



Development of Magnesium Laser Powder Bed Fusion to manufacture light-weight components for Aerospace applications

Marc de Smit
marc.de.smit@nlr.nl

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- Magnesium AM
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NLR in brief

Aerospace Innovator
More sustainable, safer, more
efficient and effective



One-stop-shop



Global player with
Dutch roots

100+

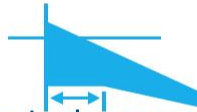
Since 1919



Amsterdam, Noordwijk
Marknesse, Rotterdam, Volkel



Innovative, engaged
and practical



For industry and
government



For fixed and
rotary wing



650 employees



€ 92 M turnover



72% Dutch, 22% EU
and 6% international



Active in 30 countries

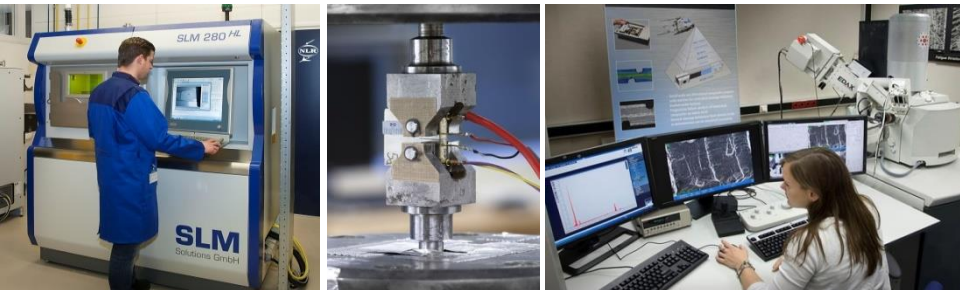
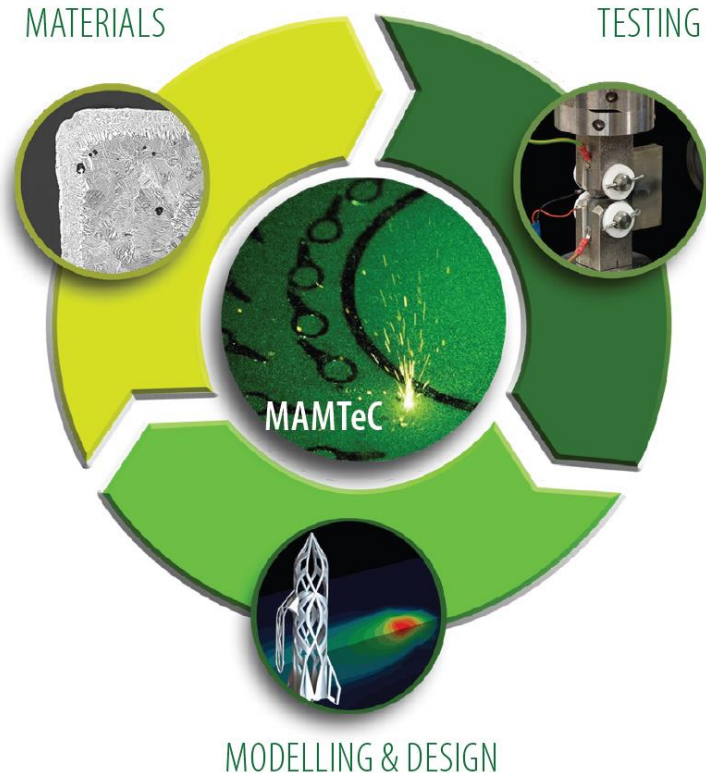


Extremely high
client satisfaction

Manufacturing Technology Centre (MAMTeC)

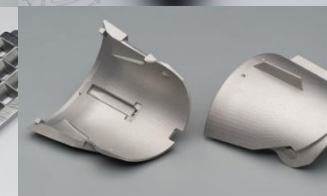
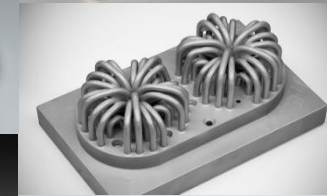
The Metal AM Technology Centre in NL

- Unique combination of knowledge, experience and facilities
- Focus on High-tech High-spec applications



Examples of MAMTeC projects

- R&D for Dutch Defence & Industry
- Parts for wind tunnel models
- Space applications
- Prototyping for various applications
- Process development new materials
- Process development Multi-material AM

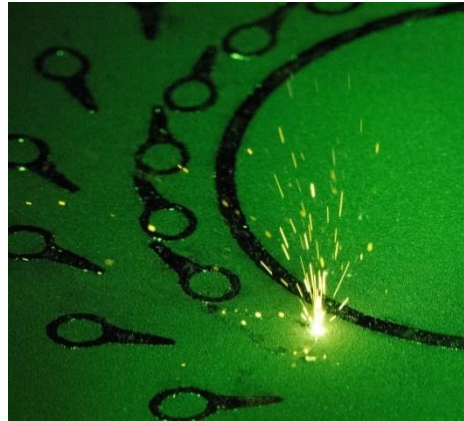
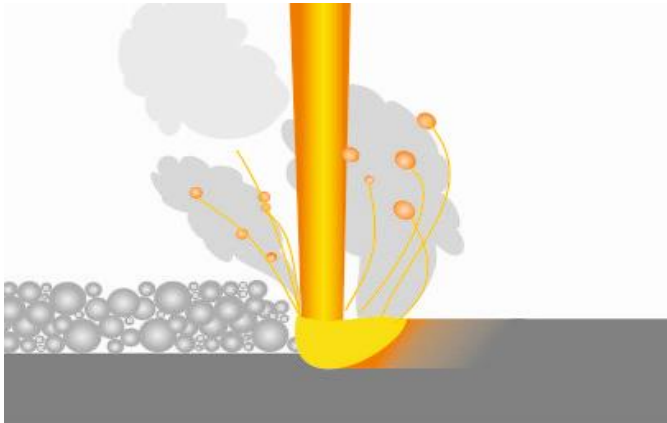


Metal Additive Manufacturing technologies @ NLR

- Powder Bed Fusion (Electron Beam or Laser)
- Directed Energy Deposition
- Sinter based metal AM (FFF based)



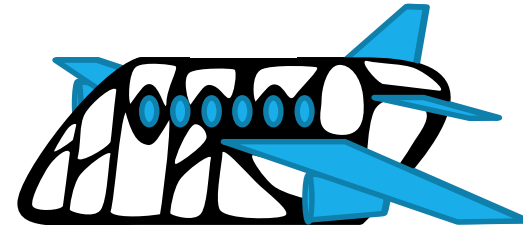
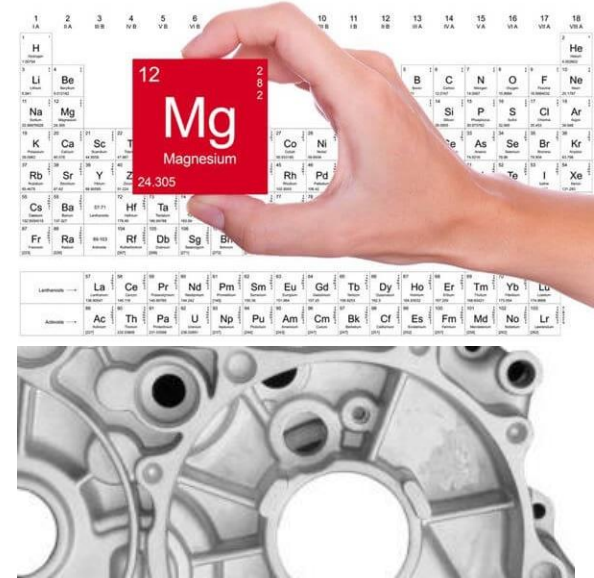
Laser Based Powder Bed Fusion (L-PBF)



Magnesium Additive Manufacturing

Opportunities for Aerospace applications:

- Low density
- high specific strength
- reduce weight
- reduce emissions
- Increasing fuel efficiency



Magnesium Additive Manufacturing

Challenges:

- Low boiling point & high reactivity with oxygen
- Excessive fumes generated
- Risk of process instability
- Suitable powder feedstock availability



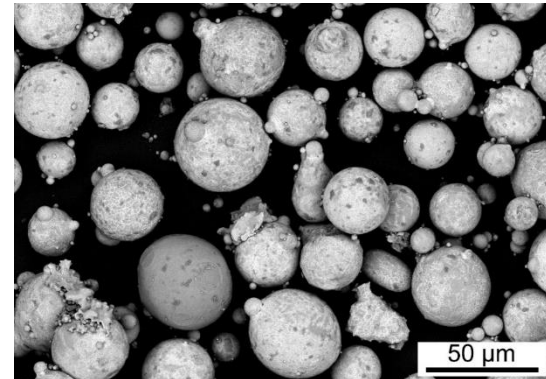
Feedstock material

- Selected alloy: WE43
- Powder must be suitable for thin layer application
- Good spreadability required
- Spherical particles
- Appropriate particle size distribution
- No contamination

Element	Weight percent [%]
Magnesium	Bal.
Yttrium	3.7-4.3
Zirconium	0.4-1.0
Zinc	0.2
Manganese	0.15
Copper	0.03
Iron	0.01
Silicon	0.01
Rare Earths	2.4-4.4
Other	0.4

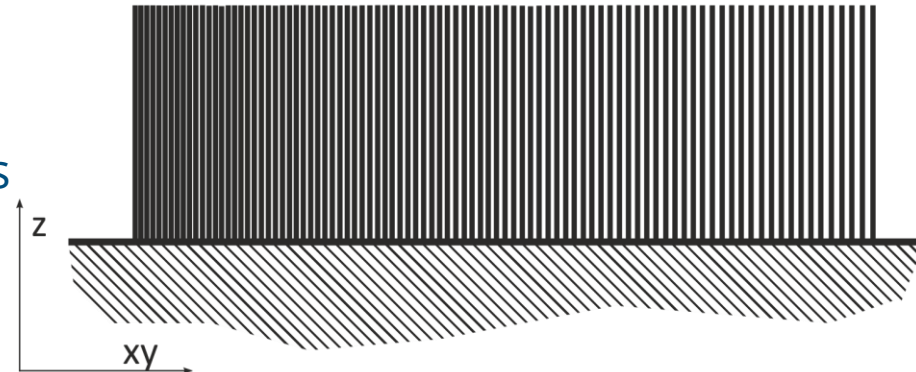
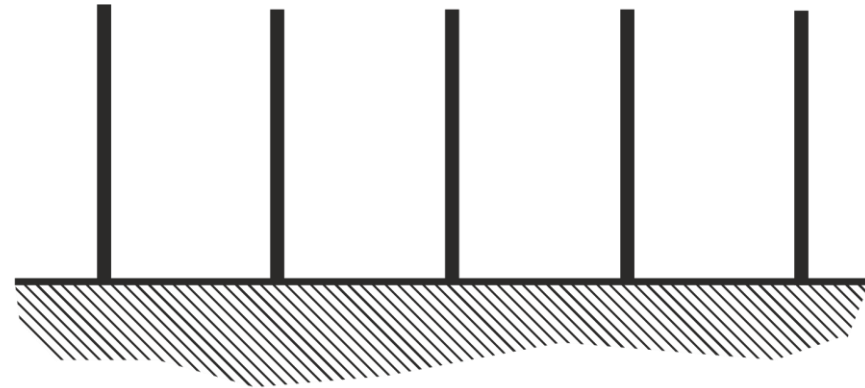
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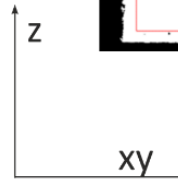
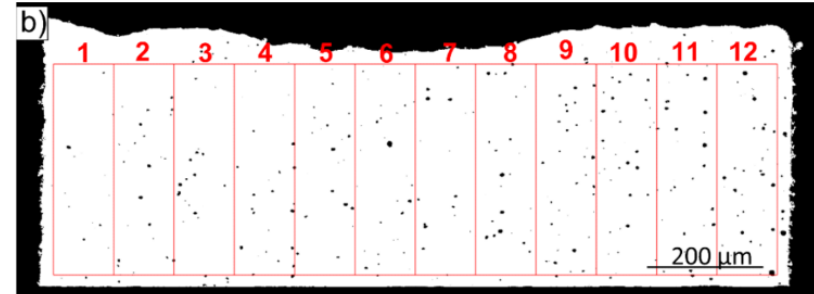
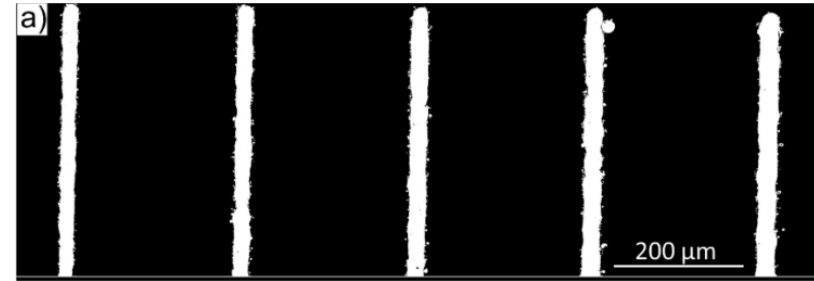
Parameter selection

- Key parameters are laser power, scan speed and scan spacing
- Optimisation method developed:
 - Thin walls
 - Variable hatch blocks
- Minimum amount of build jobs
- Automatic analysis of cross-sections



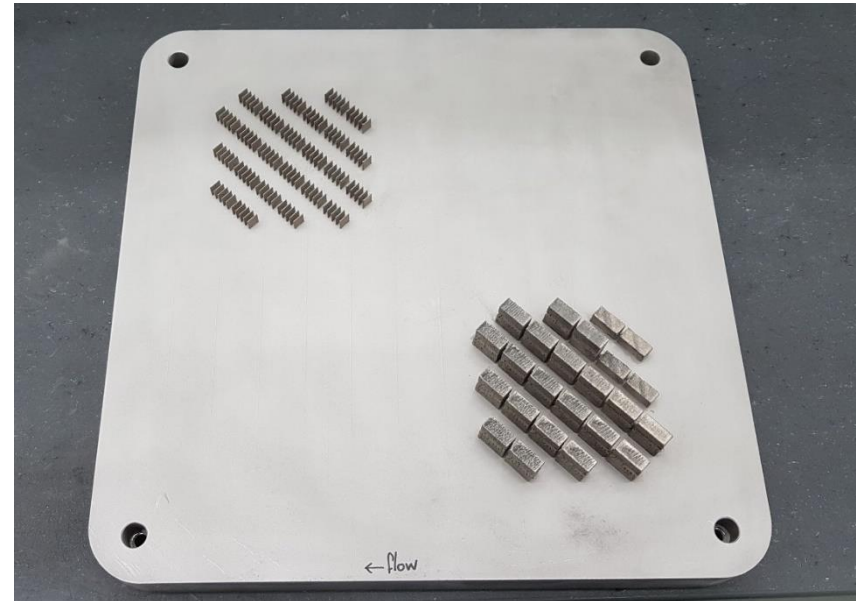
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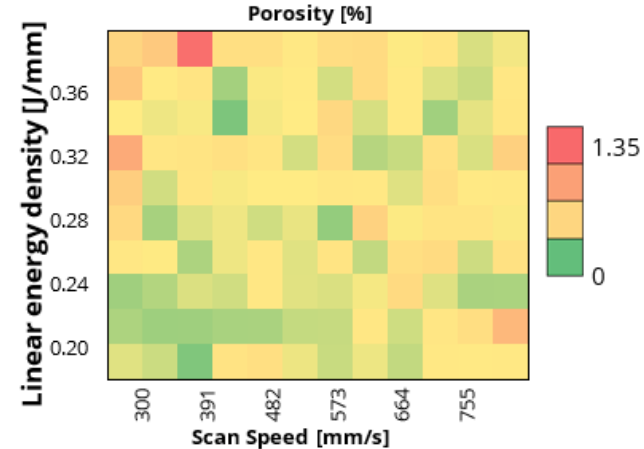
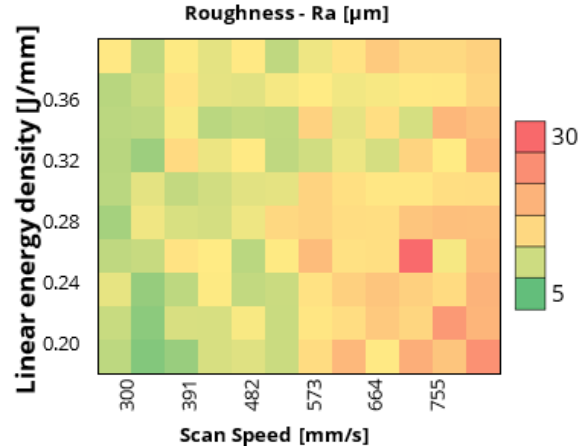
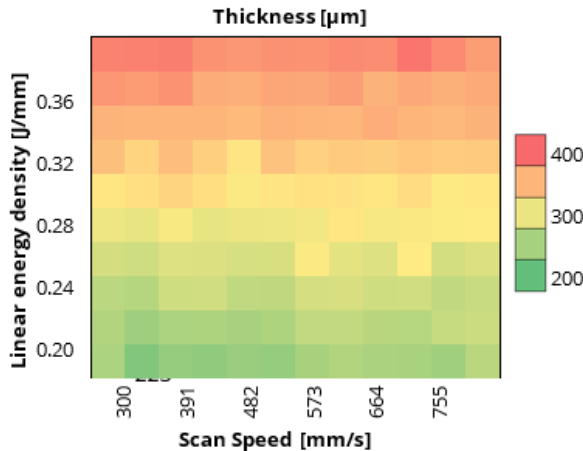
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Parameter selection

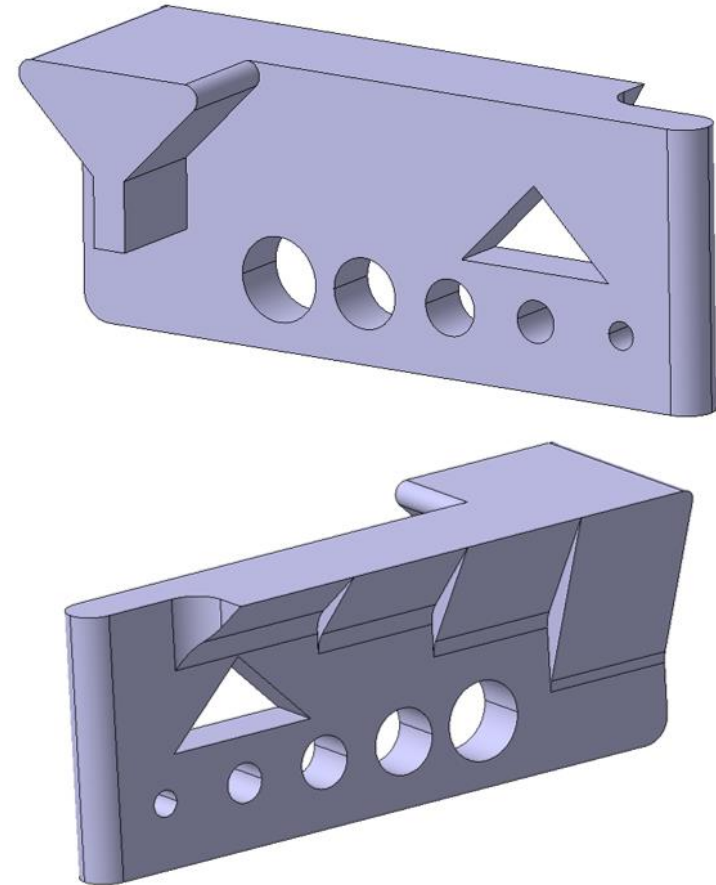
- Automatic analysis of cross-sections
- Selection of parameters based on product specific criteria



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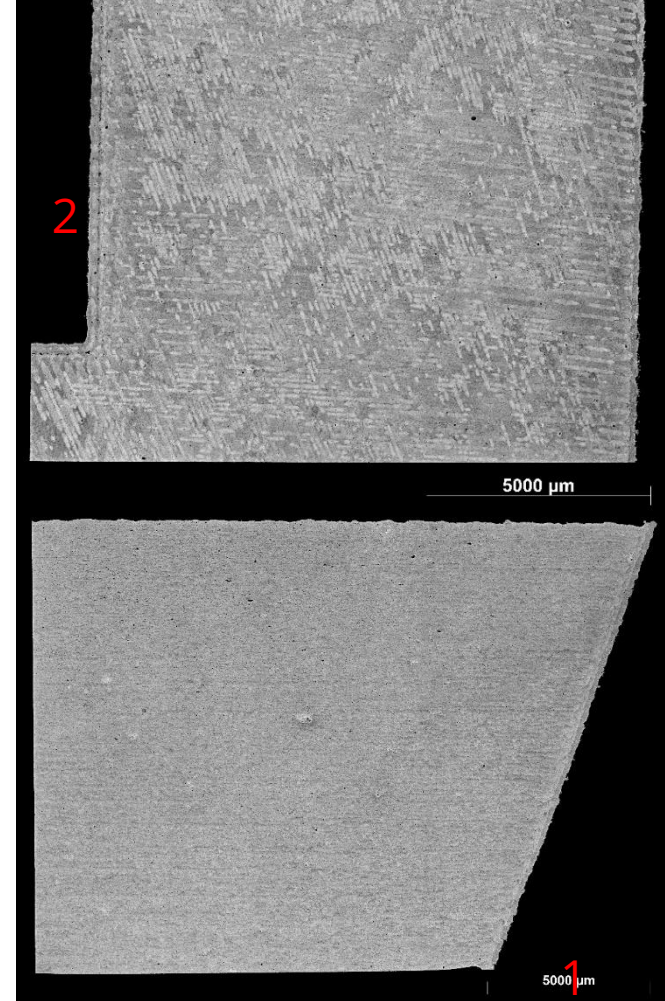
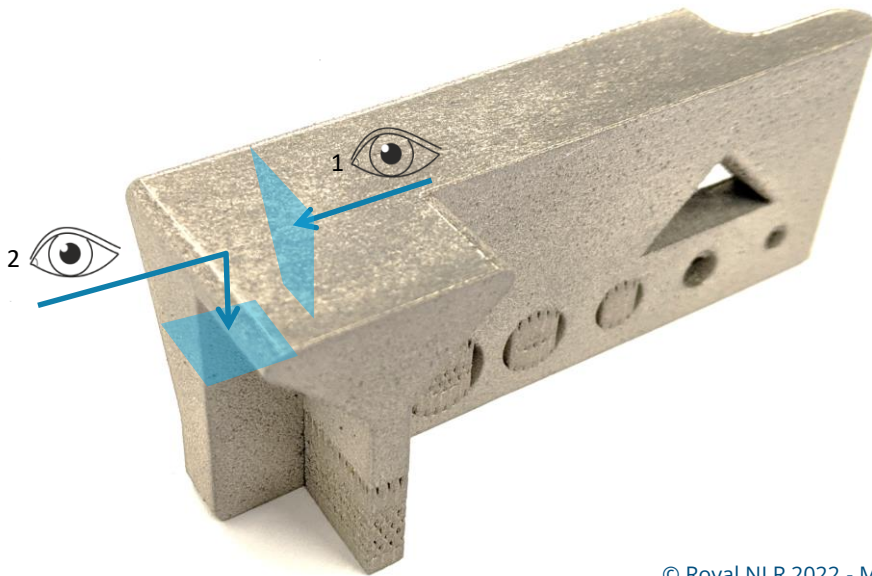
Benchmark part production

- Determining design guidelines for magnesium AM
- Evaluation of microstructure



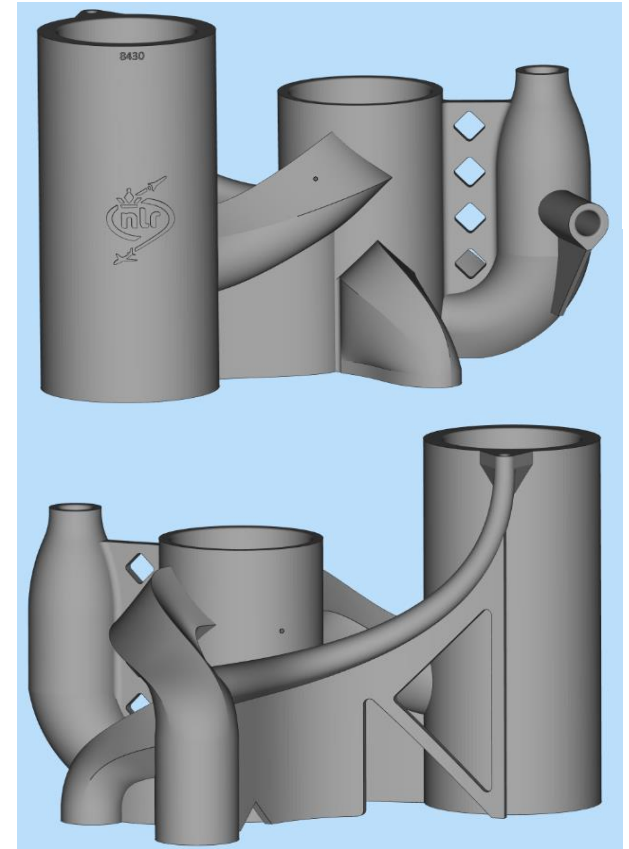
Benchmark part inspection

- Determining design guidelines for magnesium AM
- Evaluation of microstructure

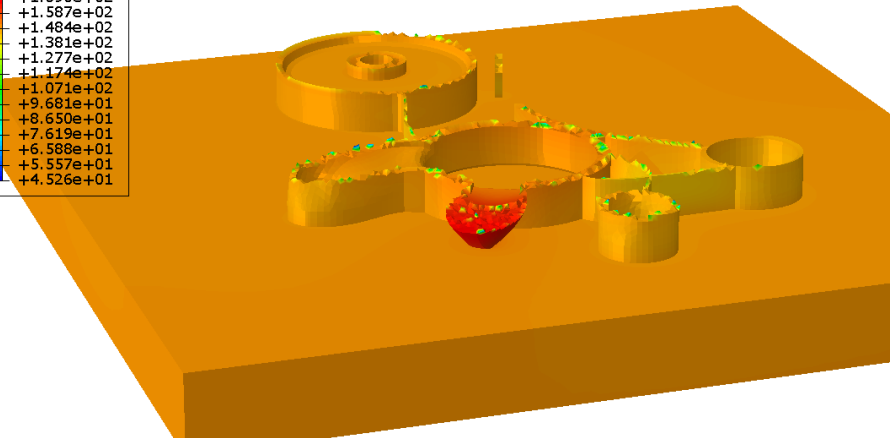
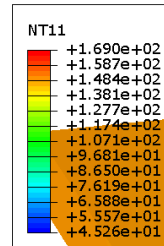
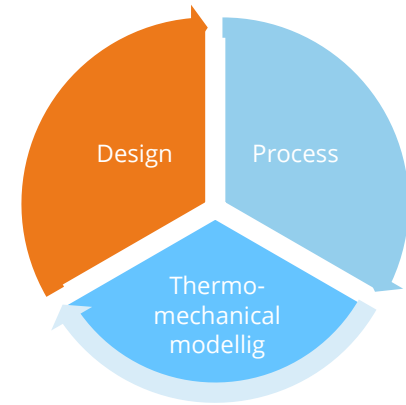


Magnesium AM Demonstrator

- Based on representative aerospace application
- Magnesium cast part
- LPBF design rules taken into account
- Thick walled sections removed
- Large overhangs prevented



3. Demonstrator production





We did it!

Magnesium AM for Aerospace applications

Conclusions

- Magnesium AM is challenging
- Capability is successfully demonstrated
- Approach enabled efficient selection of good LPBF process parameters
- Homogeneous fine microstructure obtained



Magnesium AM for Aerospace applications

Next steps:

- Develop dedicated heat treatment
- Investigate material properties
- Industrialise Magnesium AM process
- Develop feedstock QA requirements





Dedicated to innovation in aerospace

Fully engaged

NLR - Netherlands Aerospace Centrum



Voorsterweg 31
8316 PR Marknesse
The Netherlands

p) +31 88 511 44 44
e) info@nlr.nl i) www.nlr.org

Anthony Fokkerweg 2
1059 CM Amsterdam
The Netherlands

p) +31 88 511 31 13
e) info@nlr.nl i) www.nlr.org