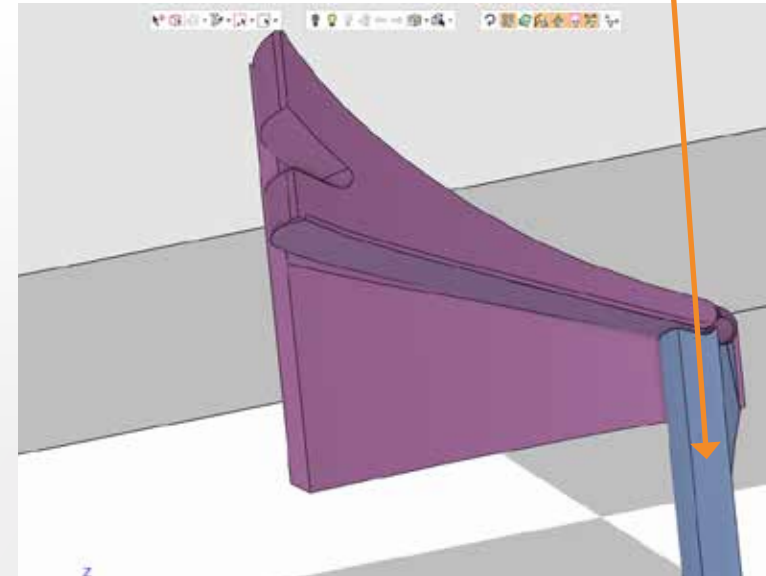
Thermal blades provide a structure to transfer heat and control the weld process for the lowest-angle features without welding to the part.

- Uses 3DXpert “Solid Support” functionality
- Supports low-angle downfacing surfaces and provides thermal management to leading edges
- Thermal blade functions as a heat sink with dissipation of heat through layer of powder to thermal blade
- Optimized gap enables easy removal with no physical supports contacting the part
- No contact remnants to remove



Powder gap

Thermal blade



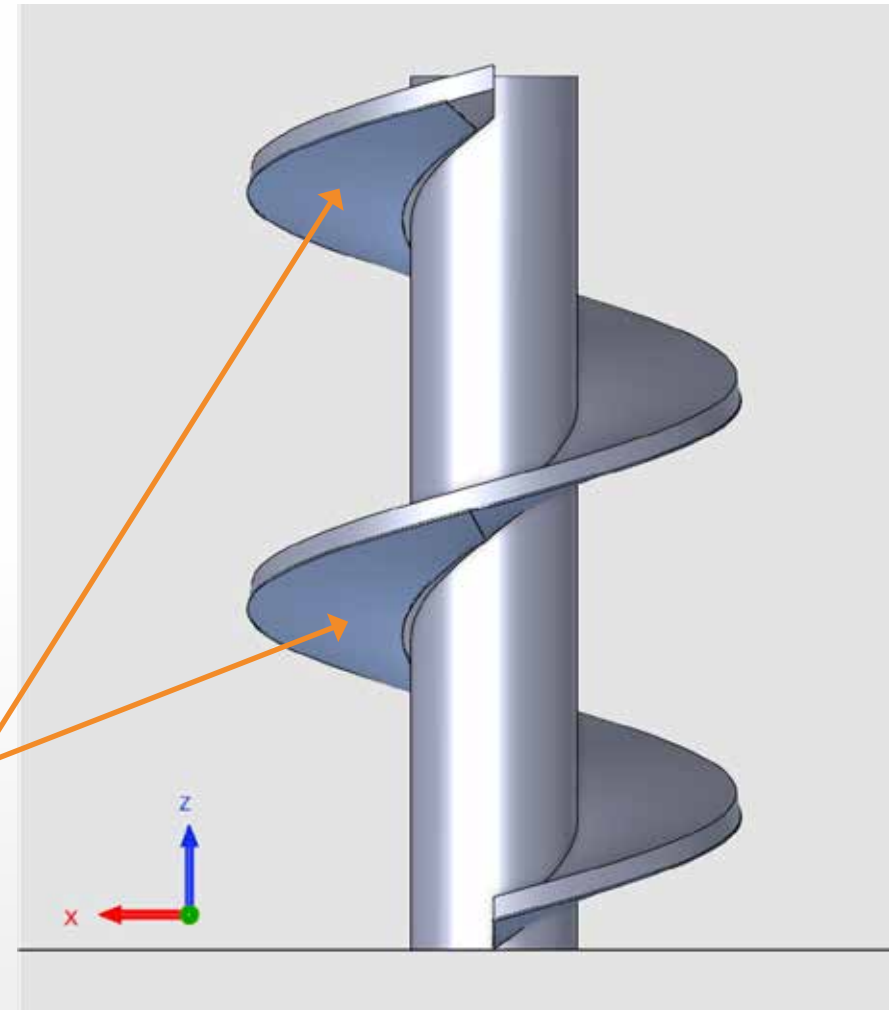
Multi-exposure

Downfacing multi-hatching parameters

Multi-exposure can drastically reduce the self-supporting angle while maintaining a high-quality surface finish.

- Strategy to consistently build regions with low overhangs that cannot be designed out or de-supported
- Downfacing improvements
- Multi-exposure parameters can be applied to specific regions

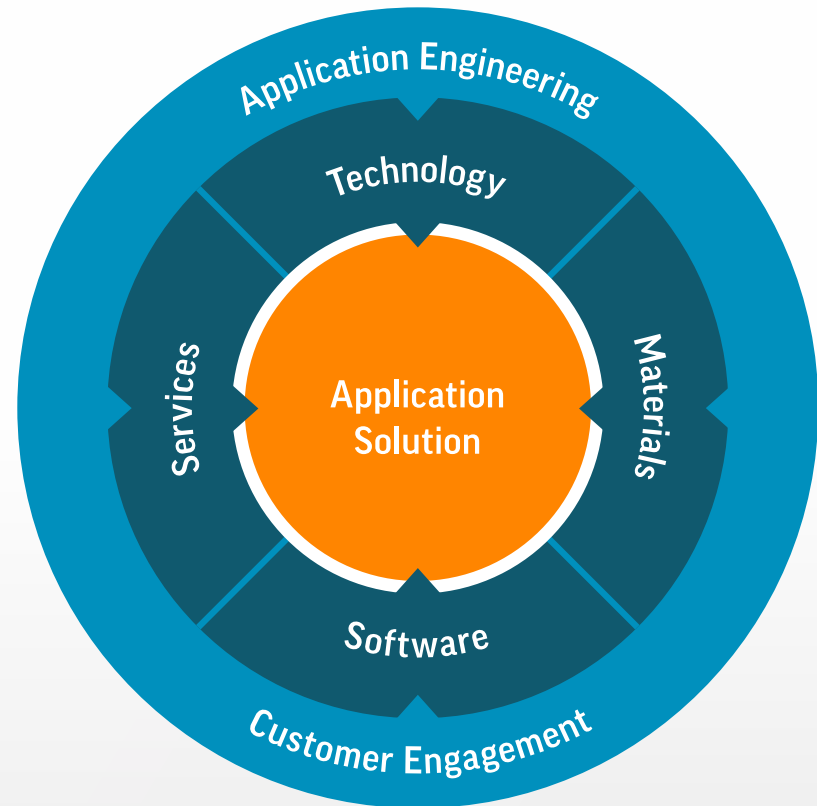
Multi-exposure
print areas



Applying NoSupports to advanced applications

3D Systems' Application Innovation Group is engaged in ongoing parameter development for the entire 3D Systems DMP material catalog and routinely works with customers to develop highly optimized parts that cannot rely on traditional DMP support strategies.

For help solving your application challenges, reach out to the [Application Innovation Group](#) at 3D Systems.



DMP printers



DMP FACTORY 500 Scalable metal additive manufacturing for seamless large parts

- Build volume 500mm x 500mm x 500mm
- Integrated powder management
- Consistent, low O2 environment
- Intelligent, seamless part production
- Scalable production manufacturing
- Multiple materials

Accessories

- Depowdering module (DPM)
- Powder recycling module (PRM)
- Parking module (PAM)
- Transporter module (TRM)
- Removable print module (RPM)



DMP FLEX 350 AND DMP FLEX 350 DUAL Robust, flexible metal 3D printer for 24/7 part production

- Build volume 275mm x 275mm x 420mm
- Fast, easy material change
- Consistent, low O2 environment
- High throughput, high repeatability
- Multiple materials

Accessories

- Removable print module (RPM)
- RPM transport cart



DMP FACTORY 350 AND DMP FACTORY 350 DUAL Scalable, high quality metal additive manufacturing with integrated powder management

- Build volume 275mm x 275mm x 420mm
- Integrated powder management
- Consistent, low O2 environment
- High throughput, high repeatability
- Dedicated material

Accessories

- Volume reduction kit

DMP Printers



DMP FLEX 100

Affordable, precise metal 3D printer for finest features and thinnest walls

- Build volume 100mm x 100mm x 90mm
- Fine features, thin walls
- Best-in-class surface finish
- Unique roller/recoater system
- Perfectly layers almost any powder
- Dedicated material



DMP FLEX 200

Professional and precise metal 3D printer with 500W laser source

- Build volume 140mm x 140mm x 115mm
- Easy loading and cleaning
- High performance at lower cost
- Fine features, thin walls
- Best-in-class surface finish
- Unique roller/recoater system
- Perfectly layers almost any powder
- Dedicated material

Accessories

- Volume reduction kit

Titanium



LaserForm Ti Gr5 (A)
High strength, low weight,
excellent biocompatibility



LaserForm Ti Gr23 (A)
High strength, low weight,
excellent biocompatibility,
lower oxygen than Gr5



LaserForm Ti Gr1 (A)
High strength, biocompatible,
extreme temperature and
corrosion resistance

Stainless steel



LaserForm 316L (A)
Able to be sterilized and
highly corrosion resistant



LaserForm 316L (B)
Able to be sterilized and
highly corrosion resistant



LaserForm 17-4PH (A)
Excellent corrosion resistance,
high strength with good toughness



LaserForm 17-4PH (B)
Excellent corrosion resistance,
high strength with good toughness

Maraging steel



Certified M789 (A)

Cobalt free, high strength tool steel with excellent corrosion resistance



LaserForm Maraging Steel (A)

Excellent hardness and strength, good wear resistance



LaserForm Maraging Steel (B)

Genuine tool steel (1.2709), high strength and hardness

Cobalt-chrome



LaserForm CoCrF75 (A)

Highly corrosion, wear and heat resistant; biocompatible



LaserForm CoCr (B) or (C)

Highly corrosion resistant, suitable for biomedical applications

Aluminum alloy



Certified Scalmalloy (A)
High strength aluminum with excellent corrosion resistance



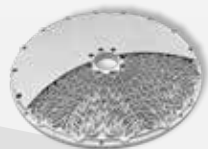
LaserForm AlSi7Mg0.6 (A)
Lightweight, good mechanical properties, and improved thermal conductivity



LaserForm AlSi10Mg (A)
Good mechanical properties and good thermal conductivity



LaserForm AlSi12 (B)
Metal powder for lightweight parts with good thermal properties



A6061-RAM2 (A)
Improved strength, ductility, and surface finish versus AlSi10Mg

Nickel super alloy



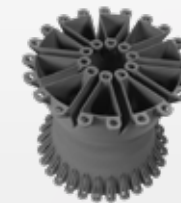
LaserForm Ni625 (A)
Excellent corrosion resistance, high strength and heat resistance



LaserForm Ni625 (B)
Excellent corrosion resistance, high strength and heat resistance



LaserForm Ni718 (A)
Oxidation-, corrosion- and extremely high-temperature resistance



Certified HX
High-performance nickel alloy for enhanced strength, resistance to corrosion

Copper alloy



Certified Copper Nickel CuNi30
Excellent stable material properties
and corrosion resistance in salt water



Certified Copper CuCr2.4
High-performance copper alloy with
conductivity in structural parts

Refractory metals



Tungsten (A)
High-density refractory pure metal with
excellent radiation shielding capabilities
and outstanding corrosion resistance

We're here to help

For more than three decades, 3D Systems has demonstrated our industry leadership and expertise to help manufacturers across a variety of industries redefine their workflows to realize the benefits of additive manufacturing.

We are committed to accelerating the development of advanced applications. From installation to hands-on training and consulting support, 3D Systems' experts enable you to quickly and effectively ramp from prototyping to volume production. 3D Systems' Application Innovation Group is a dedicated group of engineers, technicians and designers who can help you solve your most difficult design and production challenges. Whether that means identifying skill gaps, improving part performance, or scaling your manufacturing flow, we are available at every stage to apply our professional expertise to your unique goals.



Explore

Strategic consulting to identify customer needs



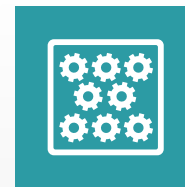
Innovate

Joint applications development and design for additive (DfAM) for specific needs



Develop

QA and process characterization from pre-prototype through prototype



Validate

Training, validation and certification



Develop

Production and manufacturing services



Scale

Scale up and technology transfer

What's next?

Our experts are here to support you.
Get in touch today – we will be right with you.

[Talk to an Expert](#)