AEROSPACE SOLUTIONS

Make Easier Manufacturing
Make a Better World

BLT

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AN OVERVIEW:

Intelligent metal additive manufacturing creates aerospace products with higher ingenuity，quality and standards.

The aerospace industry has high requirements for the structure, quality, accuracy and other aspects of parts. Metal additive manufacturing can realize the integrated forming of complex structures and lightweight manufacturing, achieve the rapid and flexible production of parts, greatly reduce the manufacturing difficulty of aerospace components, accelerate the iteration cycle, improve the production accuracy, increase service life and provide strong support for the high-quality development of the aerospace industry!

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01 INDUSTRY DEMAND

1) Material, structure and process requirements of parts:

High-performance components in Aerospace and Aviation need to be served under more extreme conditions. This has not only increased the demand for basic mechanical properties such as strength, toughness, and stiffness of materials, but also put forward higher requirements for extreme characteristics such as super bearing capacity, extreme heat resistance, and extreme lightweight of parts.

2) Innovation in manufacturing methods:

In order to obtain better and stronger overall performance, better industry solutions, the development of aerospace components is moving towards large-size, integrated and complex development.

3) Manufacturing cycle requirements:

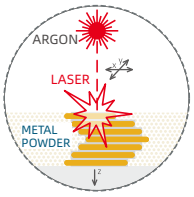
Parts are produced using traditional manufacturing methods have a long manufacturing cycle, large removal volume, low material utilization. In addition, the manufacturing cost of complex structural parts is high, and the forming is difficult, or even impossible to be manufactured, which can not only limit the imagination of designers, but also greatly lower the efficiency of product development.

02 METAL 3D PRINTING (PBF-LB/M PROCESS) SOLUTIONS

1) PBF-LB/M process principle

— Powder Bed Fused — Fused with laser —

PBF-LB/M
Laser-based powder bed fusion of metals Technology



By means of a movable laser beam, metal powder is selectively sintered locally in layers, thereby solidifying a cross-section of the component.

2) PBF-LB/M advantages

Parts can be formed directly according to the three-dimensional digital model instead of using mold

Wide range of scales: Infinitely complex structures can be Near Net Shape formed

Can process refractory metal and alloys

The parts have adequate physical and chemical performance

Metal parts with complex structure that are difficult or even impossible to be processed by traditional process methods (such as thin-walled complex structures, special-shaped curved surfaces, complex channel structures, lattice structures, heat dissipation structures, and function-first combination manufacturing, etc.) can be easily manufactured by 3D printing.

Use AM thinking to guide design innovation and shorten the development and production cycle.

In conclusion:

Metal 3D printing (PBF-LB/M process) has achieved high performance, high precision, complex structure and other forming requirements of parts out of different materials. The surface characteristics, geometric characteristics, mechanical characteristics and other key indicators of the formed parts are at the advanced level in Aerospace and Aviation.

3)Material & structure & performance integrated solutions of PBF-LB/M

Material:

Formable materials include

Titanium Alloy: Pure Titanium, Ti-6Al-4V Grade5, Ti-6.5Al-1Mo-1V-2Zr, TiAl, TiAM1, etc.

Aluminum Alloy: AlSi10Mg, AlSi7Mg, etc.

Superalloy: Inconel 718, Inconel 625, HastelloyX, K452, Inconel738, etc.

Stainless Steel: 304L, 316L, 2Cr13Mo, 15-5PH, 17-4PH, etc.

Copper: Pure copper, CuCrZr, etc.

◉ The following are some of the typical mechanical properties of materials:

Material Categories	Materials	Forming Technology	Rm/MPa	$R_{p0.2}$/MPa	A/%
Titanium Alloy	Ti-6Al-4V Grade5	PBF-LB/M	960-1100	900-960	12.0-19.5
		Forging	895	825	10.0
	Ti-6.5Al-1Mo-1V-2Zr	PBF-LB/M	1030-1130	950-1050	13.5-18.0
		Forging	930-1130	855	10.0
	TiAM1	PBF-LB/M	950-1000	880-930	12.0-18.0
		Forging	/	/	/
Aluminum Alloy	AlSi10Mg	PBF-LB/M	290-320	190-205	12.0-18.5
		Casting	235	/	2.0
	AlSi7Mg	PBF-LB/M	420-450	270-300	4.0-10.0
		Casting	235	/	4.0
Superalloy	IN718	PBF-LB/M	1400-1500	1200-1300	15.0-20.0
		Forging	1280	1030	12.0
	IN 625	PBF-LB/M	870-980	430-550	40.0-60.0
		Forging	830	410	30.0
	HastelloyX	PBF-LB/M	700-740	300-320	45.0-55.0
		Forging	690	275	30.0
	GH3230	PBF-LB/M	900-950	380-420	40.0-45.0
		Forging	793	345	40.0
	K452	PBF-LB/M	1100-1300	790-850	5.5-15.0
		Casting	830	715	4.1

	Materials	Forming Technology	Rm/MPa	$R_{p0.2}$/MPa	A/%
Stainless Steel	304L	PBF-LB/M	550-670	350-390	53.5-75.5
		Forging	520	205	40.0
	316L	PBF-LB/M	605-710	385-445	45.0-68.0
		Forging	480	177	40.0
	15-5PH	PBF-LB/M	1418-1434	1250-1300	10.0-15.0
		Forging	1310	1170	10.0
	17-4PH	PBF-LB/M	1150-1250	980-1050	10.0-18.0
		Forging	1070	1000	12.0

◉ New materials

Material	Characteristics	Function	Applications
BLT-Ti_2AlNb	High specific strength, outstanding oxidation resistance, non magnetic and good high temperature performance	Reduce the weight of the aircraft, improve fuel efficiency, and improve high temperature service performance	New Heating Parts with Lightweight and High Temperature Structure for Aviation, Aerospace, Satellite
BLT-Ti65	Excellent strength, plasticity, creep resistance, corrosion resistance, and thermal stability	Improve high-temperature service performance;	High-temperature components for aviation, aerospace, engines, chemical equipment, etc

Manufacturing technology:

Macroscopic control: "Large" (Large size) › "Great" (Great quality) › "Special" (New materials and special structures) › "Precision" (High precision)

Micro-controllability: High density, High quality

Structure:

Component integrated structure design, lightweight structure design,
topology optimization structure design based on additive manufacturing technology

03 TYPICAL CASES

Aviation & Aerospace & Aeroengines

Central Gear Drive Housing

Application: Aeroengines
Material: Titanium Alloy
Size: 210mm×300mm×350mm
System: BLT-S450
Forming Time: 90h

Technical Details: The part is integrated by additive manufacturing, which avoids the complex combined processing of traditional methods. After the topological optimization of the part, the final weight is reduced by more than 10%; the forming quality of the complicated oil flow channel meets the design requirements, and the manufacturing cycle is only 1 month.

Aero-Engine Fan Blades

Application: Aeroengines
Material: Titanium Alloy
Size: 400mm×400mm×800mm
System: BLT-S500
Forming Time: 140h

Technical Details: People usually use superplastic forming method and diffusion bonding technology to manufacture hollow blades before, which is extremely easy to make connection defects. These kinds of production methods have lots of disadvantages, for example, low yield, high mold costs, high manufacturing costs, and long production cycles. PBF-LB/M integrated manufacturing solves the problem of connection defects which are common problems on formal hollow blades. The inner W-shaped stiffener of the hollow blade can reduce weight by nearly 30% and has better strength and shorter manufacturing cycle compared with the traditional structure. This kind of inner structure can only be manufactured by PBF-LB/M method.

Engine Exhaust Nozzle

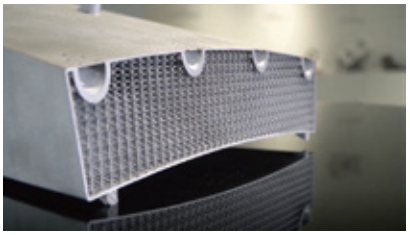
Application: Aeroengines
Material: Pure Copper
Size: Φ210mm×295mm
Machine: BLT-S300
Forming Time: 96h

Technical Details: 3D printing helps the design team successfully solved the problems of forming copper, such as, low absorption rate, high forming difficulty, low efficiency and difficult control of metallurgical quality. The inner and outer walls of the structure are designed with 50 cooling channels. Due to the integration of complex cooling channels cooling efficiency of the engine is greatly improved, and the design is more compact and lighter. While these large number of cooling channels can only be manufactured by PBF-LB/M technology.

Guide Rail Bracket

Application: Aerospace
Material: Aluminium Alloy
Size: 327mm×317mm×360mm
System: BLT-S450
Forming Time: 400h

Technical Details: The minimum wall thickness of the thin-wall+lattice structure in the guide rail bracket is 0.5mm, and the minimum lattice rod diameter is 0.5mm, which are extremely easy to deform. Compared with traditional processing, 3D printing can greatly reduce the weight of the parts while ensuring the strength, and the deformation is controllable.



Impeller Disk

Application: Aeroengines
Material: BLT-K418
Size: 90mm×90mm×25mm
Machine: BLT-S310
Forming Time: 10h

Technical Details: The thickness of the most thick part on this impeller disk is 0.8mm. BLT adopts size compensation technology to control the blade accuracy, and successfully controlled the deviation within 0.1mm. The impeller disk has undergone over-rotation rupture test, during which the speed can reach 122000r/min.

Exhaust Nozzle

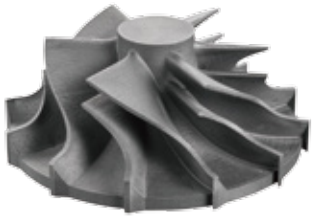
Application: Aeroengines
Material: Superalloy
Size: 110mm×110mm×130mm
Machine: BLT-S310
Forming Time: 70h

Technical Details: The exhaust nozzle has a thin-walled structure, which can only be assembled by different parts manufactured by traditional methods. PBF-LB/M technology can directly realize the integration of multiple parts.

Impeller

Application: Aeroengines
Material: Titanium Alloy
Size: Φ120mm×70mm
Machine: BLT-S310
Forming Time: 40h

Technical Details: It is manufactured by laser precision forming technology with shaped curved surface. It has good size consistency, with material utilization of more than 98%. The product can be manufactured in small batch. However, traditionally forged and machined ones feature high cost, long cycle and low material utilization.



The Component of Guide Evaporation Tube

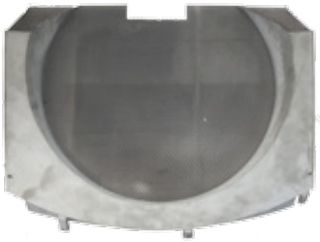
Application: Aeroengines
Material: Superalloy
Size: 115mm×115mm×120mm
Machine: BLT-S310
Forming Time: 60h

Technical Details: The component of guide evaporation tube is a thin-walled structure, which can only be assembled by different parts manufactured by traditional methods. While PBF-LB/M technology can directly realize the integration of multiple parts.

Hydrazine Bottle Adapter

Application: Aerospace
Material: Aluminium Alloy
Size: 631mm×592mm×151mm
System: BLT-S600
Forming Time: 400h

Technical Details: The hydrazine bottle adapter is a large-size load-bearing part made of 3D printing lattice material. The products are printed separately in 6 pieces, and the final assembled diameter is 1200mm. As the supporting structure of hydrazine bottle in the resource platform of remote sensing satellite in-orbit propulsion system, the structure is also the key load-bearing part of the entire thrust system. The large size structure of thin lattice structure, with the minimum wall of 0.5mm and lattice wire diameter of 0.5mm can only be manufactured by PBF-LB/M technology. Compared with traditional process, the overall weight of the structure is reduced by more than 60%.



Thrust Chamber Body

Application: Aerospace
Material: Stainless Steel
Size: ϕ200mm×350mm
Machine: BLT-S300
Forming Time: 240h

Technical Details: The thrust chamber body is an important part of aerospace engines. It often works under high temperature conditions. Therefore, the cooling requirements in this part are very strict. The traditional cooling channel is realized by milling and welding technology, which has a long production cycle, high cost as well as it is difficult to guarantee performance. 3D printing can completely solve the above difficulties. PBF-LB/M process can not only achieve the part's large flow channel, guarantee flow channel accuracy and roughness of the parts, but also shorten the production cycle by 2-3 weeks, achieving a technological leap in the efficiency of the thrust chamber of the liquid rocket engine from 95% to 99%.

04 TYPICAL USERS

中国商飞 COMAC · AIRBUS · SAFRAN · LANDSPACE · iSPACE · JAYJ · 空天引擎 AAENGINE · 星河动力

05 Aerospace Machines and Systems

BLT-S1500 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy, Stainless Steel, High-strength Steel

Build Dimension

1500mm×1500mm×1200mm（W×D×H）

Laser Power

500W×26

BLT-S1300 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy, Stainless Steel, High-strength Steel

Build Dimension

1300mm×1300mm×1400mm（W×D×H）

Laser Power

500W×26

BLT-S1000 ⋙

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy, Stainless Steel, High-strength Steel

Build Dimension

1200mmx600mmx1500mm (W × D × H)

Laser Power

500WX8; 500WX10; 500WX12

BLT-S815 ⋙

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy, Stainless Steel, High-strength Steel

Build Dimension

800mm×800mm×1500mm(W × D × H)

Laser Power

500W×6; 500W×8; 500W×10

BLT-S800 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy,

Stainless Steel, High-strength Steel, Tool Steel

Build Dimension

800mm×800mm×650mm（W×D×H）

Laser Power

500W×6; 500W×8; 500W×10

BLT-S615 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy,

Stainless Steel, High-strength Steel

Build Dimension and Laser Power

600mm×600mm×1500mm(W×D×H)
500W×4

650mm×650mm×1300mm(W×D×H)
500W×6

BLT-S600 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy,
Stainless Steel, High-strength Steel, Tool Steel

Build Dimension

650mm×650mm×850mm（W×D×H）

Laser Power

500W×4；500W×6；500W×8

BLT-S450 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy,
Stainless Steel, High-strength Steel, Tool Steel

Build Dimension

450mm×450mm×500mm（W×D×H）

Laser Power

500W×4；500W×6；500W×8

BLT-S400 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy,
Stainless Steel, High-strength Steel, Tool Steel

Build Dimension

400mm×300mm×400mm（W×D×H）

Laser Power

500W×2；500W×3；500W×5；500W×6

BLT-S310/S320 »

Supporting Materials

Titanium Alloy, Aluminum Alloy, Superalloy, Stainless Steel,
High-strength Steel, Tool Steel, Copper Alloy

Build Dimension

250mm×250mm×400mm（W × D × H）

Laser Power

500W; 500W×2

The technical terms used in this document is referenced from
《EN ISO/ASTM 52926 Additive Manufacturing of metals - Qualification principles》