
华曙高科
FARSOON TECHNOLOGIES

Farsoon Introduction

- **Farsoon**
- Founded 2009 by Dr. Xu
- Two share holder, Dr. Xu and Mr. Hou
- SLS and SLM machine manufacturer
- SLS nylon powder producer
- **Dr Xu's expertise:**
- 20 years of expertise acquired in the US as technology director at 3DS , DTM and Solid Concepts
- Recognized as innovator of advanced scanning strategies and GUI at DTM / 3D Systems
- **Farsoon Positioning:**
- Open Platform Systems
- Strong R&D arm
- Innovation/ speed of execution / adaptability to become a true alternative to current state of the art SLS and SLM machine manufacturers

Farsoon Introduction

- **First material developed Sept. 2011, FS3200 PA12 like material**
- **Since then more than 10 plastic and 10 metal materials developed or configured for Farsoon machines**

+

- **Stainless Steel 316L**
- **Stainless Steel 17-4**
- **CoCr**
- ***Ti Alloy***
- ***Al Alloy***
- ***In 718***
- ***HX***
- ***1.2709***
- ***W***
- ***Ta***

Farsoon Introduction

- **Aug, 2012 first commercialized machine FS401 developed**

eForm

Build Volume	250x250x320 mm
Layer Thickness	60-300 um
Laser Type	30W
Chamber Temp	190C
Control System	Make Star
Scan Speed	7.6m/s

252P Series

Build Volume	250x250x320 mm
Layer Thickness	60-300 um
Laser Type	60W / 100W
Chamber Temp	220C / 280C
Control System	Make Star
Scan Speed	10m/s

403P Series

Build Volume	400x400x600mm
Layer Thickness	60-300 um
Laser Type	30W / 60W / 100W
Chamber Temp	190C / 220C
Control System	Make Star
Scan Speed	Upto 15.2 m/s

Farsoon Introduction

- Oct, 2014 opening of new campus
- Dec, 2014 received China's National Engineering Laboratory status for additive manufacturing

2009	2010	2011	2012	2013	2014	2015	2016

Farsoon Introduction

- **Nov, 2015 FS271M metal machine developed**

FS271M

Build Volume	275x275x320 mm
Layer Thickness	20-100 um
Laser Type	500W
Laser Diameter	70-200 um
Control System	Make Star M
Scan Speed	15m/s

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016

Farsoon Introduction

- **Feb, 2016 FS121M small scale metal machine developed**

FS271M

Build Volume	120x120x100 mm
Layer Thickness	20-80 um
Laser Type	200 W
Laser Diameter	40-100 um
Control System	Make Star M
Scan Speed	15m/s

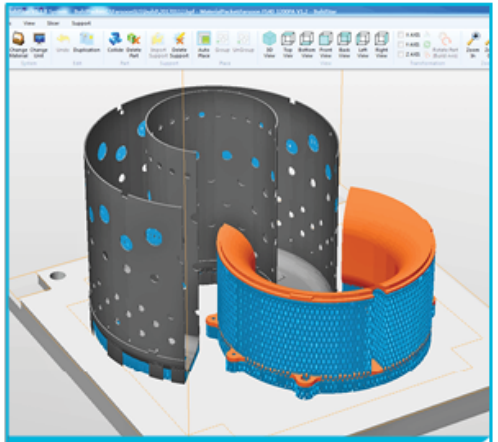
2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016

Farsoon Introduction

Full software package

- Self developed
- Build preparation & Machine Control
- Open parameters

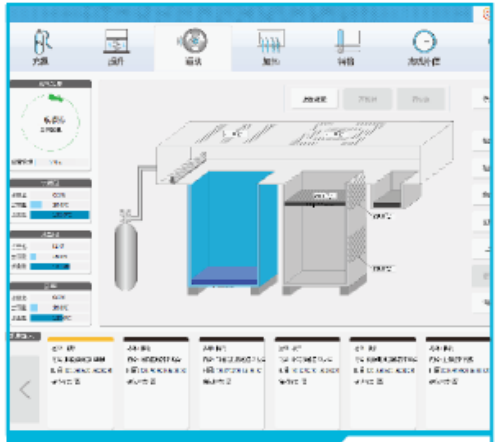
BuildStar



Pre-build Preparation

- Layout(translate, rotation ,etc)
- scaling
- part preview
- Support generating
- Compensation & calibration
- Parameters setting
- Collision detection
- Material & time estimation
- Scan path preview
- measuring

MakeStar



Build Process

- Interchangeable expert mode and production mode
- Real-time parameters modification
- Real-time data monitoring
- Remote monitoring
- Multi-zone temperature control
- Real-time data displaying & recording
- Intelligent powder feeding

Farsoon Structure

Innovation R&D

- SLS & SLM printers
- Resins for Photopolymerisation
- Plastic Powder for selective laser sintering

Production

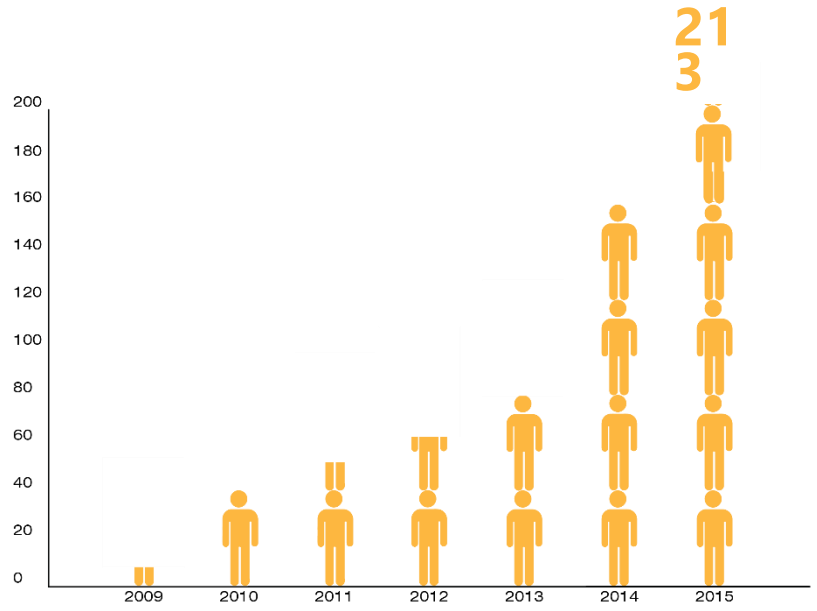
- Machine Production
- Material Production

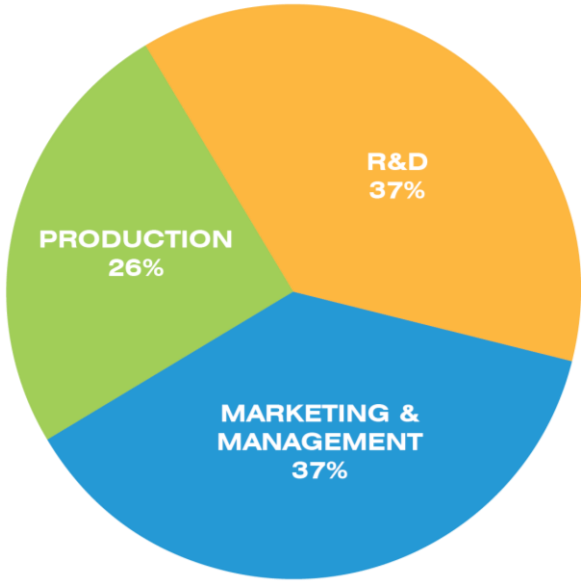
Design & Application

- Parts design & engineering
- 3D Scan – inspection
- Parts production
  - All 3D printing technoly
  - Metal fusion
  - Tooling & injection

Marketing & Sales

- Advertising
- Media
- Social Networking
- Sales channel development
- Global Business cooperation





China Locations

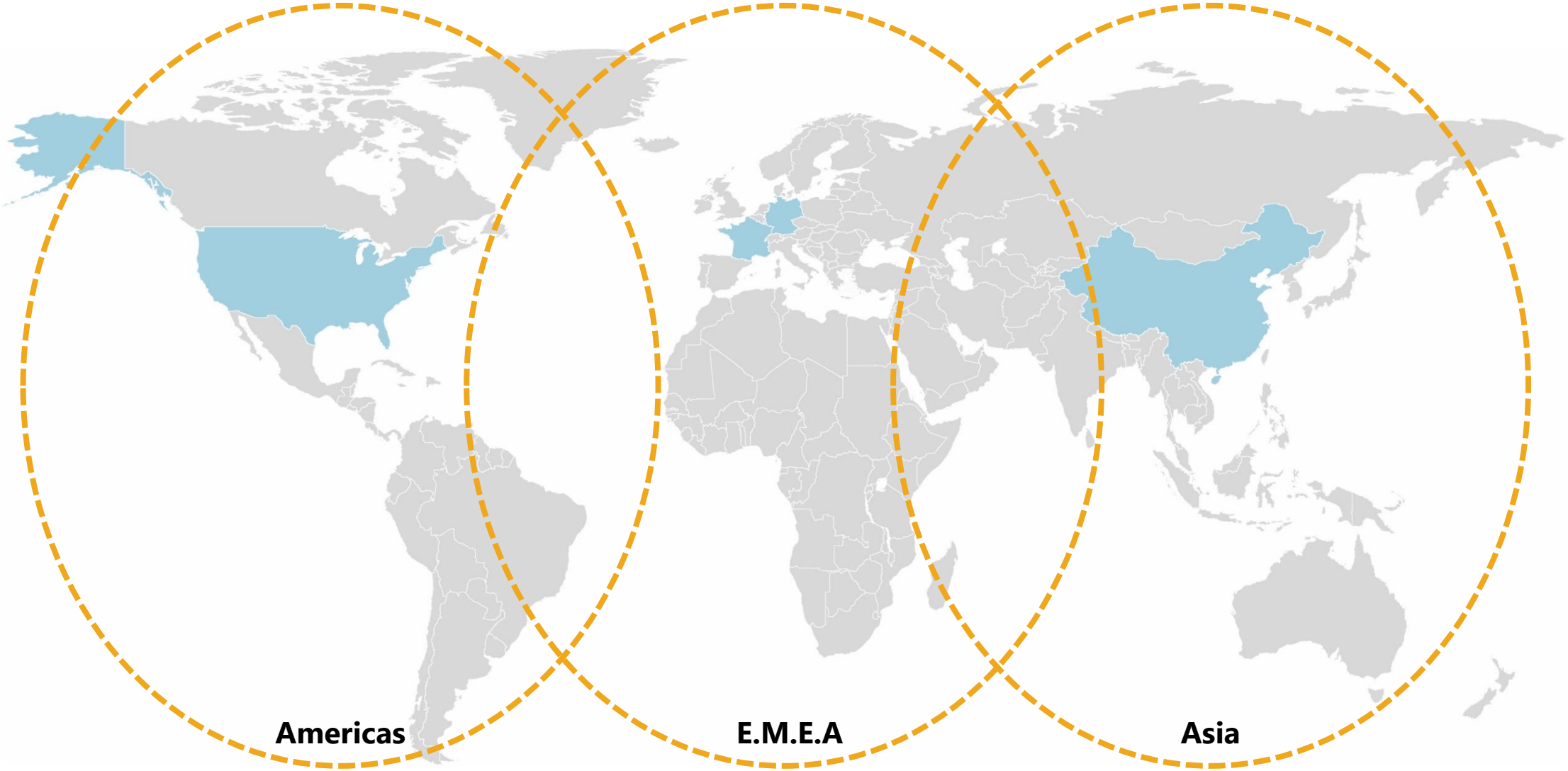
1. Farsoon Headquarters
2. Shanghai Sales Office
3. Shenzhen Sales Office
4. Chongqing Sales Office
5. Beijing Sales Office

International Partners

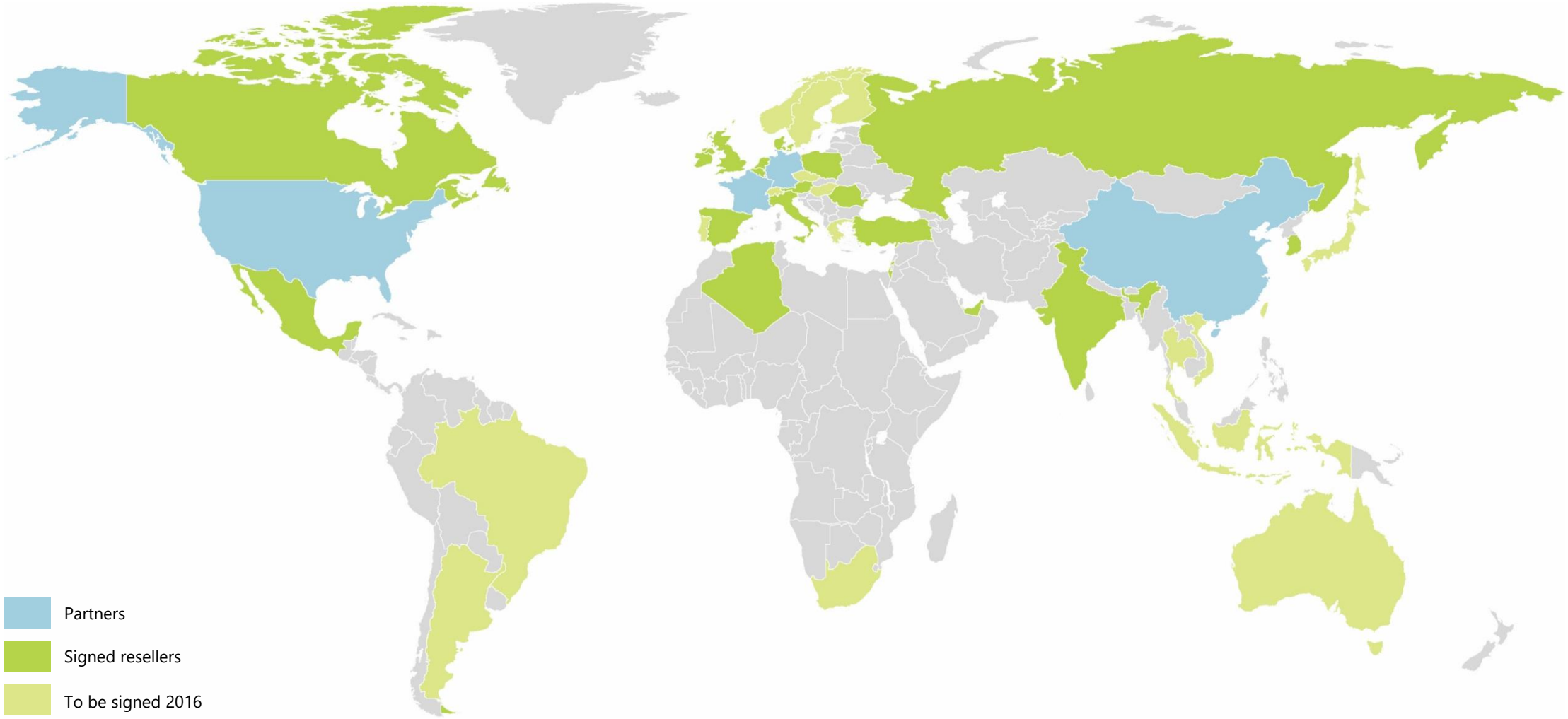
	Distribution	Service	R&D	Application
LSS Additive Manufacturing Solutions	X	X	X	X
PRODWAYS The new way of producing	X		X	X

- **Bringing together more than 20 years experiences in the additive manufacturing field**
- **3D printer manufacturing and design**
- **Rapid prototyping and manufacturing**
- **Material know how**
- **Service and Maintenance**

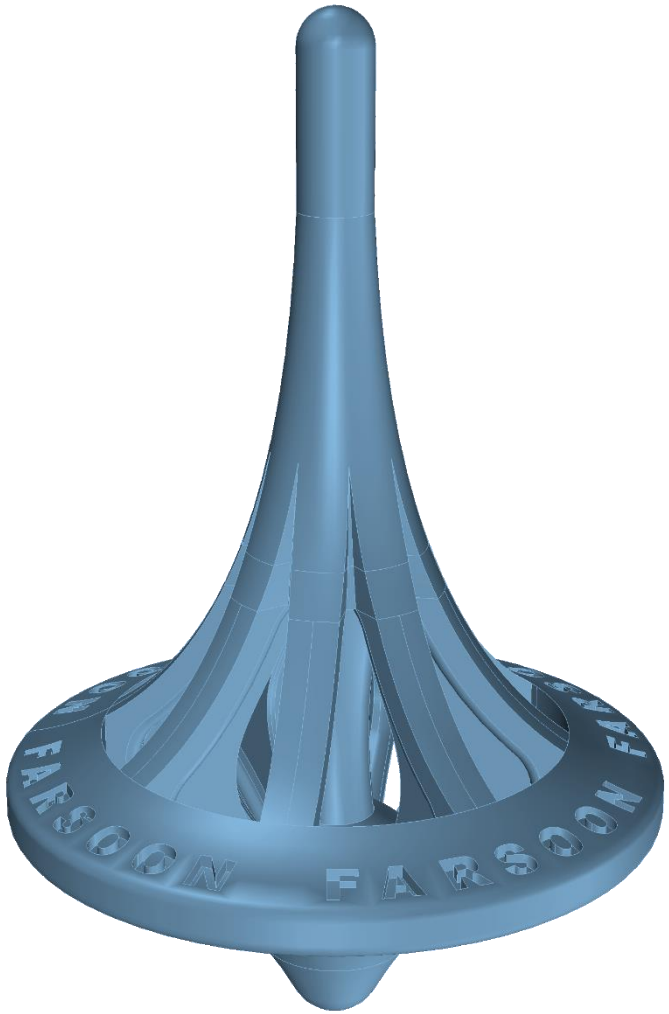
Global Sales and Support Coverage



Extensive Reseller Network



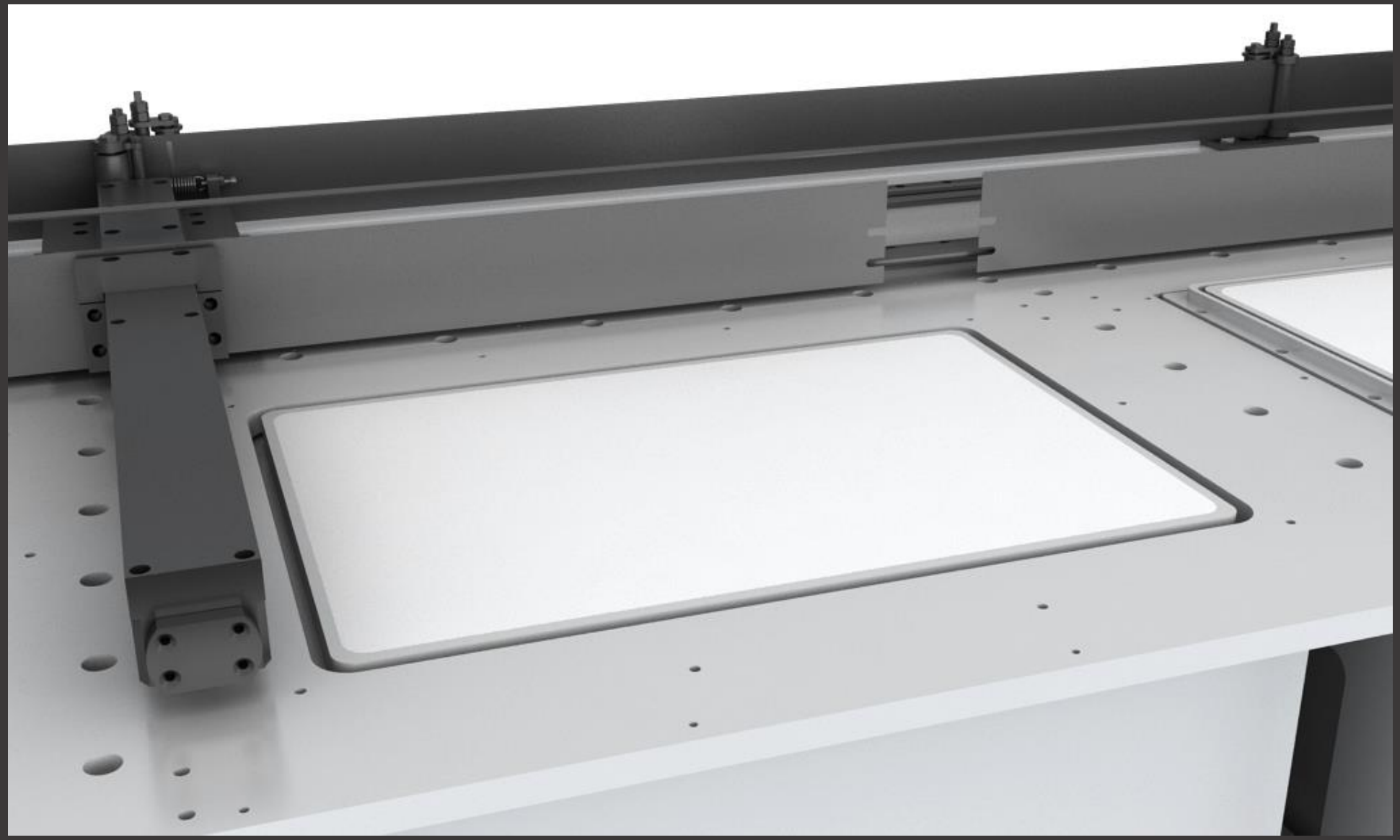
Laser Sintering Technology



Fully Digital

Layer Based

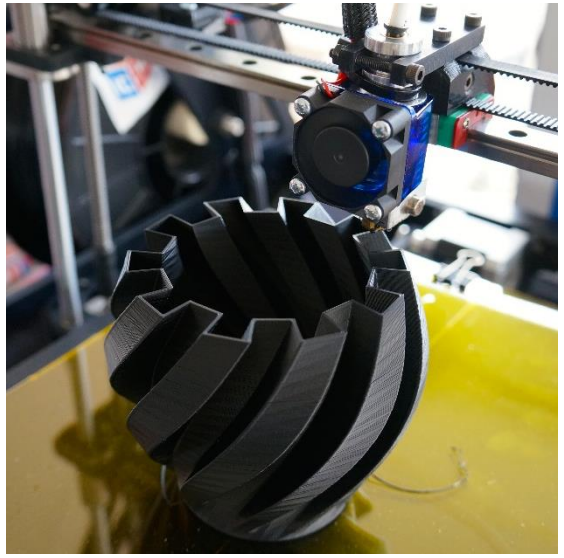
Additive Technology



Many 3D Printing Technologies

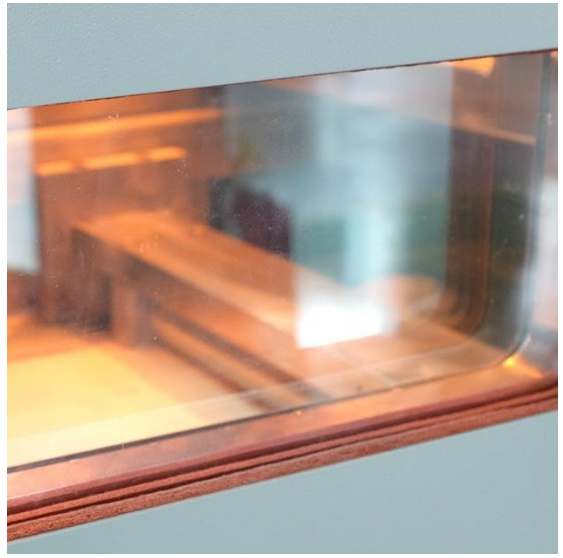
RESIN

SLA
DLP



FILAMENT

FDM



POWDER

SLS
SLM
PolyJet Fusion

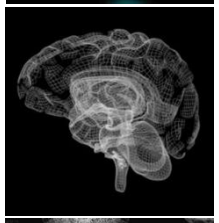
Advantages of SLS

	Part Strength	Production Speed	Surface Finish	Support Structures	Cost
SLS	★★★★	★★★★★	★★★	★★★★★	★★★
SLA	★	★★★	★★★★★	★	★★
FDM	★★	★★	★★	★	★★★★

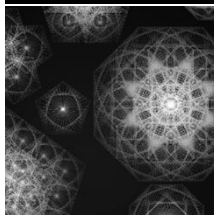
Laser Sintering Applications

AEROSPACE

MEDICAL



Art & Design



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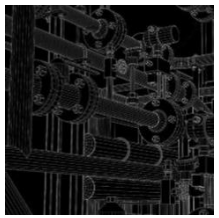
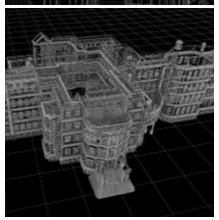


ARCHITECTURE



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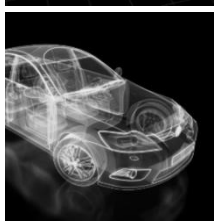
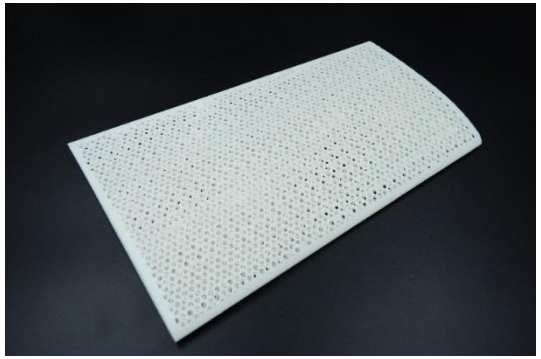


Aircraft Engine Fuel Injector

- Material: Inconel HX
- Similar to work done at GE, Farsoon has been working with manufacturers to find additive solutions for fuel injectors in the aerospace industry



UAV wing structure

- Material: PA3200
- Worked with local partner to enhance wing strength for UAV's. Farsoon was challenged to reduce weight of UAV wing piece while at the same time increasing strength and rigidity. Was successful by using internal mesh structure which allowed for increased strength while reduce weight.

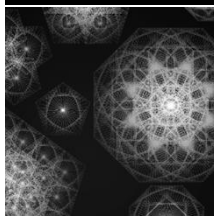
Bearing brackets

- Material: Ti6Al4V
- Challenged to reduce weight on aeronautic bearing brackets while retaining same or greater strength than traditional designs. 3d printing allowed for quick design studies and testing.

AEROSPACE

MEDICAL

Art & Design



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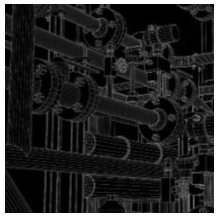

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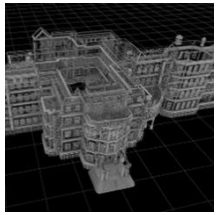

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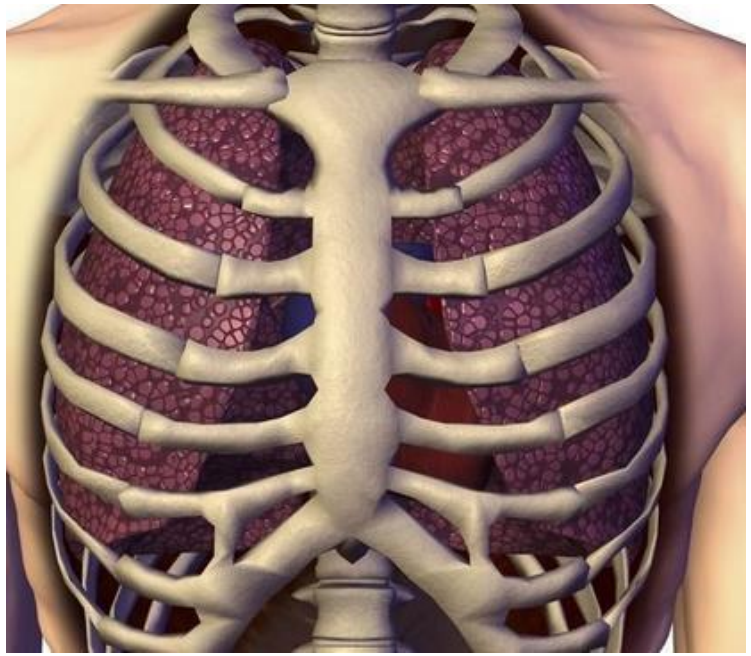
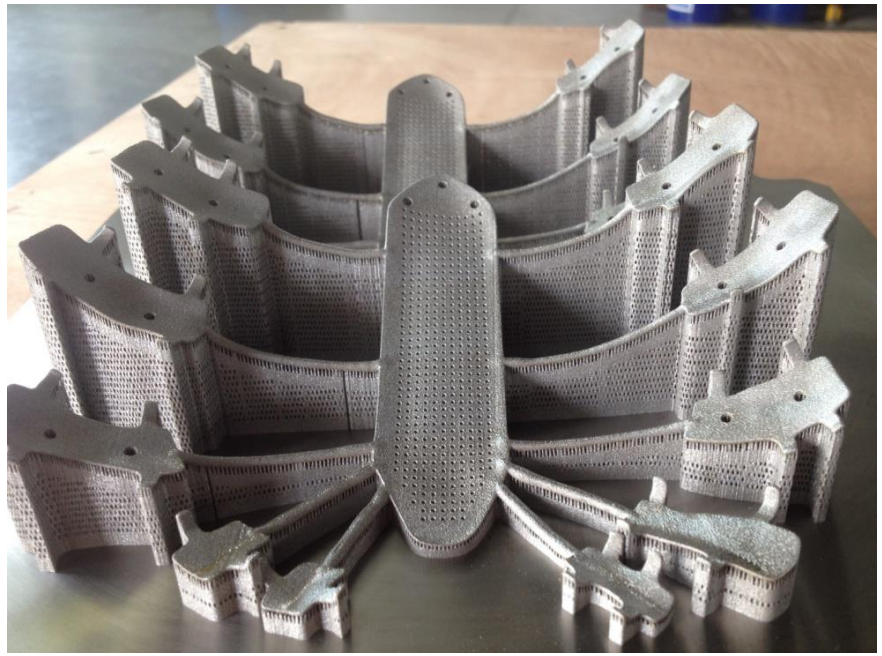




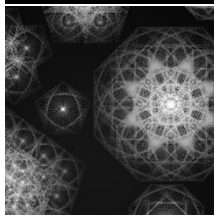
Rib cage implant

- Material: Ti6Al4V

AEROSPACE

MEDICAL

Art & Design



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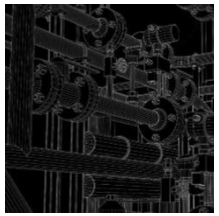

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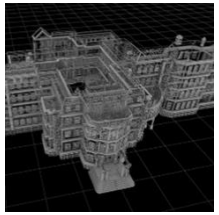

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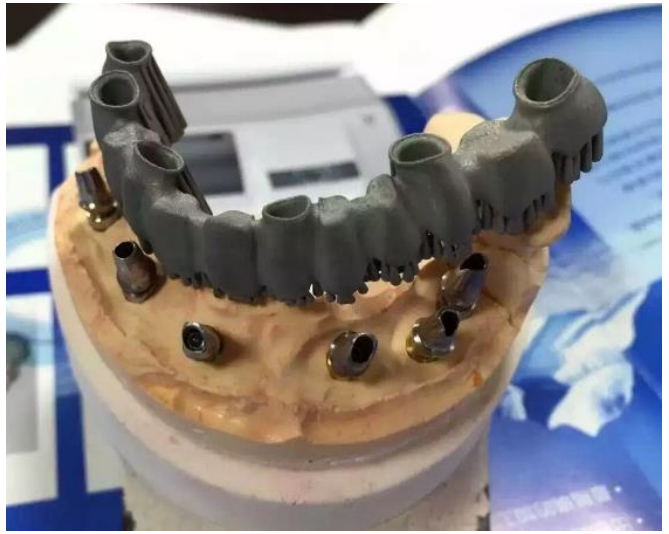


150 Crowns in Under 6 Hours

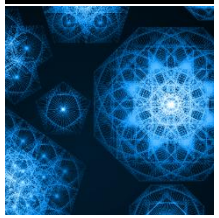
Dental crowns

- Material: CoCr
- Farsoon is collaborating extensively with dental industry experts to find a 3d printing solution for dental crowns and caps.
- Current state of the art is both time consuming and labor intensive
- 3d printing can reduce time of production as well as reducing the complexity of production
- Farsoon specifically developed the FS121 small scale metal machine to suite the dental industry
- Current target is 150 crowns printed in under 6 hours.

AEROSPACE

MEDICAL

Art & Design



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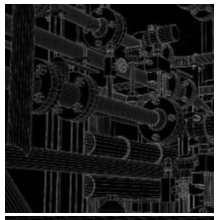

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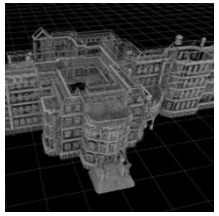


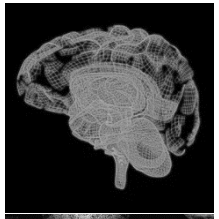
AUTOMOTIVE

Sculptural Lighting

- Material: PA3200
- Farsoon is working closely with design firm **Xuberance** to help them realize their vision. Farsoon's technology allows designers to produce previously impossible to manufacture products while at the same time keeping costs at a acceptable level to allow for multiple rounds of design and development

AEROSPACE

MEDICAL



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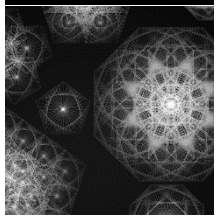

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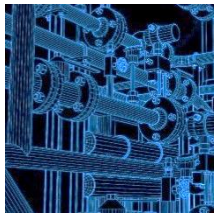

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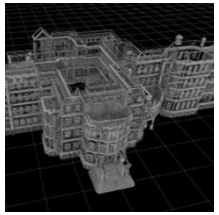

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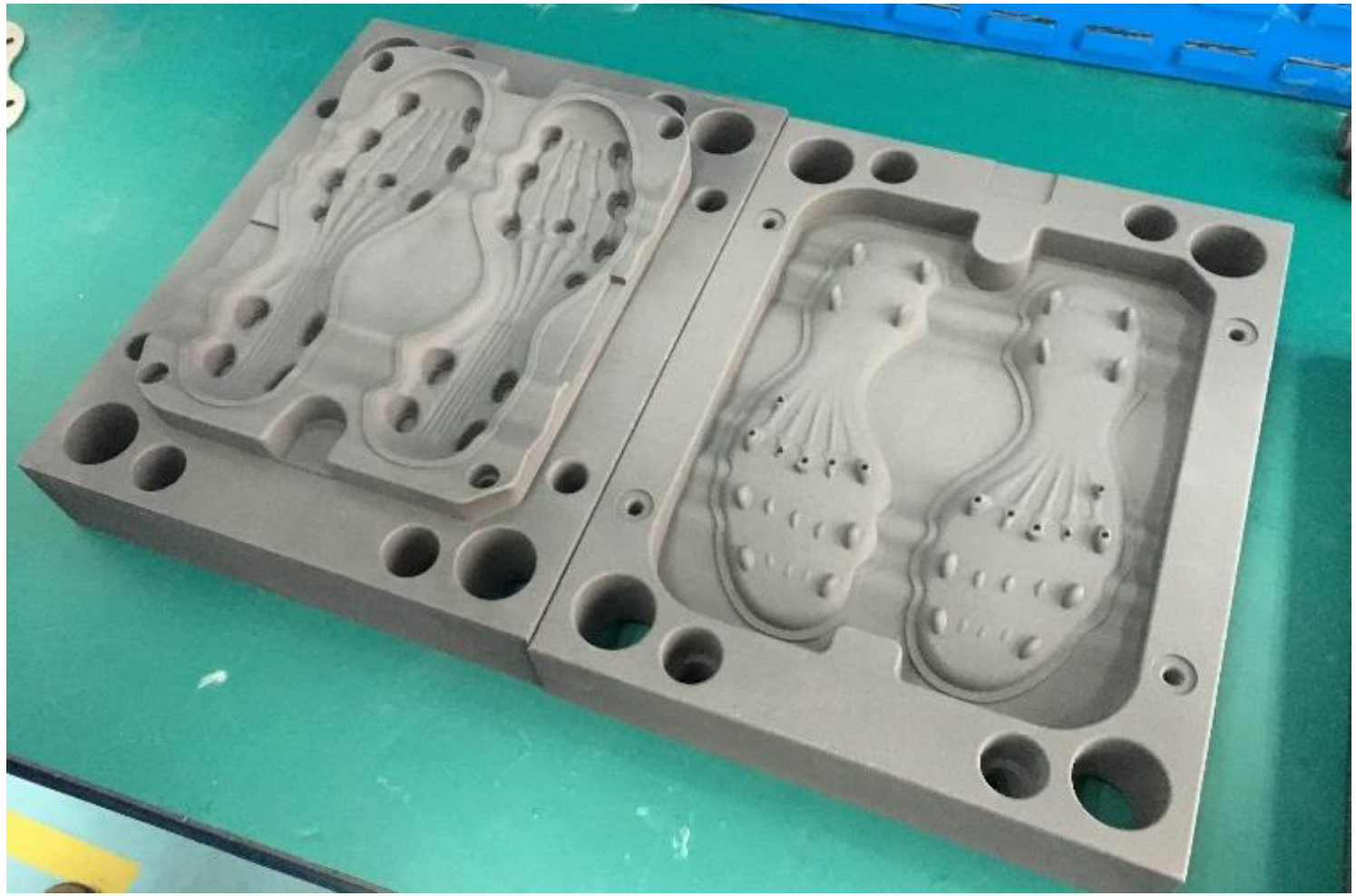
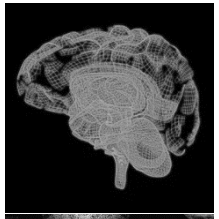


Temporary molds

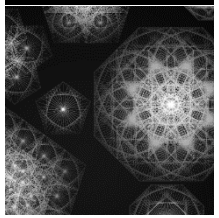
- Farsoon is working with footwear companies to look at the possibility of producing low yield / low cost injection molds produced from nylon and other plastic materials

AEROSPACE

MEDICAL



Art & Design



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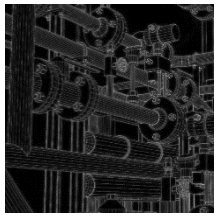

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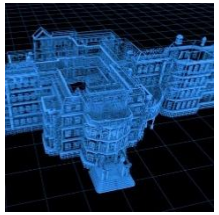

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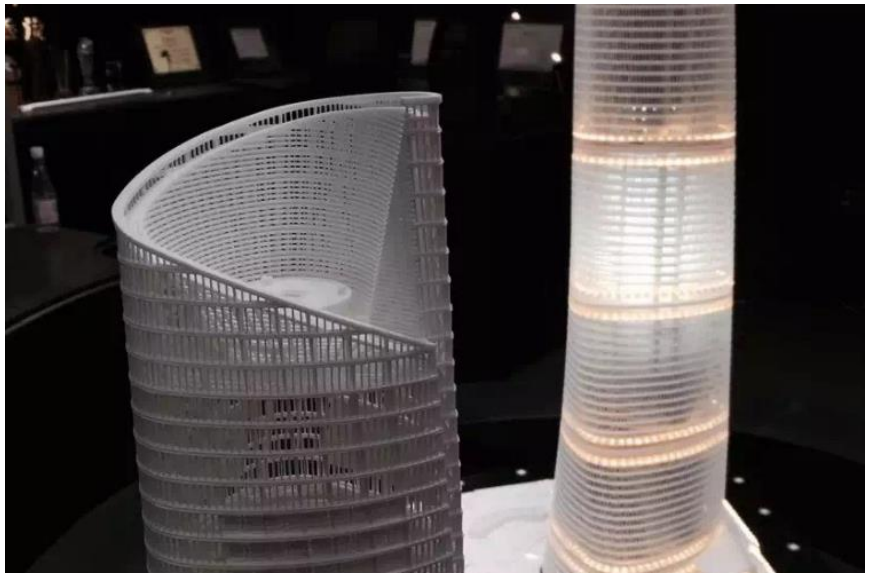


Architectural models

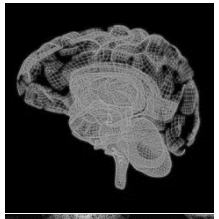
- Many architectural models have been produced using Farsoon machines. Architecture offices will often explore various solutions to a problem and will require multiple models to help visualize their designs. Rapid prototyping provides a fast and accurate method to do this.

Interior paneling

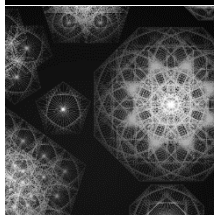
- Interior paneling is a viable application for 3d printing today. 3d printing allows designers to explore new and innovative designs.

AEROSPACE

MEDICAL



Art & Design



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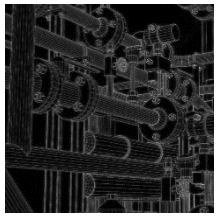

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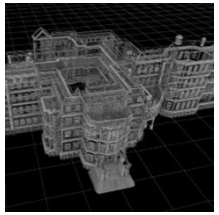

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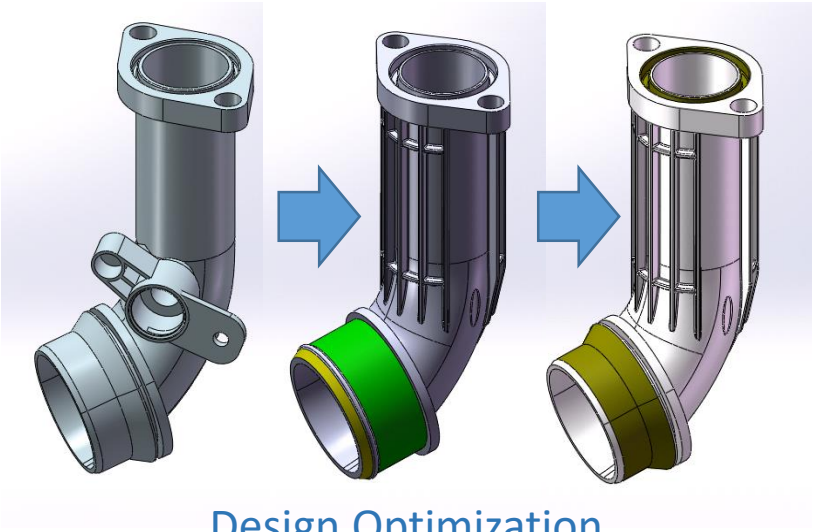
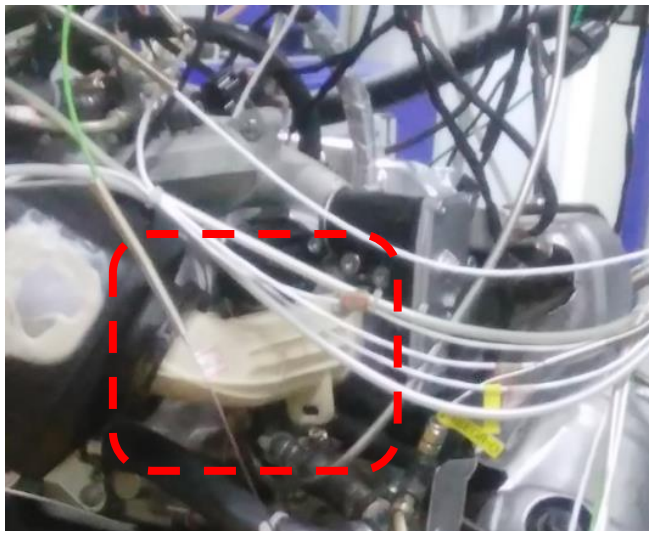


Design Optimization

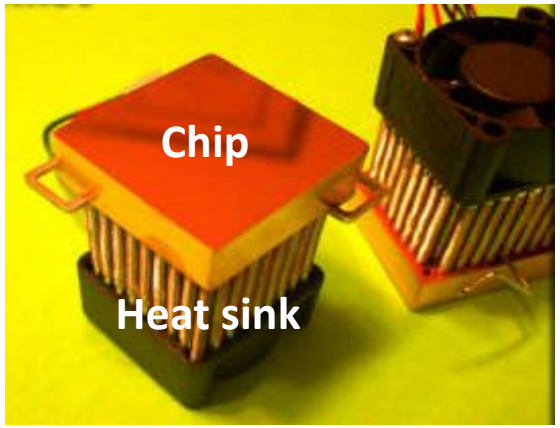


Automotive Turbocharger Adapter

- Material: PA6
- Design optimized for PA6 and laser sintering
- Farsoon is working closely with automotive OEM's to develop direct use applications for laser sintering
- Farsoon's HT251 and HT403 systems are one of the only systems in the market capable of processing PA6
- PA6 shows increased strength and heat deflection compared to standard PA12 laser sintering materials and show improved properties over injection molded PA6 parts
- Passed in vehicle dynamic 700 hour test, high temperature and high vibration environment

CASE STUDIES

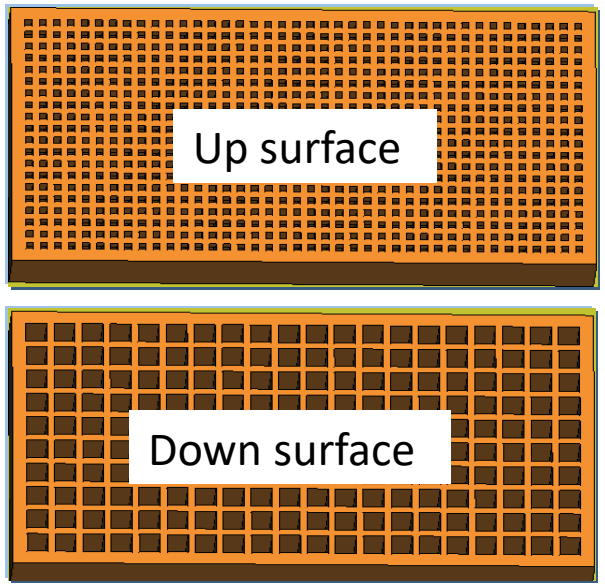
Aerospace case study - Tungsten (W) in aerospace heat sink



Problem of real products

- Deformation of copper heat sink
- Destroy the chip

Porous W
+
Copper infiltration



Problems in traditional manufacturing method

1）Process complex

Raw powder → Molding → Sintering → CNC

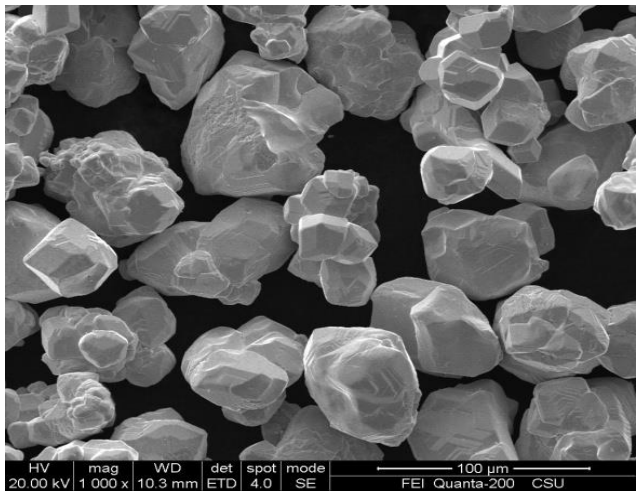
2） Porous structure is difficult to mold, also high cost

3）Very difficult to machine

Aerospace case study - Tungsten (W) in aerospace heat sink

The complete solution

- ✓Materials
- ✓Machine
- ✓Process
- ✓Property
- ✓Structure

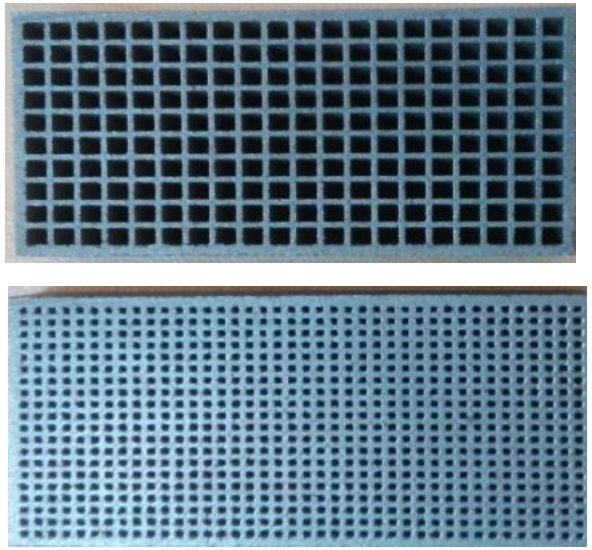


W powder

Parameters

Laser powder	450W
Scan speed	500 mm/s
Layer thickness	0.03mm

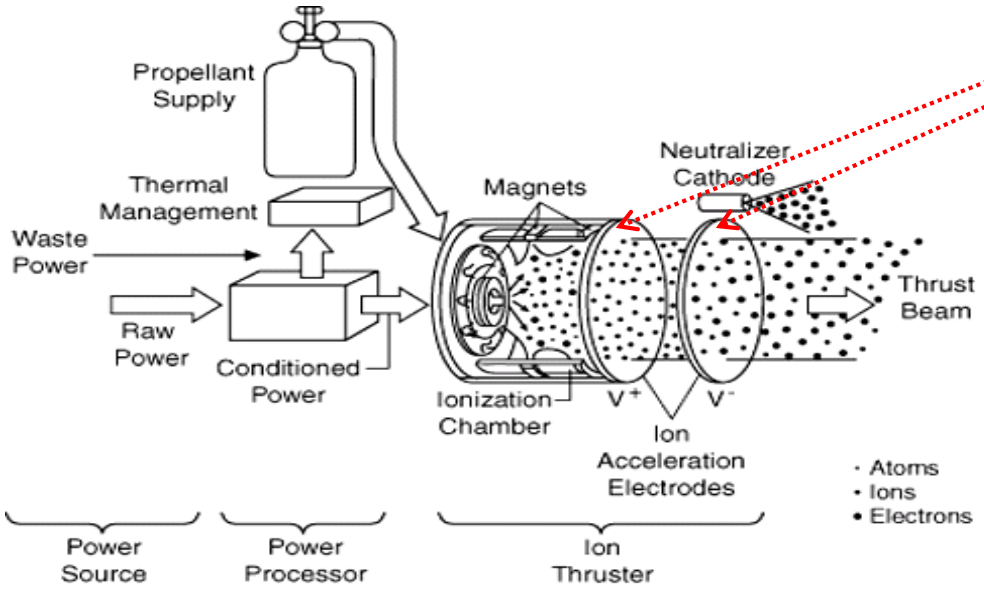
Part density>96%

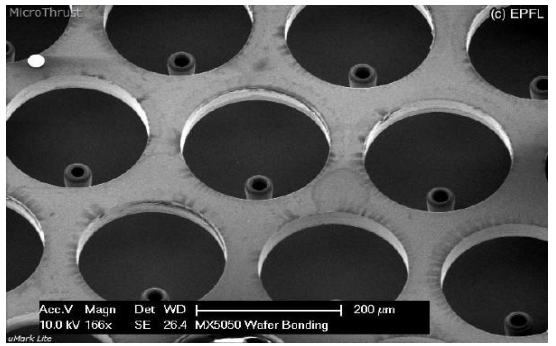


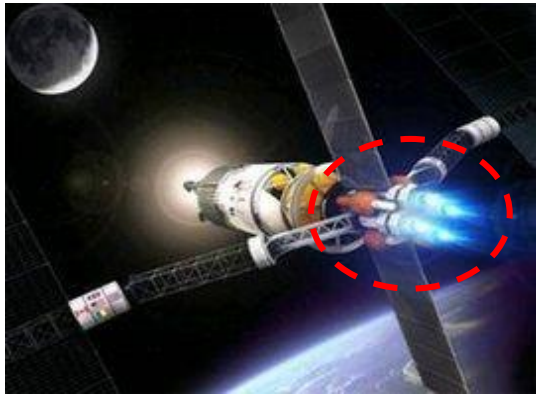
Big pores: 1.5±0.02mm
Small pores: 0.5±0.02mm

Aerospace case study – Ion thruster

- Two mesh screen for each ion thruster
- Ion acceleration
- Ti alloy



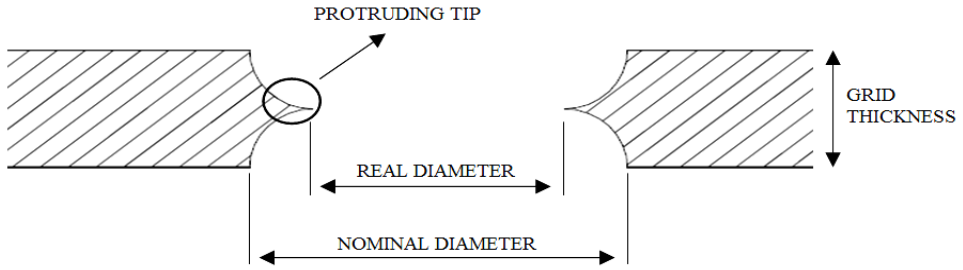




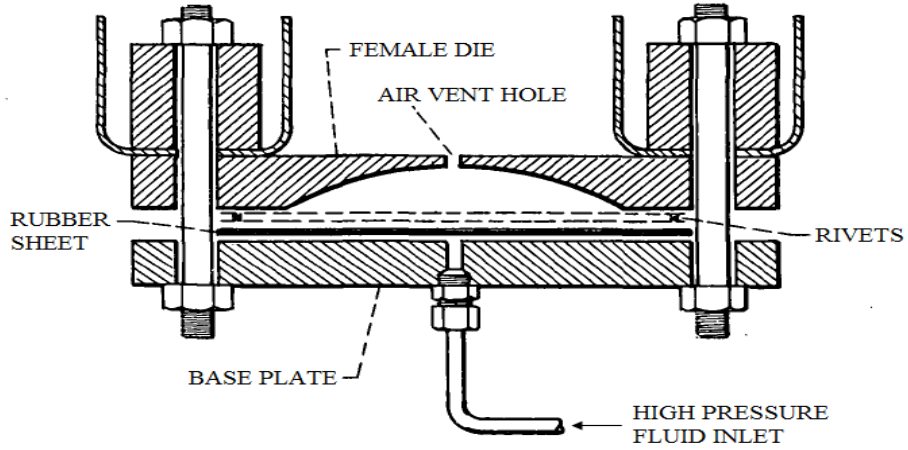
Ion thruster

Aerospace case study - Ion thruster

➢Traditional method



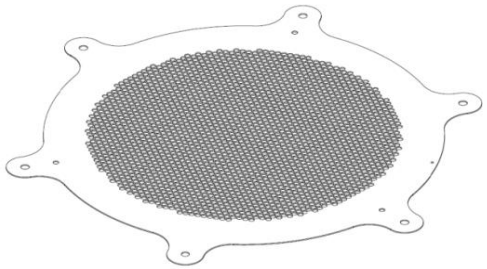
Photocatalytic corrosion

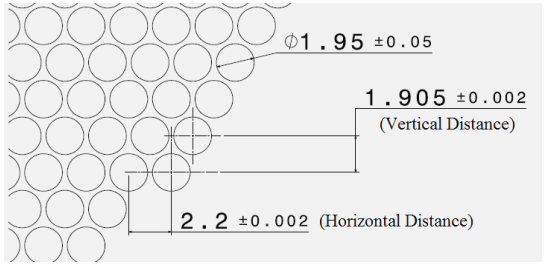


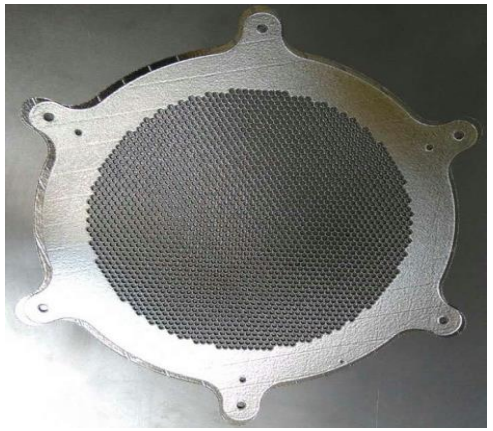
Hydraulic shaping

✓ 3D printing

- Simple process（2h vs 20h）
- High material utilization
- Environment friendly







Aerospace case study – Turbojet engine parts

STEP 1: Basic material performance verification-Third party report

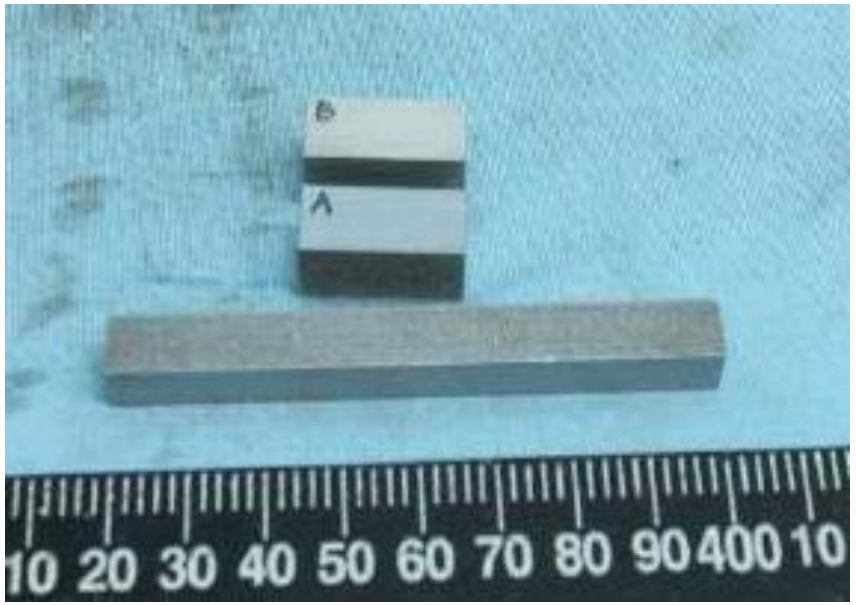
SGS ilac-MRA CNAS 中国认可 国际互认 检测 TESTING CNAS L0167

TEST REPORT

No. : GZIN1603009332ML
Date : Mar 24, 2016
Page: 1 of 4

CUSTOMER NAME: HUNAN FARSOON HIGH-TECH CO., LTD.
ADDRESS: NO.181 LINYU ROAD, CHANGSHA NATIONAL HIGH-TECH INDUSTRIAL ZONE, CHANGSHA, HUNAN, CHINA

The following sample(s) was/ were submitted and identified on behalf of the client as:
Sample Name : FS AlSi10Mg



1. Tensile test

ASTM E8/E8M-13a

2. Hardness test

ASTM E384-11

3. Surface roughness

ISO 4287-1997/Cor. 2:2005,AMD. 1:2009

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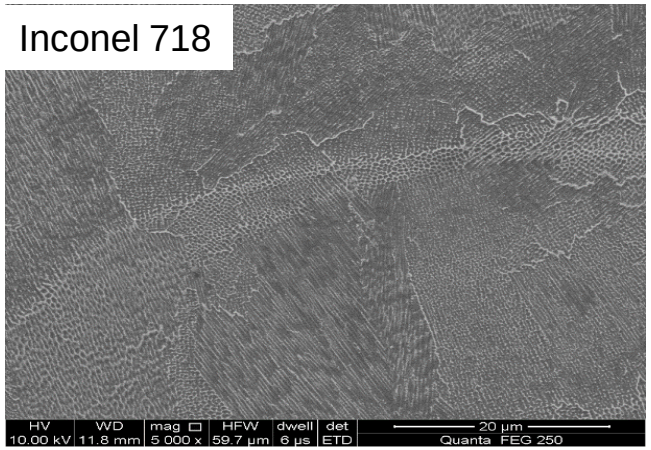
AVIATION INDUSTRY CORPORATION OF CHINA

中国航发
AECC

Aerospace case study – Turbojet engine parts

STEP 1: Basic material performance verification-High density and properties

Inconel 718

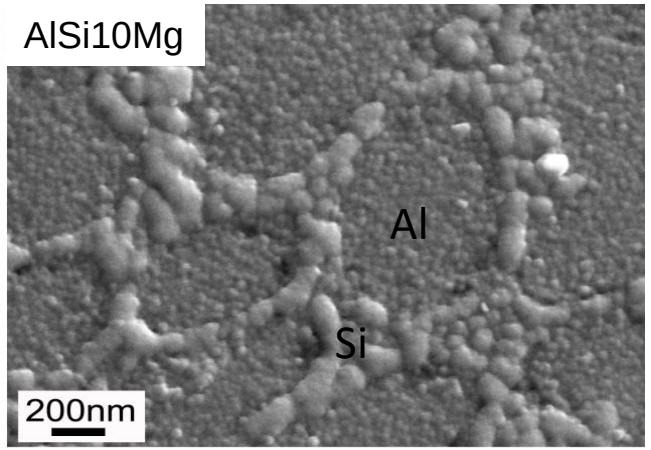


Properties of SLM Inconel 718 is similar with wrought standard

	$\sigma_{0.2}$ (MPa)	σ_{UTS} (MPa)	ε_f (%)
SLM	789±15	1094±20	17±5
Wrought	800	1036	12

Wrought data from ASM-aging

AlSi10Mg



Twice the yield strength, 50% higher ultimate tensile strength

	σ0.2 (MPa)	σUTS (MPa)	δ (%)
SLM/Ar	260±11	430±8	3.4±0.6
Casting	145	300	2.5

[1]Die casting data from B. Suárez-Peña, J. Asensio-Lozano, Mater. Charact. 57 (2006) 218-226.

Aerospace case study – Turbojet engine parts

STEP 2: Bench mark testing of key parts of turbojet engine

AlSi10Mg rotor part
(φ125mm x 64mm)
Printing time: 25h

Inconel 718 rotor part
(φ125mm x 30mm)
Printing time: 15h

Results: Above two parts have all passed 100,000-rotations-per-minute test and no apparent deformation comparing with the same parts produced using traditional manufacturing methods ruptured at speeds below 100,000 turns per minute.

Aerospace case study – Turbojet engine parts

STEP 3: Higher speed bench mark testing

Following the successful testing of the 3D printed jet engine parts, the 3D printed parts will also be put through their paces at even higher speeds (160,000 rotations per minute) to see how they cope.

Future: Integrated design to improve overall engine life

The next step after property testing will be aircraft engine optimization, to significantly reduce the number of parts and joints needed and to improve the overall engine life.

THANK YOU

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