

Additive Manufacturing for Aerospace & Defense

Accelerate and de-risk your additive manufacturing
application development



3D Systems launched the 3D printing industry in 1986 and has continuously led additive manufacturing innovation ever since.

Our broad portfolio of hardware, software, materials, and service solutions spans from plastics to metals, and is backed by industry-specific engineering expertise in our Application Innovation Group (AIG). We take a consultative, application-focused approach to solving your most difficult design and production challenges.

The combination of our solutions, expertise, and innovation helps our customers eliminate conventional manufacturing limitations and maximize the value of additive manufacturing to their organizations.

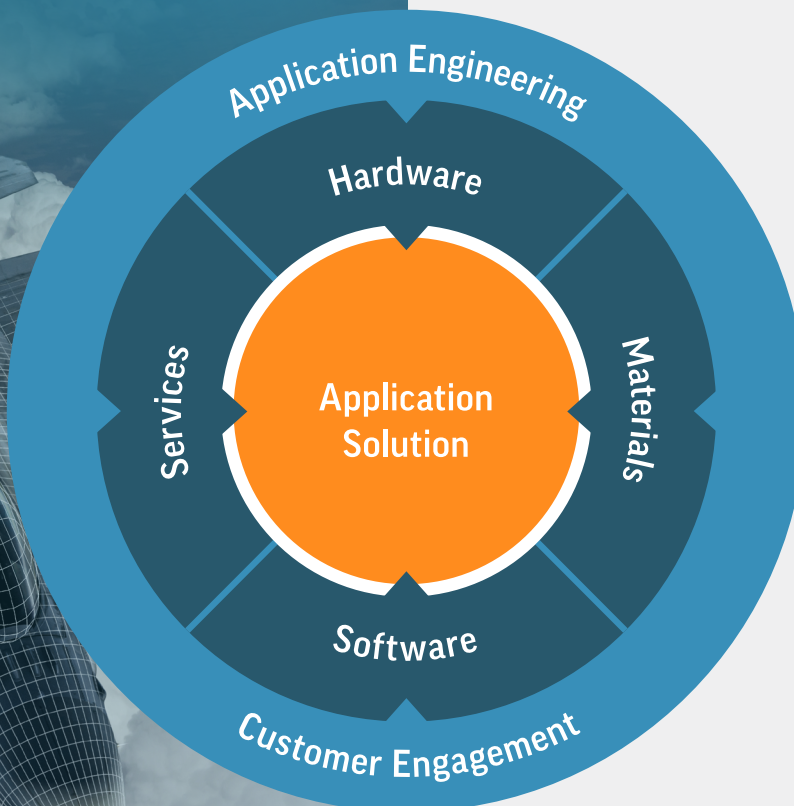
Providing Repeatable, Reliable, and Scalable Additive Manufacturing Solutions

Adoption of metal additive manufacturing in aerospace and defense is only possible when processes meet the same requirements that conventional manufacturing does today.

Our global AIG reduces risk and creates a faster ROI for our customers by developing qualified, transferrable, and scalable production processes. This is a key differentiator when developing new production additive manufacturing (AM) applications.

[Learn More about A&D Metal Materials](#)

[Learn More about AM Plastic Materials](#)



Advance Your AM Applications With Confidence



Function-Led Design

With AM, application requirements lead, and the manufacturing process is built to follow. This broader design space can enable better optimized fluid flow and heat transfer. AM can also provide stronger and lighter structures, assembly consolidation, and even utilize new and novel materials among other benefits.



Speed to Market and Supply Chain Integration

AM enables drastic reductions in lead time from the first prototype, to test samples, and full production in a more flexible, localized, and compressed supply chain.



Additive Manufacturing Expertise and Capability

Establish AM capabilities within your organization and suppliers by partnering with our Application Innovation Group to rapidly progress from concept to successful production.



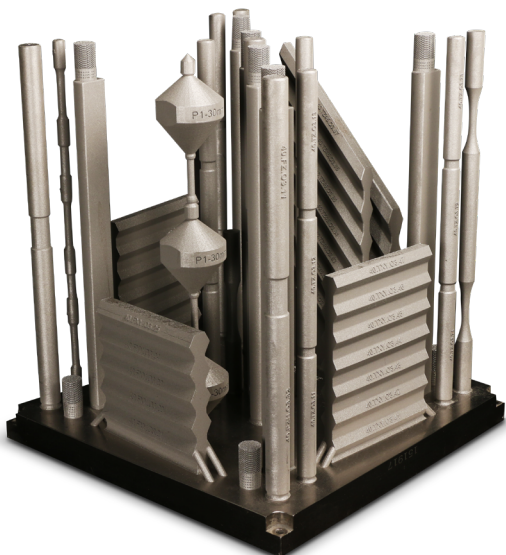
Repeatability and Reliable Production

Our production-grade additive solutions ensure consistent, high material quality and part accuracy along with tight control of mechanical properties from build to build and across machines and locations.



Scalability and Risk Reduction

Our AS/EN9100 and ITAR registered pilot manufacturing facilities offer increased capacity, flexibility, and risk reduction to move development programs efficiently forward. Pilot production is followed by technology transfer and qualification of your internal facilities or suppliers with replicated and scaled manufacturing processes.



Build plate for mechanical property testing.

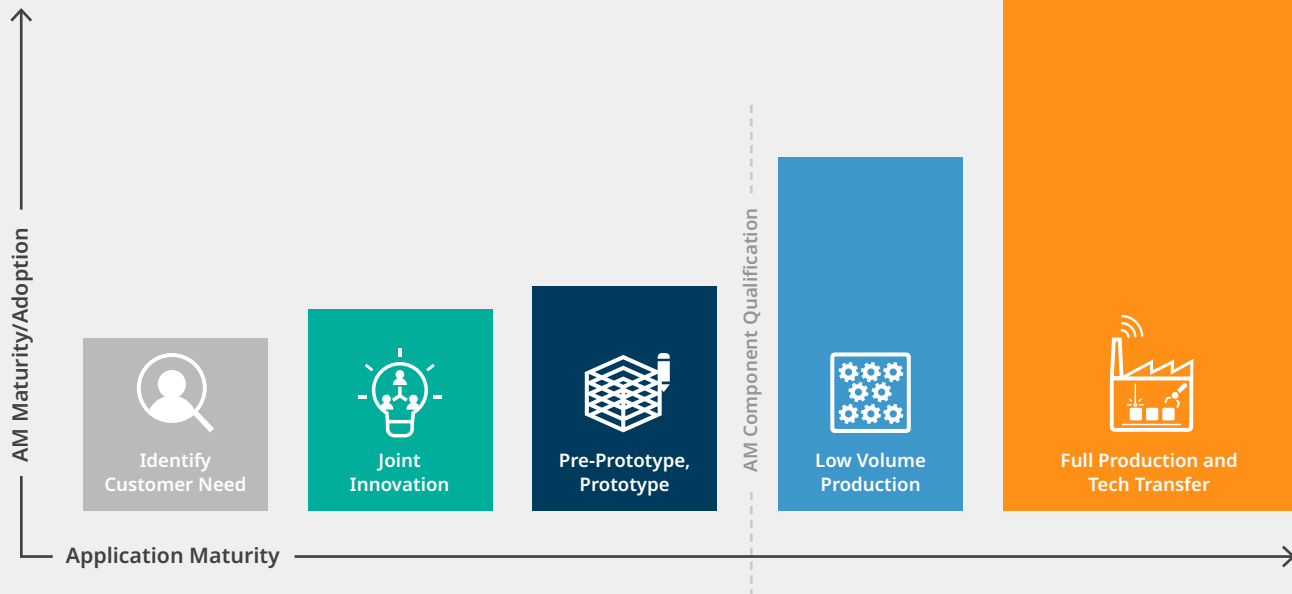
Figure 4® High Temp 150C FR Black –
Production grade flame-retardant photopolymer



The AM Customer Journey

3D Systems' Application Innovation Group impact

The AIG exists to accelerate and de-risk your AM application development. We help each customer chart their own course forward.



Application-Tailored Solutions to Accelerate Your Path to Successful AM Production

Exemplary AIG service models

1	Applications Screening	1 day	7	Validation and Qualification	5-18 months typ.
2	Design for Metal Additive Manufacturing Training	1 day	8	Pilot Production	Customer + Application driven
3	Custom Process-Material Development	1-6 months typ.	9	Technology Transfer	Customer + Application driven
4	Application Development - Quality by Design	6-18 months typ.			
5	Application Support	1-day modules			
6	Gap Assessment for Validated Direct Metal Printing (DMP) Production	1 day on site + final report 1-2 weeks			

AM Component Qualification

Application Innovation Group (AIG) Professional Services Module Scope

Each solution is tailored to customer and application requirements.

1 Applications Screening 1 day <ul style="list-style-type: none"> A complete analysis and scorecard for up to 5 prioritized applications 	
2 Design for Metal Additive Manufacturing Training 1 day <ul style="list-style-type: none"> Introduction to design for additive manufacturing (DfAM) DMP basics, design, and preparation guidelines Methodology to approach product design Co-engineering workshop on customer applications 	
3 Custom Process-Material Development 1-6 months typ. <ul style="list-style-type: none"> Assessment of alloy feasibility, printability Process-specific parameter optimization Design/execution of custom material development program Creation of custom material/parameter database Process qualification with custom database 	7 Validation and Qualification 5-18 months typ. <ul style="list-style-type: none"> Risk assessment and process characterization Implementation of quality and process control ecosystem Writing of procedures related to peripheral processes such as powder management, maintenance, and test method validations Writing of procedures and protocols related to equipment, process, and software validation Execution of corresponding validation activities Data analysis and reporting of validation activities <p>Participation of a 3D Systems validation engineer in the first regulatory body audit covering the DMP validation</p>
4 Application Development - Quality by Design 6-18 months typ. <ul style="list-style-type: none"> Project initiation/feasibility assessment Process development Validation and verification Design transfer 	8 Pilot Production Customer + Application driven <ul style="list-style-type: none"> Compliant manufacturing process setup in AS9100/ ISO 9001 production environment Streamlining manufacturing process flow through continuous improvement Develop process experience and best practices in full manufacturing workflow Bridging AM production capacity in preparation for technology transfer Manufacturing of finished DMP parts
5 Application Support 1-day modules <ul style="list-style-type: none"> Design optimization Support strategies Manufacturing workflow Troubleshooting Tips and tricks for parameters 	9 Technology Transfer Customer + Application driven <p>Gap Assessment</p> <ul style="list-style-type: none"> Technology and quality gap assessment Customer on-site facility assessment Customer current QMS, existing processes and organization analysis Additive process recommendations Statement of work (SoW) to successfully integrate additive manufacturing to customer production within defined timeline and budget
6 Gap Assessment for Validated Direct Metal Printing (DMP) Production 1 day on site + final report 1-2 weeks <ul style="list-style-type: none"> Introduction to our proven validation strategy Analysis of customer QMS Review of products/processes/process controls Assessment of potential QMS gaps related to adopting AM technology for production Gap assessment report Proposal based on 3D Systems' proven validation strategy 	<p>Milestone Driven Technology Transfer (Exemplary work packages)</p> <ul style="list-style-type: none"> AM equipment installation, performance and operational qualification AM quality process controls Post-processing and controls (heat treatment, plate removal, finishing, etc.) Application/product-specific technology transfer

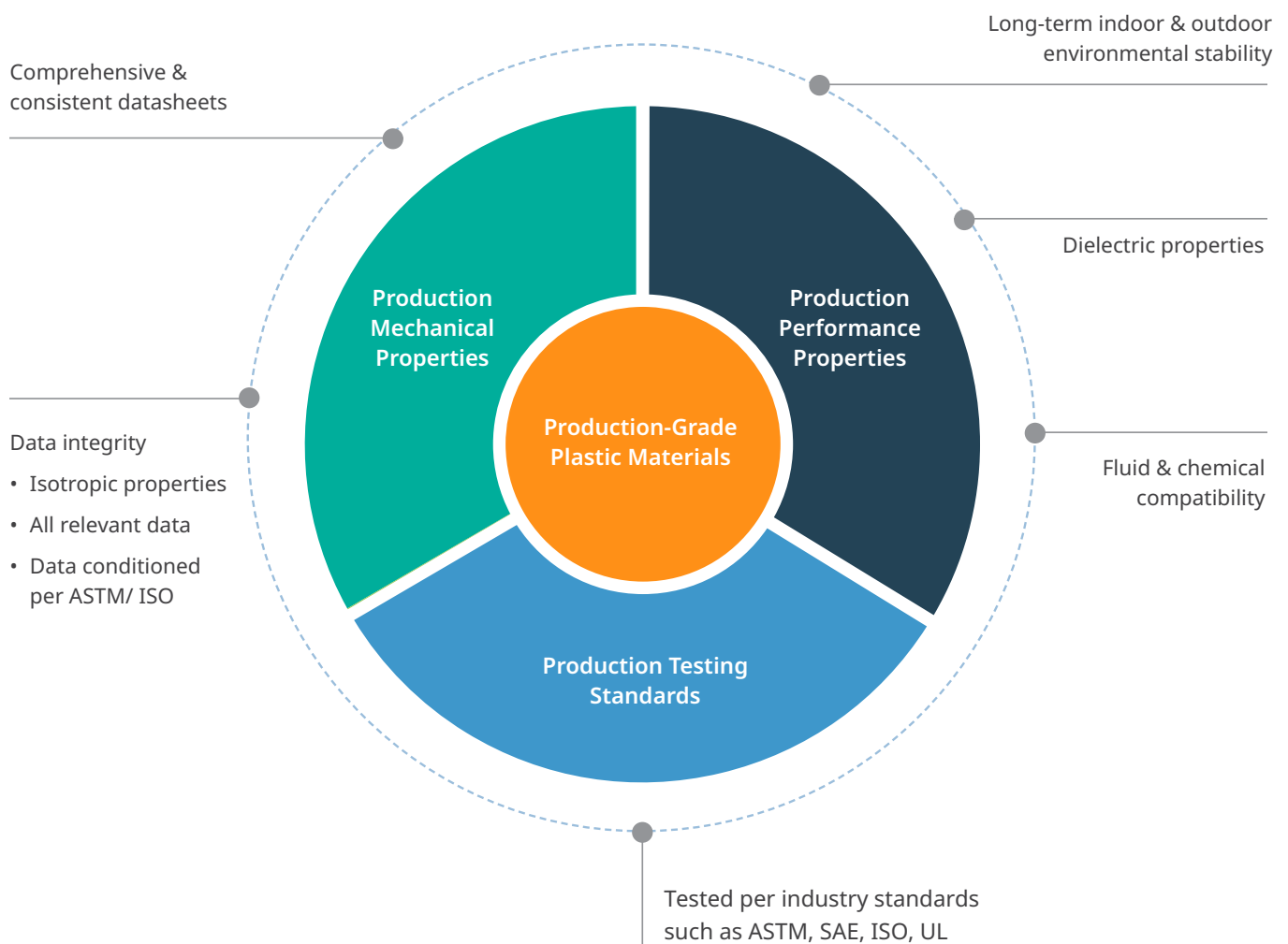
AM Component Qualification

An Engineering Approach to Production-Grade Plastic Materials

3D Systems offers over 100 plastic materials in a variety of production processes and takes a systematic approach to helping design engineers evaluate suitability for their production applications.

AM plastic materials must have the right mechanical and performance properties demonstrated by industry standard testing in order to be adopted into production workflows in aerospace.

Material Selection Guide

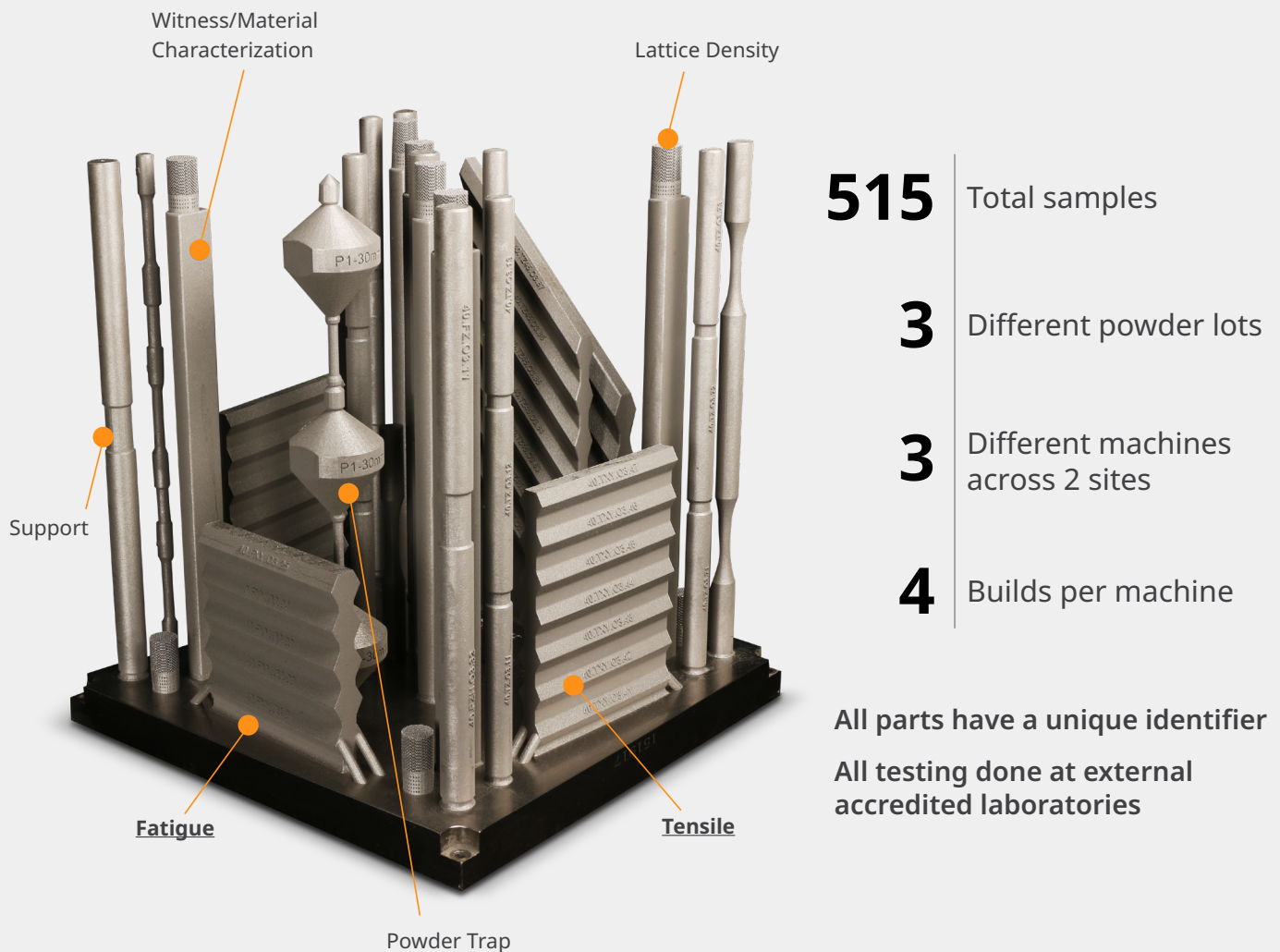


An Engineering Approach to Production-Grade Metals

3D Systems has developed a large dataset of mechanical properties for LaserForm Ti Gr23 (Ti-6Al-4V ELI) printed on the DMP Flex 350. This data was developed at accredited third-party testing facilities and can support application development and certification. The dataset demonstrates the high quality, repeatability and reproducibility of metal produced through the Direct Metal Printing process.

The dataset contains 515 total samples and is suitable for allowables generation. Test data is available for cryogenic to high temperature tension, compression, high and low cycle fatigue, shear, and bearing and is comparable to conventionally produced Ti-6Al-4V.

For detailed questions contact our Application Innovation Group.



Application Solution for Satellites

Technology - Direct Metal Printing



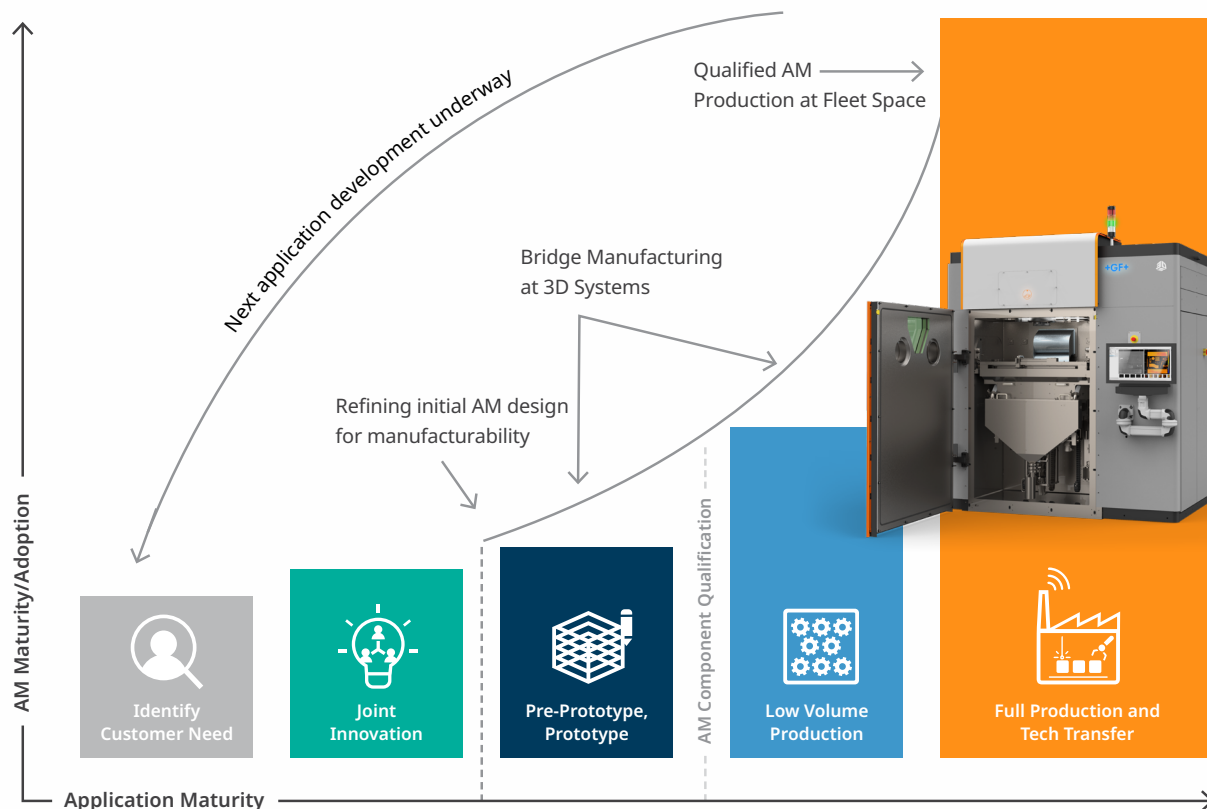
Customer Story - Fleet Space Technologies

Relevant AIG Services:

- 6** Pre-Prototype, Prototype **8** Low Volume Production **9** Technology Transfer

3D Systems' Application Innovation Group assisted with process development, bridge production, and technology transfer of additively manufactured radio frequency (RF) patch antennas for Fleet Space Technologies. The DMP Flex 350 has enabled Fleet to bring antenna production in-house for their 140+ Alpha satellites in the constellation.

- 3 Weeks: AIG Prototype to small batch production
- Vertical thin-wall construction: <1 mm wall thickness
- A6061-RAM2 offers improved as-printed surface finish vs. AlSi10Mg
- 55 units / 58 hrs on single laser DMP Flex 350
- 64 Patches/ Alpha satellite
- 140+ Satellites/ constellation
- Structural application development to follow



Advancing the Science of Passive RF Components

3D Systems has extensive experience building complex passive RF components for leaders in research and industry.

[Learn more on Passive RF Applications](#)

Multi-Switch Waveguides - Airbus Defence and Space

Technology: Direct Metal Printing

Together with Tesat-Spacecom, an Airbus Subsidiary, 3D Systems manufactured 70 units of this multi-switch assembly module for two Eurostar Neo spacecraft. Additive manufacturing of this component improved size, weight, and performance of the system while reducing assembly, test and integration cost and schedule for the program.

- Material: LaserForm AlSi10Mg
- Hardware: DMP Flex 350
- Monolithic structure with reduced assembly interfaces
- Self-supporting structures where possible
- AM part space claim roughly 80 x 180 x 250 mm
- Reduced footprint/ volume required to achieve function
- Printed component weight approx. 1.5 kg

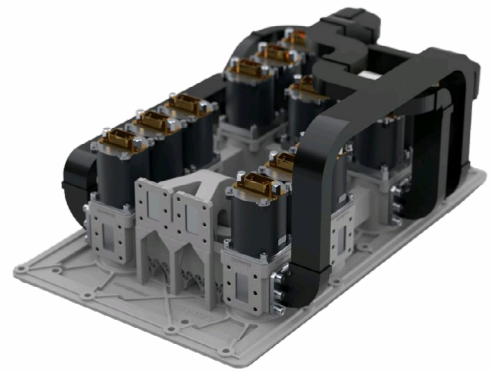


Image: Tesat-Spacecom, as Airbus Subsidiary

Compact C-band Corrugated Horn Antenna - Thales Alenia Space

Technology: Direct Metal Printing

Thales Alenia Space and 3D Systems collaborated to realize this compact and lightweight C-band horn with AM. More information can be found in the reference paper below.

- Material: LaserForm AlSi10Mg
- Hardware: DMP Factory 500

AM value vs. traditional manufacturing:

- 35% reduction in horn length
- Improved return loss over a wide bandwidth
- Smaller computation complexity
- Reduction in manufacturing complexity and risk using DfAM
- Reduced lead time at comparable cost to machining
- Same radiation performance maintained



L. Foucaud et al., "Disruptive C-band Corrugated Horn Antenna in Additive Manufacturing," 2023 17th European Conference on Antennas and Propagation (EuCAP), Florence, Italy, 2023, pp. 1-5, doi: 10.23919/EuCAP57121.2023.1013308

Advanced Propulsion Components

Additive manufacturing is playing a key role in the race to provide lower cost, faster, commercial launch options. 3D Systems is supporting a growing number of highly innovative customers and applications which are helping to make this a reality.

Ursa Major Technologies: Showcase Thrust Chamber

Technology: Direct Metal Printing

Ursa Major focuses solely on rocket propulsion, bringing high-performance, staged combustion engines to market for space launch and hypersonic applications.

- Showcase thrust chamber material: LaserForm Ti Gr23 (A)
- Tall monolithic construction of additively manufactured thrust chamber
- Thrust chamber is representative of component for Lox/ Kerosene propelled engine.
- Thrust chamber is representative of component for reusable system delivering 5,000 lbf thrust at sea level for use in LEO, GEO, in-space, and hypersonic applications

*Image courtesy of Ursa Major



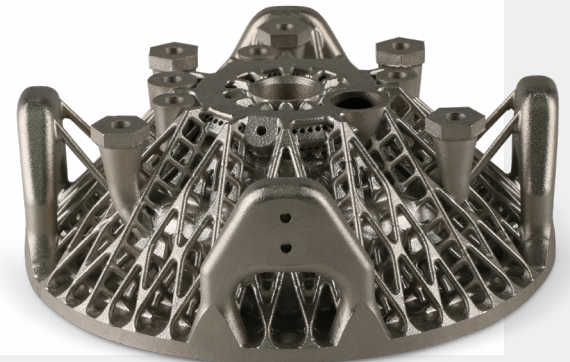
Vaya Space – STAR-3D Engine Combustion Chamber

Technology: Direct Metal Printing

Vaya Space is developing Dauntless, the world's first mass-producible, 'launch-on-demand' small satellite launcher, powered by their STAR-3D™ hybrid rocket engines.

- Material: LaserForm Ni718(A)
- Application: Combustion chamber
- Advanced structural and fluid flow optimization
- Enables Vaya to build engines within 1-2 days typ.
- <30 days recurring build, integrate, launch cycle target
- 1000 kg payload in LEO applications, 650 kg in SSO applications

*Image courtesy of Vaya Space



[Learn More about AM Propulsion Applications](#)

Cost Effective Pellet Extrusion for Large Fixtures and Tooling

Technology: Extrusion Printing, Hybrid Extrusion and Machining

The scale, speed, and economy offered by 3D Systems EXT Titan Pellet 3D printers opens new doors to manufacturing processes where additive wasn't previously viable.

Pellets vs. Filament

- **Reduced Cost:** Pellets cost up to 10X less than similar filament materials.
- **Wide Variety:** 100's of grades of pellet materials, including high performance and custom formulations. Not locked into OEM's specific filaments.
- **Faster Print Speeds:** Pellet extrusion is up to 10X faster than filament extrusion due to higher deposition rates and using larger nozzles (.6mm – 9mm)
- **Build volumes up to 50 x 50 x 72"**



Pellet Extrusion vs Filament Extrusion CF ULTEM Layup Tool		
	Pellet	Filament
Print Time	12 Hours	120 Hours
Material Cost	\$480 @ \$45/kg	\$3,239 @ \$395/kg

*Typical pricing information gathered from open market suppliers



Production-Grade Stereolithography (SLA) and Selective Laser Sintering (SLS) Solutions

Additive manufacturing technologies such as stereolithography and selective laser sintering enable OEMs and suppliers to design and build optimized components while reducing lifecycle cost and time-to-market versus conventional manufacturing.

QuickCast® 3D Printed Casting Patterns

Technology: Stereolithography

Vaupell, a 70-year supplier of aerospace components and subassemblies and more than 20-year veteran of 3D printing, uses the 3D Systems QuickCast® process to deliver unprecedented speed and quality to its customers at a fraction of the cost of traditional methodologies. The QuickCast process is ideal for low volume, highly complex aerospace parts.

- Material: Accura® CastPro™ Free
- Large parts or multiple small parts using ProX® 800 print envelope of 25.6 x 29.5 x 21.65 inches (650 x 750 x 550 mm)
- Accuracy of 0.001-0.002 inch (0.025-0.05 mm) per inch of part dimension
- 2-3 days typical time for production-grade molds vs. months to more than a year for wax tools



[Learn More about AM Investment Casting Applications](#)

Complex ECS Ducting

Technology: Selective Laser Sintering

By using SLS to manufacture non-structural, low volume ducting, such as ECS ducting for aerospace, you can design highly optimized, very complex single piece structures.

- Variable wall thickness as required for strength
- Possible to integrate multiple features such as complex channels and baffles, bosses, flanges, gasket channels into a monolithic structure
- Increased strength-to-weight ratio with structurally optimized webbing



[Learn More about Thermoplastic SLS Applications](#)

Production-Grade Photopolymer Solutions

Ultra-fast additive manufacturing technologies such as vat photopolymerization (VPP) in the Figure 4® system are creating new opportunities in aerospace direct and indirect production. Figure 4 is a scalable solution with comprehensively tested materials, high accuracy, repeatability, and low operational cost.

Figure 4 Production – Flexible, Scalable Solution

Technology: Figure 4

Figure 4 offers material solutions including durable plastics, elastomers, heat resistant materials, and specialty materials for casting of silicone, metals, and ceramics.

- Max build volume: 124.8 x 70.2 x 346 mm with Figure 4® Production
 - Tall parts possible
 - High-density vertical stacking for small parts
- Six sigma production printing repeatability across all materials
- Isotropic material properties
- World-leading production throughput of up to 65 mm/hr, prototyping speeds of up to 100 mm/hr
- Highly automated end-to-end process supported by 3D Systems software



[Learn More about Figure 4 Production Technology](#)

Figure 4 High Temp 150C FR Black – FAR 23/25 Tested

Technology: Figure 4

Figure 4® High Temp 150C FR Black is a rigid, flame-retardant black material that can be used for production parts requiring UL94 V0 rating as well as FAR 25.853 and 23.853 capability. It provides long-term environmental stability with an injection molded-like surface quality.

- May be applied to small FAR 25/23.853 in-cabin parts
- Self-extinguishing, flame-retardant material
- Excellent surface quality, accuracy and repeatability
- Capable of plating and painting
- Long-term indoor/outdoor stability testing per ASTM standards

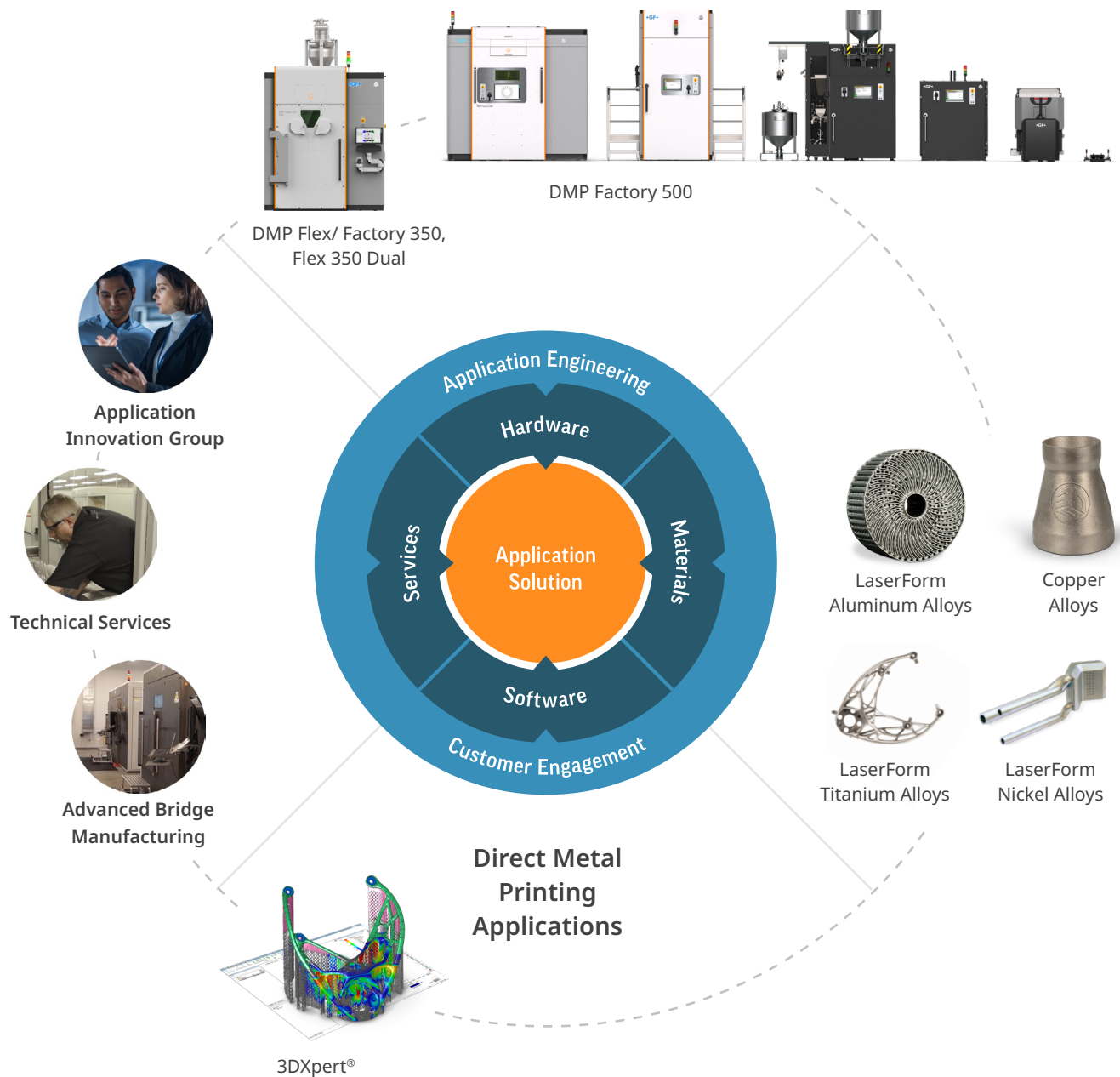


[Learn More about Figure 4 High Temp 150C FR Black](#)

Solutions for Metal Applications in Aerospace & Defense

3D Systems' hardware, software, material, and service solutions come together to accelerate and de-risk your additive manufacturing application development.

Our Application Innovation Group is made up of super-users of our own technology. This means that we bring years of hands-on and industry-specific experience and success with metal additive manufacturing development, qualification, and production scaling to your organization.



Solutions for Polymer Applications in Aerospace & Defense

3D Systems offers a broad range of polymer solutions for aerospace and defense applications.

Our Application Innovation Group will provide tailored solutions based on each customer and application requirement. Together, we maximize the benefits you receive from your AM investment.





Talk to an Expert

Partner with 3D Systems to accelerate and de-risk your additive manufacturing application development.

Get in Touch

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