Application of Direct Laser Sintering for manufacture of synchrotron components

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What is Direct Metal Laser Sintering?

DMLS uses a laser to selectively melt powered metals to produce a 3D product

What are the advantages?

- Material only where required
- Variable wall thickness
- Integrated cooling channels
- Highly complex webbing and ribbing
- Small feature size, eg 0.4mm holes
- Parts that cannot be produced by traditional methods
- Reduced mass
- Higher stiffness
- Single components can replace welded or bolted parts
- Faster manufacture

What metals can be used?

- Stainless steels (316L, GP1, PH1)
- Maraging (MS1) and Cobalt Chrome Steels (MP1 and SP2)
- Cupro Nickel (DM20)
- Titanium Alloys (Ti6Al4V)
- Aluminium Alloys (AlSi10Mg)
- Nickel Alloys (Inconel 725, 618, 625)
- Silver alloys (Argentium, 0.3% Ge)
- Copper based alloys

How small can the features be?

- 20µm or 40µm layers
- 20 µm or 5µm powders
- 50 µm hole
- Threaded holes require no post finishing

What are the largest components that can be made?

Largest Machine is currently XLine 1000R manufactured by Concept Laser GmbH. This has a build volume of 630mm x 400mm x 500mm which has recently made a part 474mm x 367mm x 480mm.

A typical build volume is 250mm x250mm x 315mm

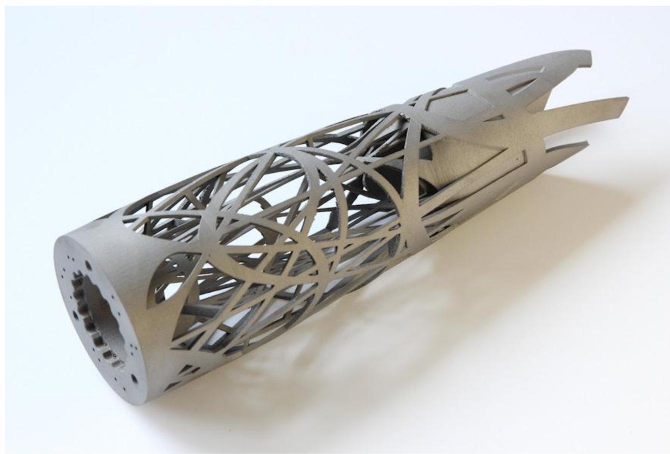
Future ?

- Larger machines with larger build volumes.
- New materials including metal matrix composites
- Improved optimisation and design software

Non Synchrotron Examples

Conventional steel cast bracket (left) and titanium bracket with optimised topology made by using DMLS technology (Source: EADS)

Prototype of a topology optimised Airbus A380 bracket made of stainless steel powder produced via DMLS with conventional bracket behind (Source: EADS).

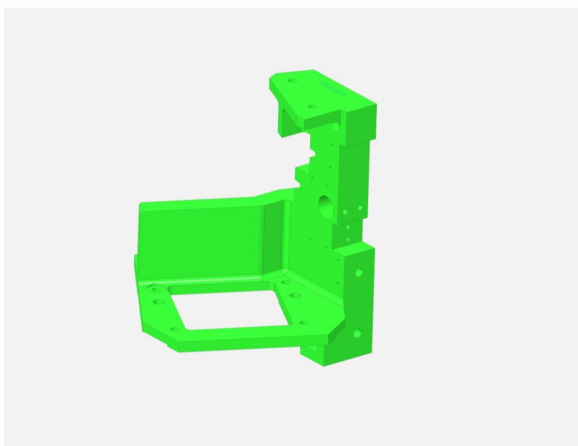


Queen's Baton for Glasgow 2014 Commonwealth Games

Synchrotron Examples

Test sample used for outgassing tests – SS 304

B07 Mirror cooling clamp - 304



Support structure for I20 Turbo slits – Maraging steel

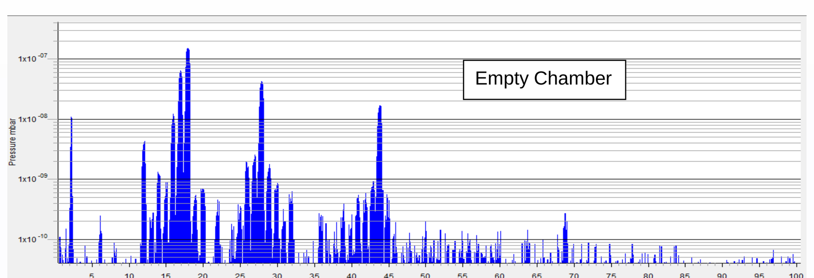
I09 – UHV conflat connector - 304

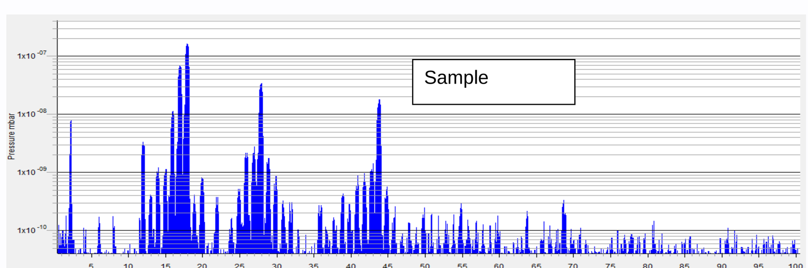
Is it suitable for use UHV?

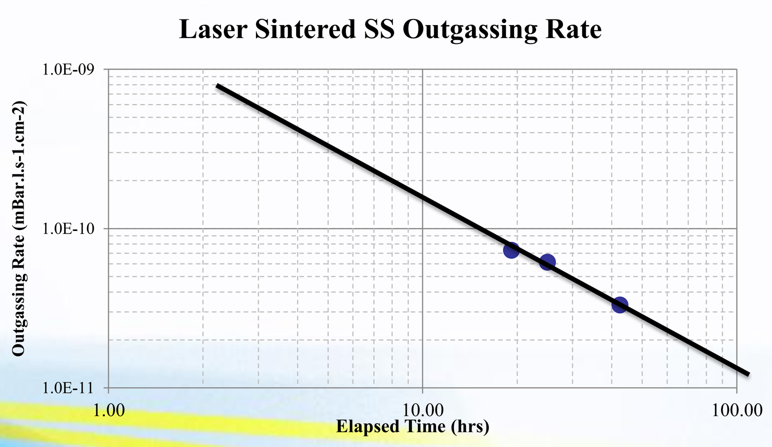
The finished components are fully dense with no porosity

Tests have shown that the material has the same outgassing properties as solid material.
There are no impurities shown in the RGA scans

Vacuum boundary components leak tested $<10^{-10}$mbar.l/sec







Issues that need attention

Components are made on a plattern and are built up layer by layer so the component may need supporting structure.

As the component grows stresses may be generated.

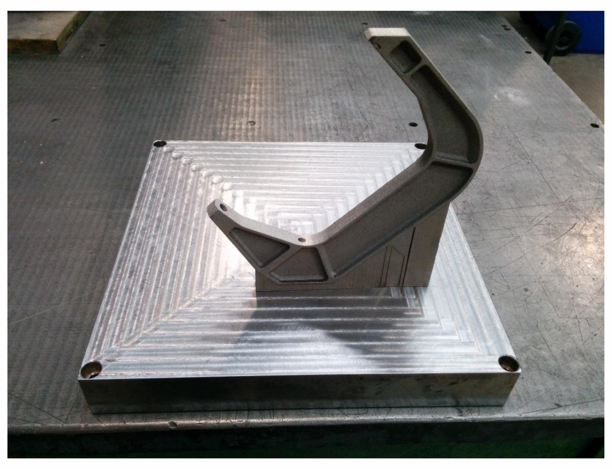
Thick sections are best avoided.

Avoid sharp edges, a minimum radii 0.5mm is recommended

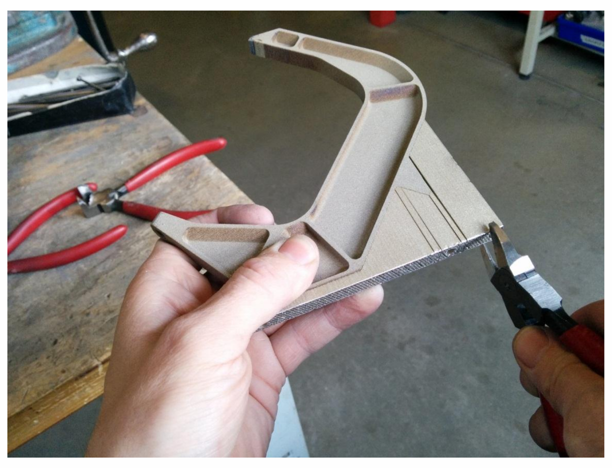
Design Guidelines are available.

Post finishing operations may be required such as
- Support removal
- Stress relieving
- Final machining to achieve tolerances
- Blasting to improve surface finish
- Polishing

Design needs to be optimised..



B07 Mirror cooling showing support structure



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