

Linking DFAM, Design Optimization, and Generative Design

Allin Groom

EngD Research Engineer | @UniS_Materials



Scope

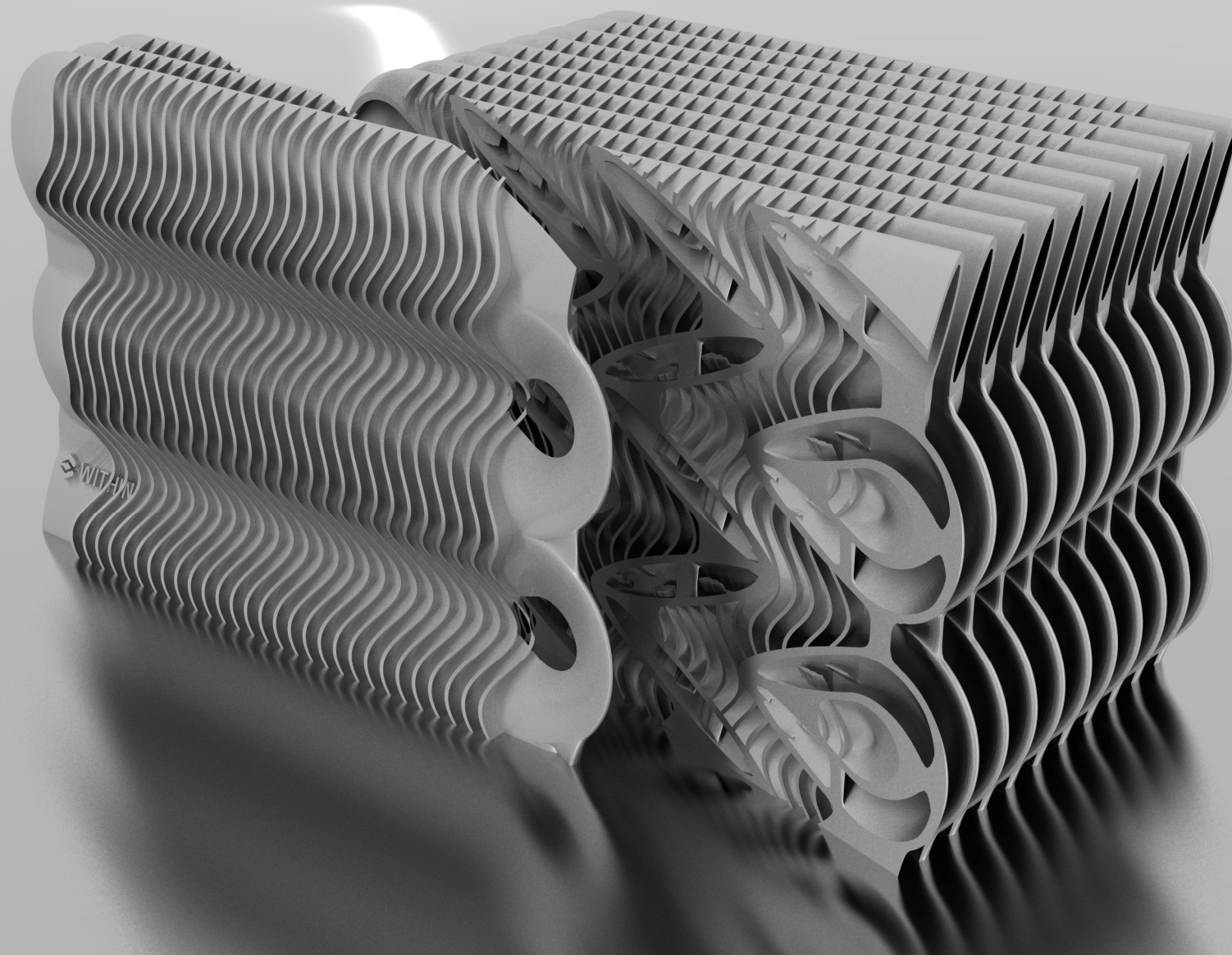
- Introduction
- DfAM
- Laser Powder Bed Fusion
- The Challenge
- Practical Research
- Future Research
- Conclusion

About the Speaker

- MEng in Materials Science and Engineering from Queen Mary, University of London.
- Background in Polymer Nano-Composites for use in ballistic armour applications.
- Commissioned Officer in the British Army – Royal Electrical and Mechanical Engineers.
- Now pursuing an Engineering Doctorate with University of Surrey sponsored by Autodesk.
- Autodesk Research – Manufacturing Industry Futures, London









Additive Manufacture

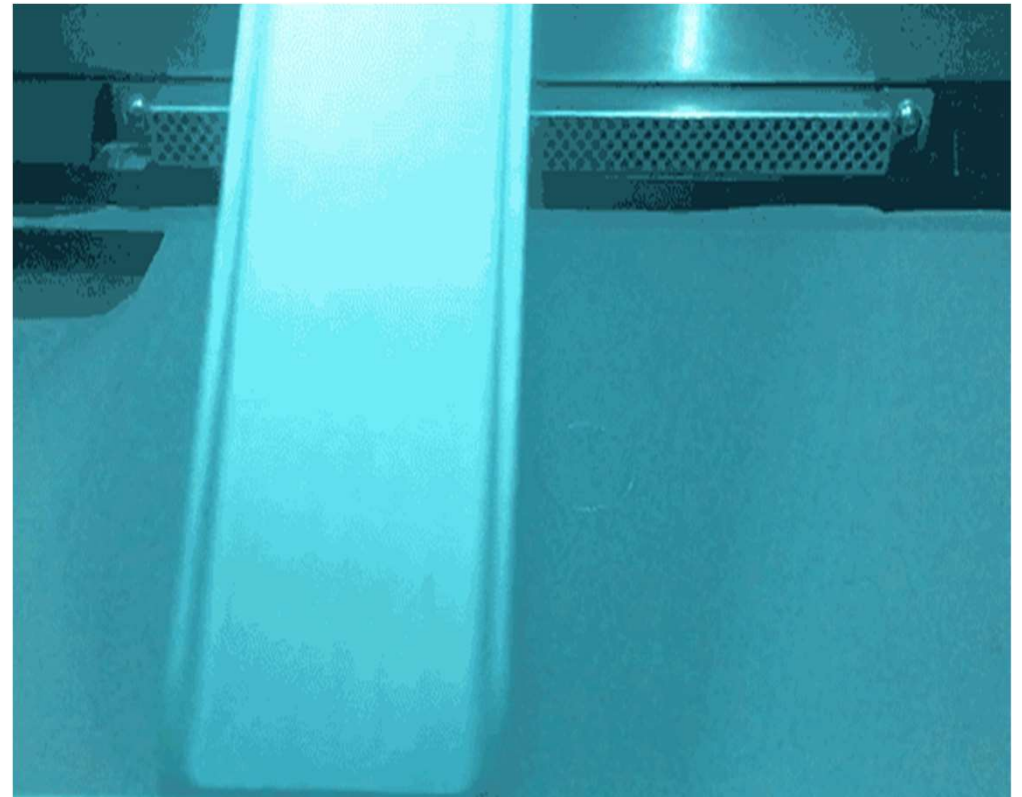
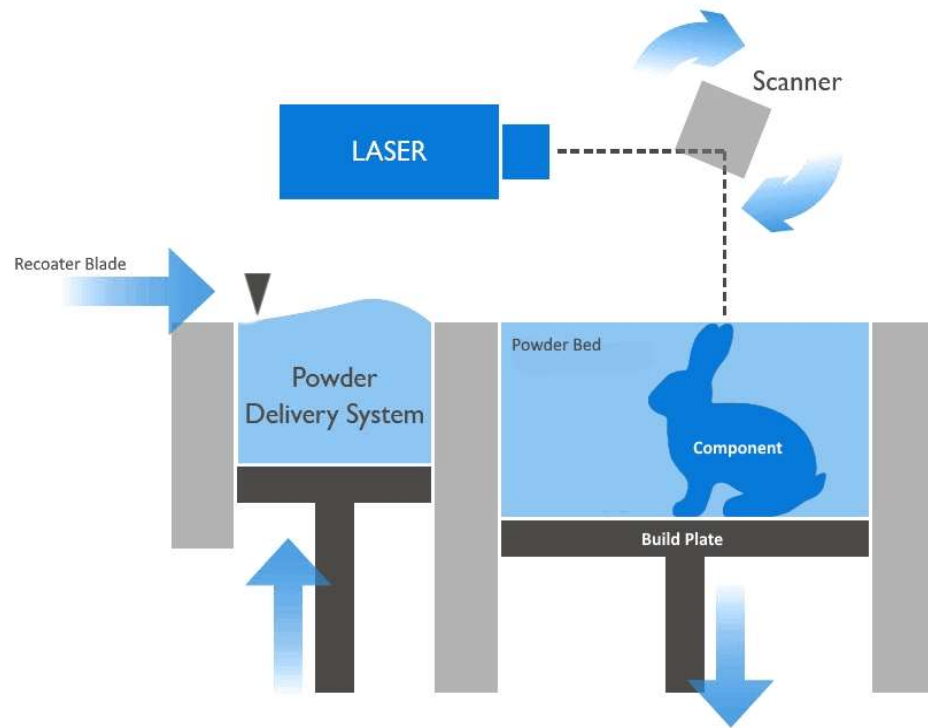
Design for Additive Manufacture (DfAM)



Images courtesy of Renishaw and The MTC

Laser Powder Bed Fusion

L-PBF



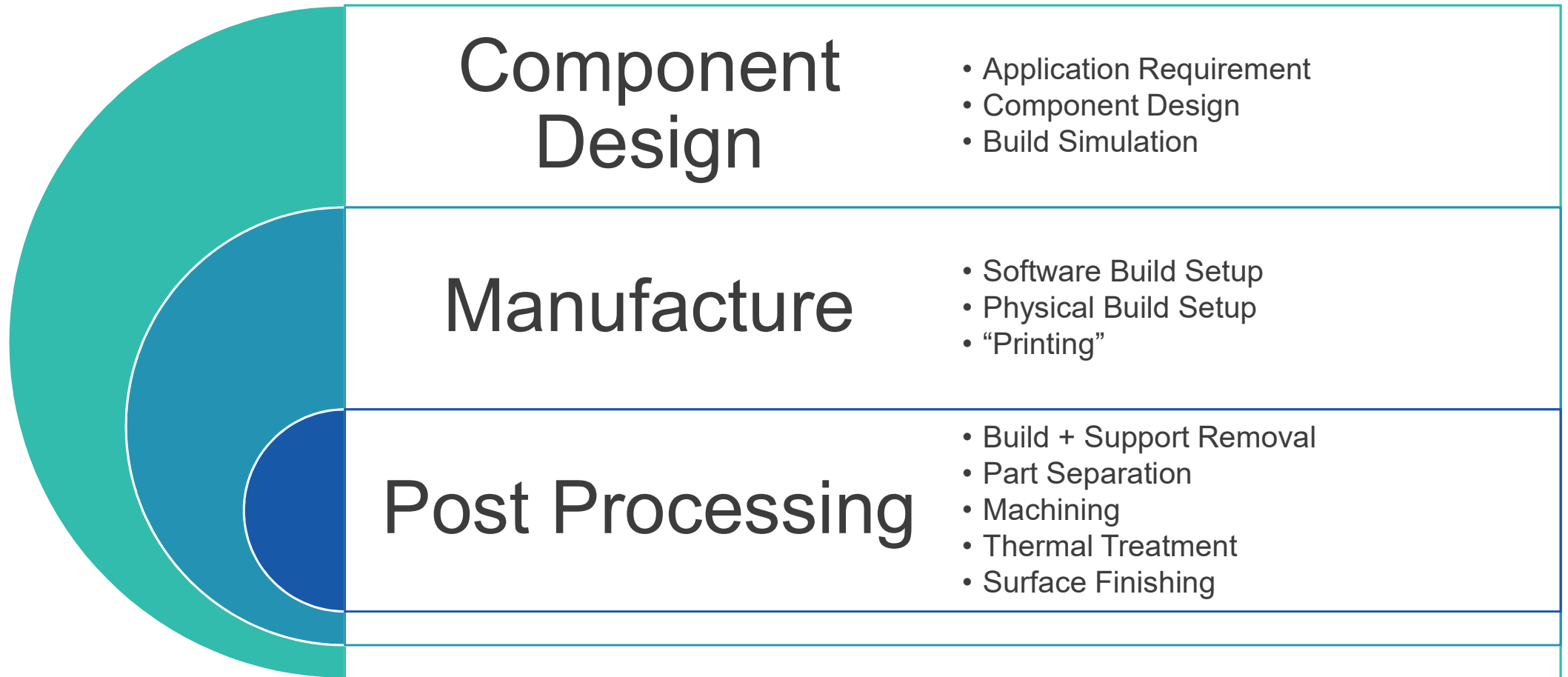
GIF courtesy of The MTC



Image courtesy of General Motors

Workflow

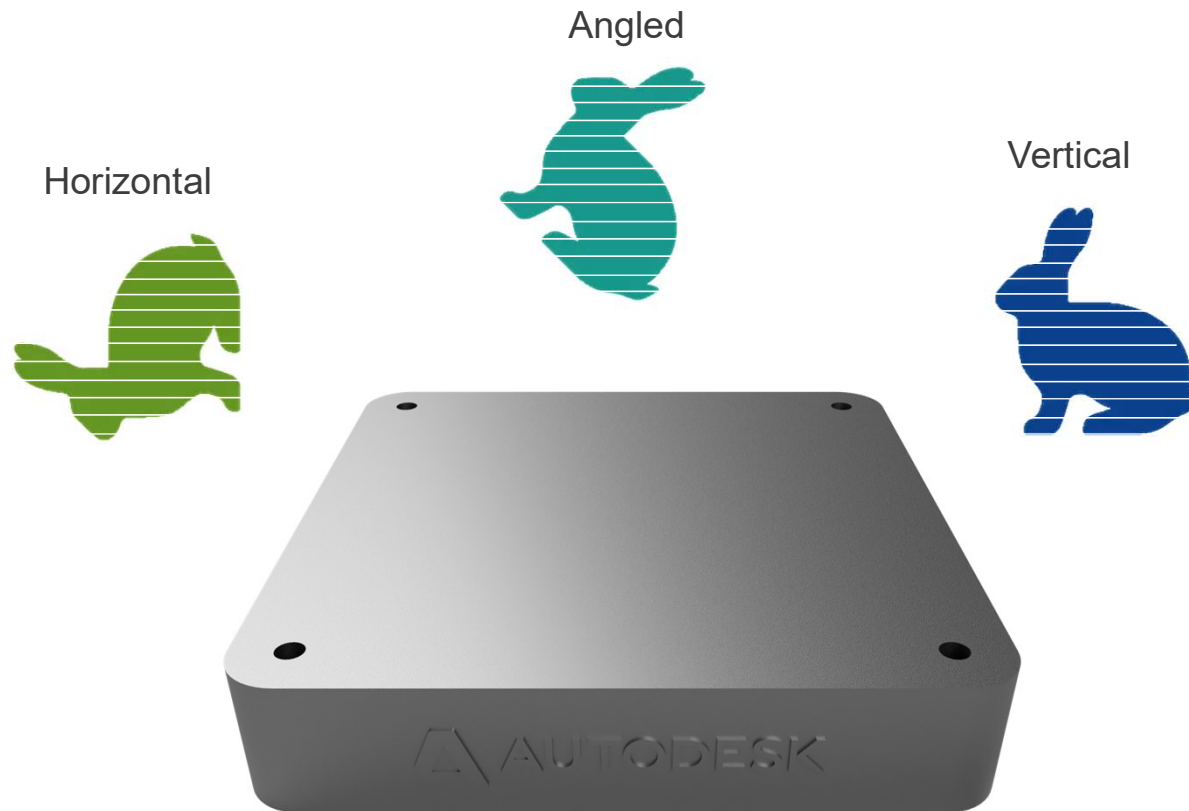
Considerations down stream.



The Challenge

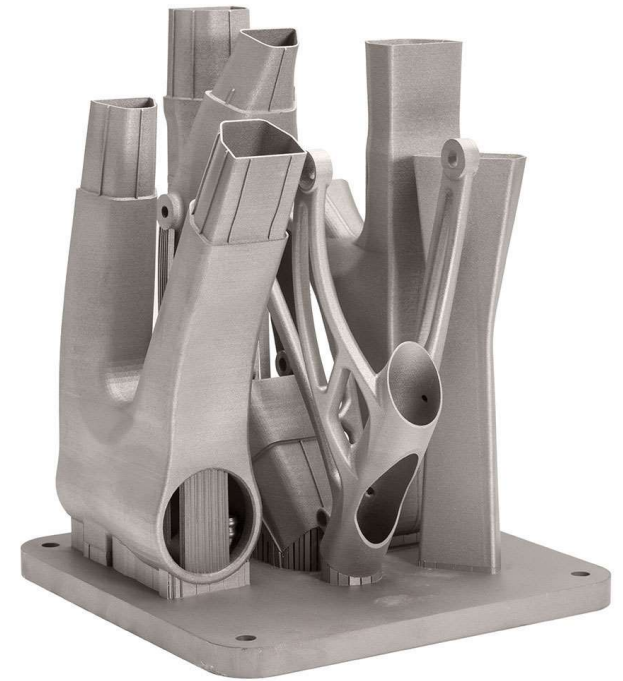
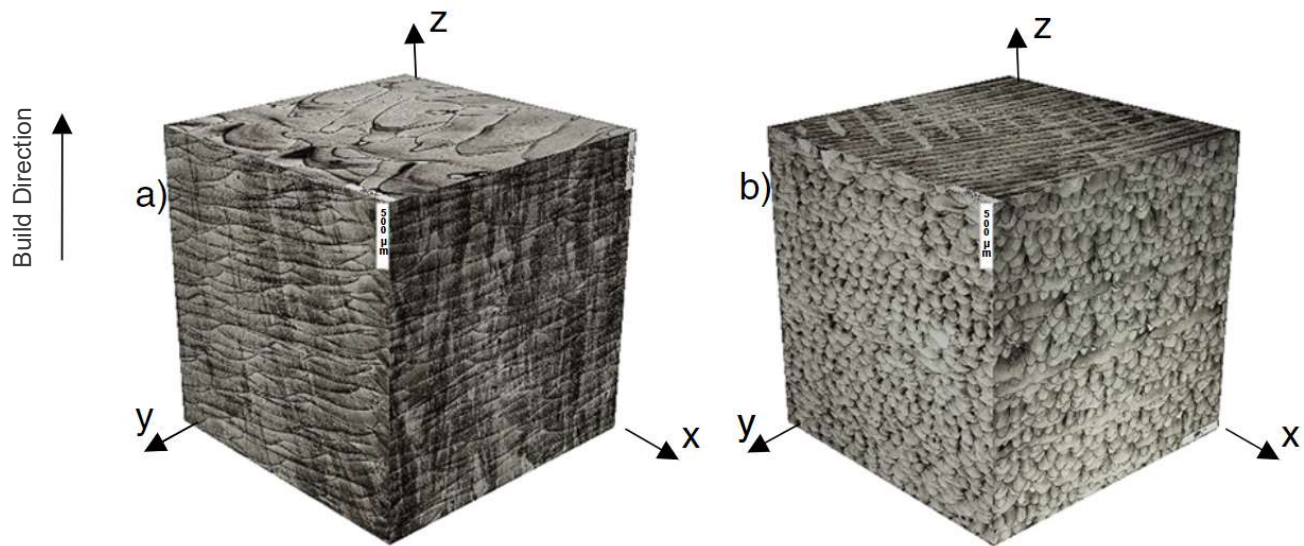
Build Orientation

How will this affect part performance?



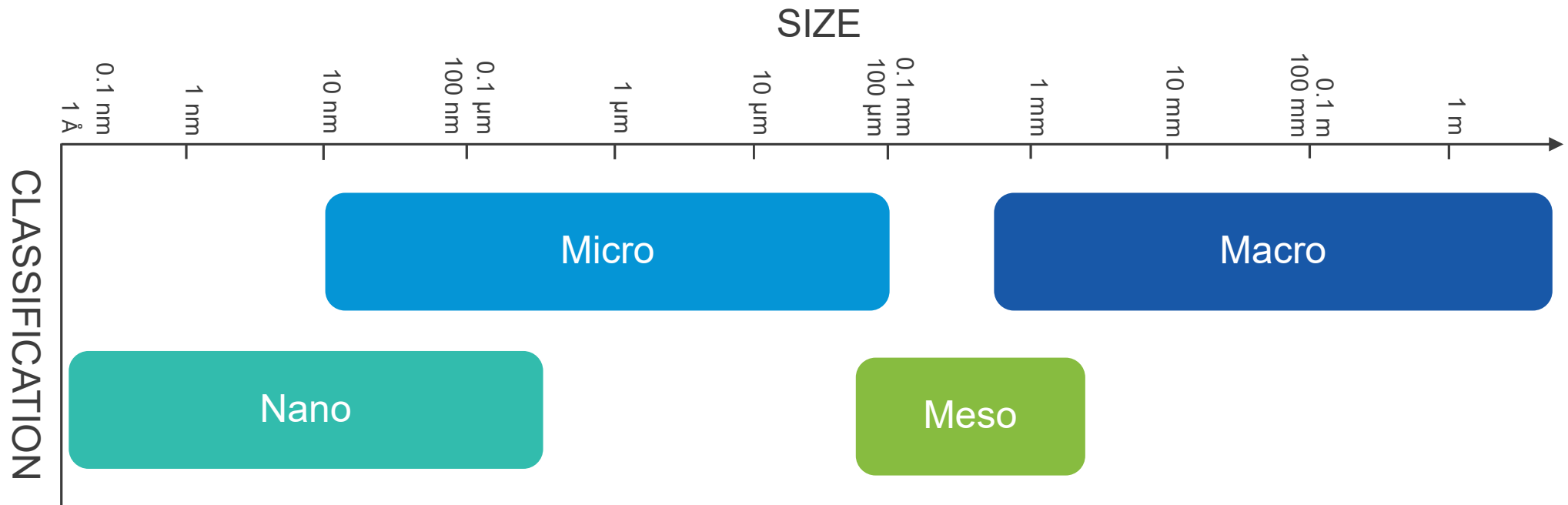
Build Geometry

Microstructural Anisotropy



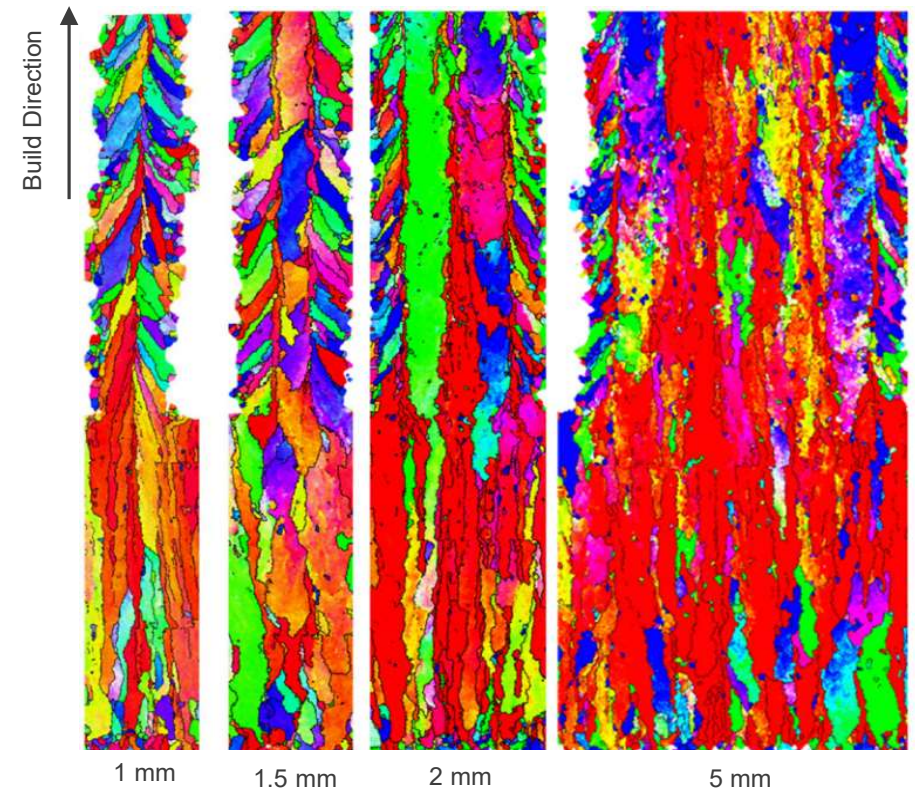
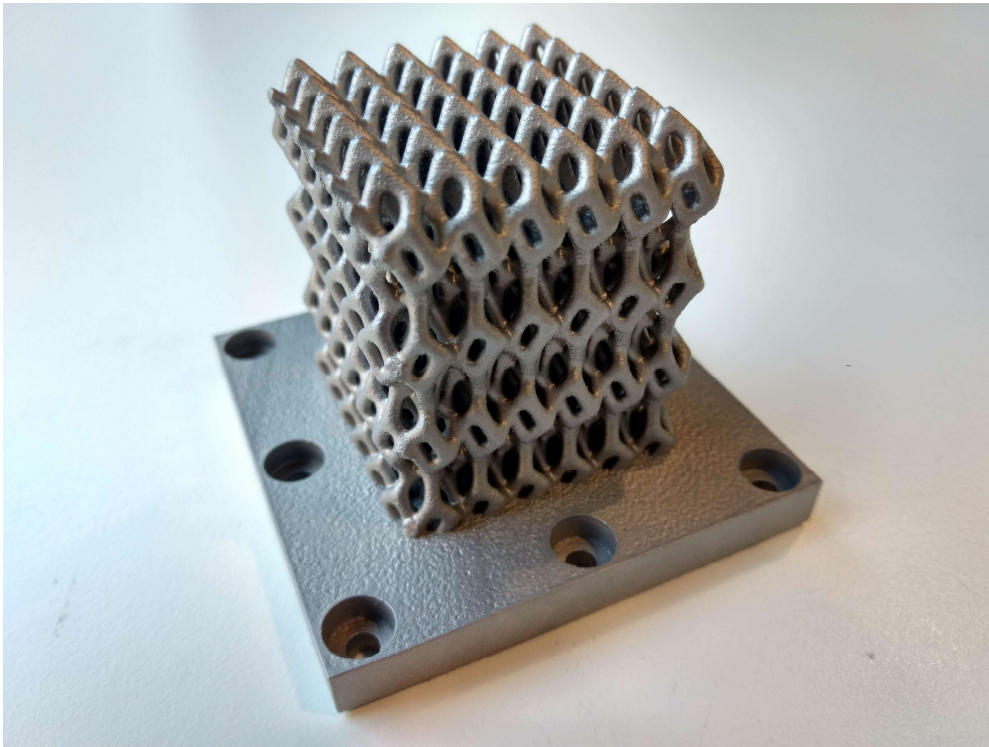
Manufacturing Scale

Mesoscale 0.1 – 5 mm



Feature Thickness

Bulk vs Surface Influence



The background features a series of blue, three-dimensional, curved shapes that resemble stylized waves or architectural elements. These shapes are layered and have a soft, ethereal glow. A white, semi-transparent rectangular box is positioned on the left side of the image, containing the text. The overall color palette is light blue and white, creating a clean, modern aesthetic.

Practical Research Approach

Experimental

Representative Testing

- Representative sample design.
- Mechanical testing – Uniaxial tensile and fatigue.
- Compositional and microstructural analysis.
- Fracture surface analysis.
- Post process impact.

Materials

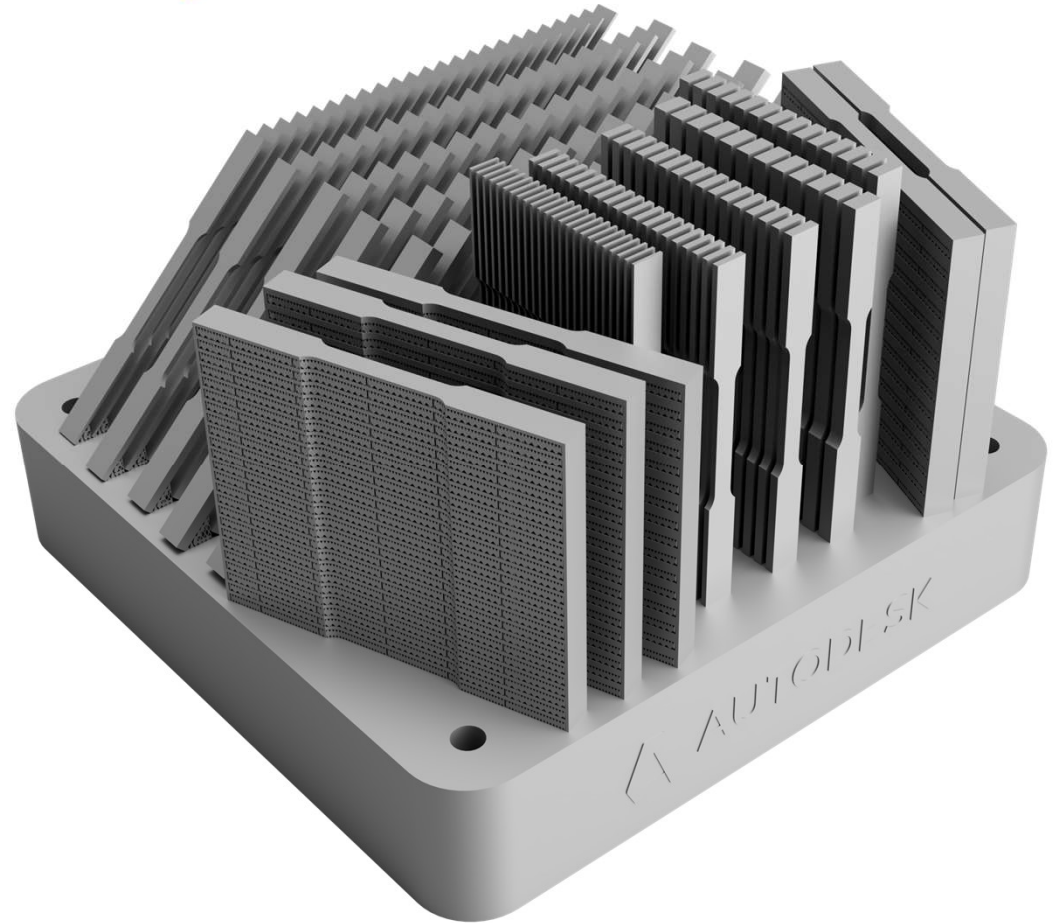
Additive Alloys

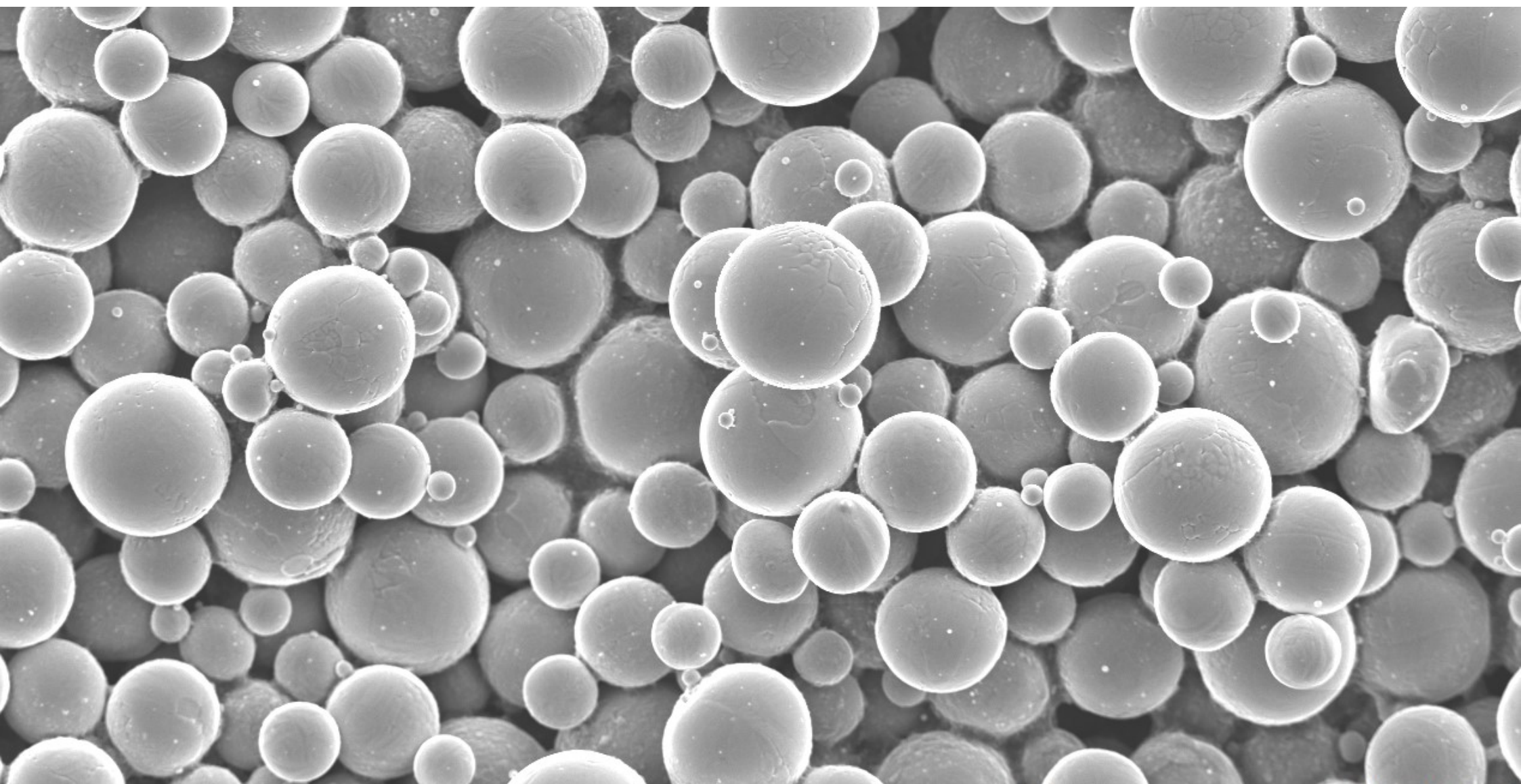
- Ti-6Al-4V
- Al-Si-10Mg
- Inconel 718
- Maraging Steel M300



Sample Design and Build Layout

ASTM E8





Ti6Al4V Virgin Powder

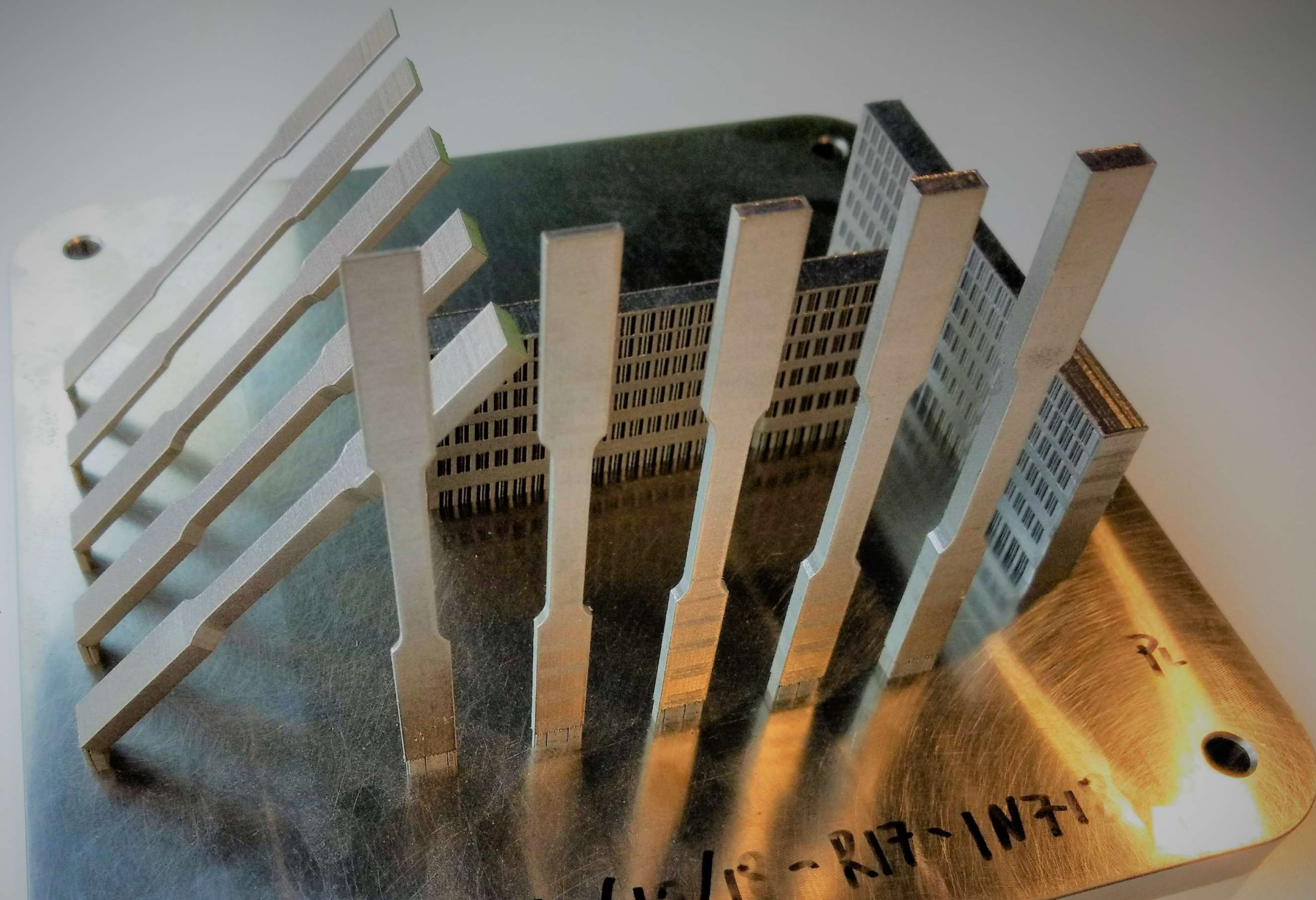
x330

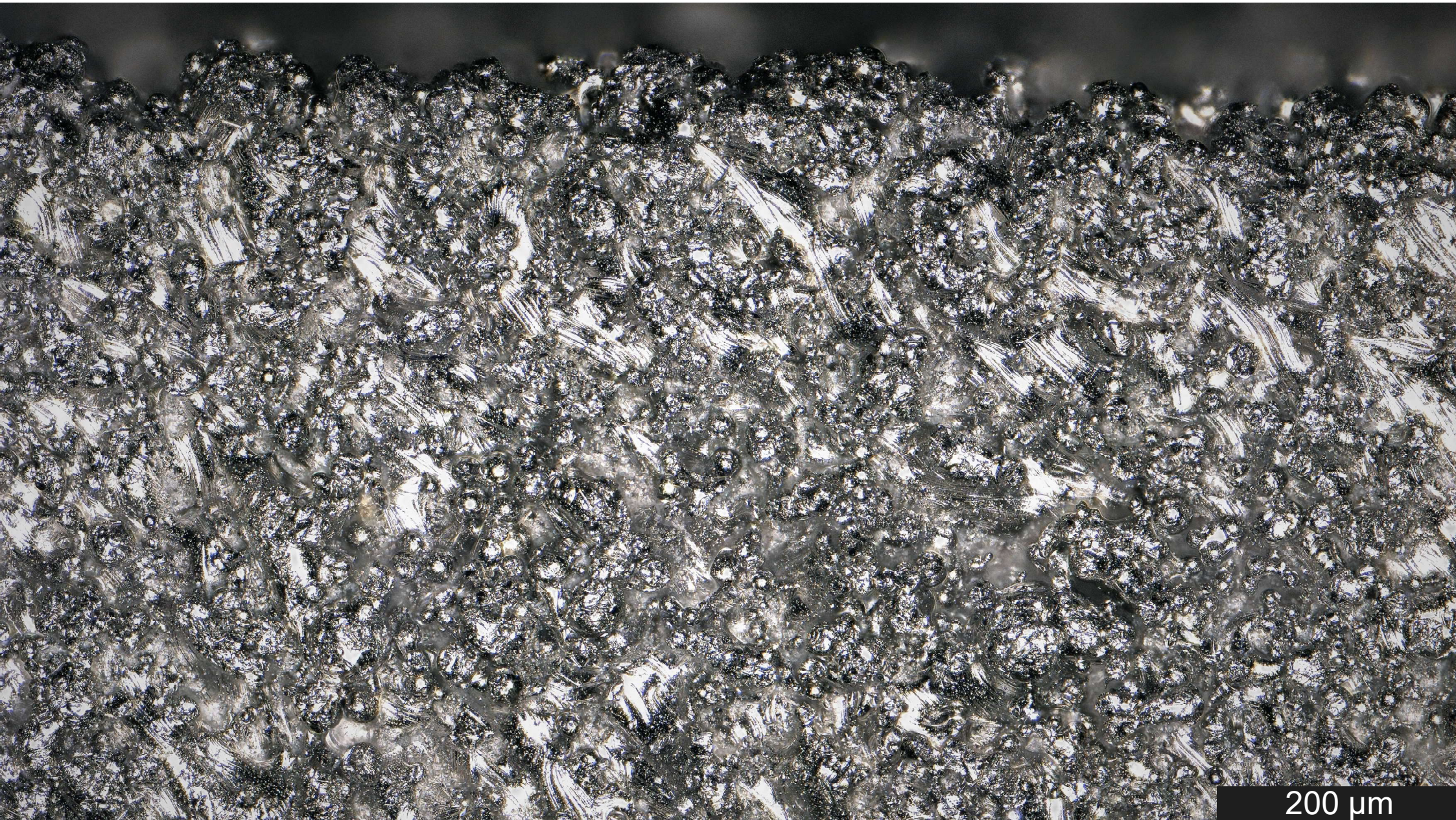
15.0kV LED

10μm

MSSU
SEM

11/20/2018
WD 10.0mm





200 μm

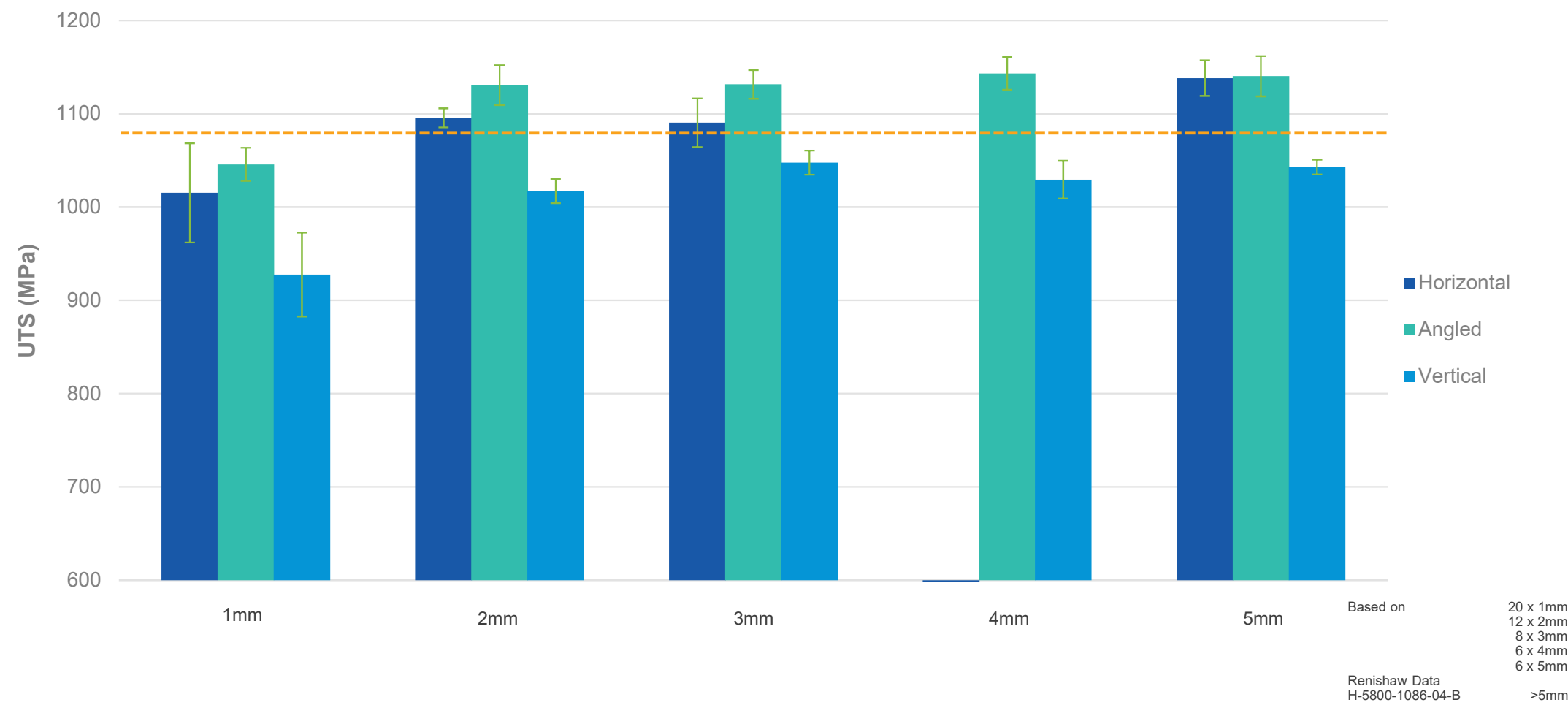




Practical Research Results

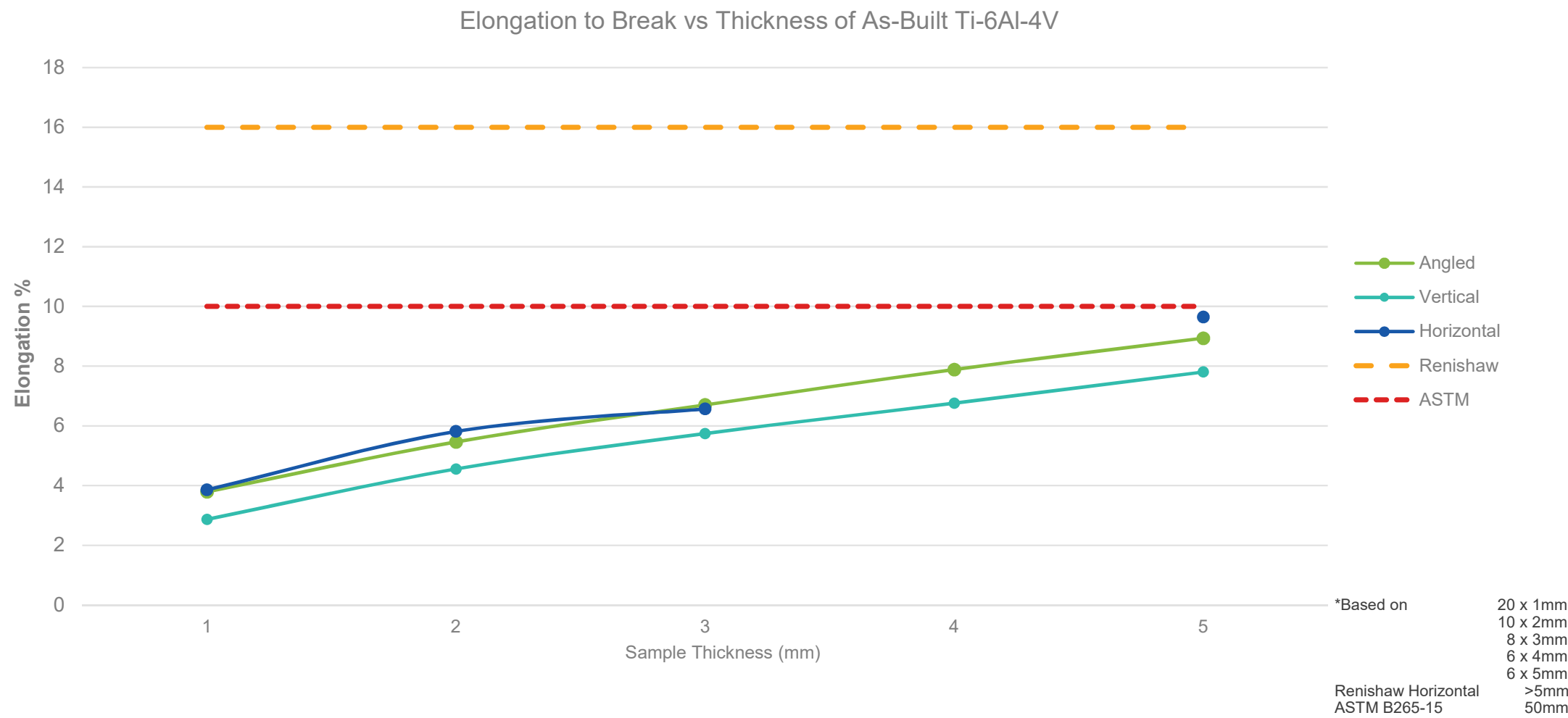
Practical Results

L-PBF Ti-6Al-4V (As Built) Mean UTS



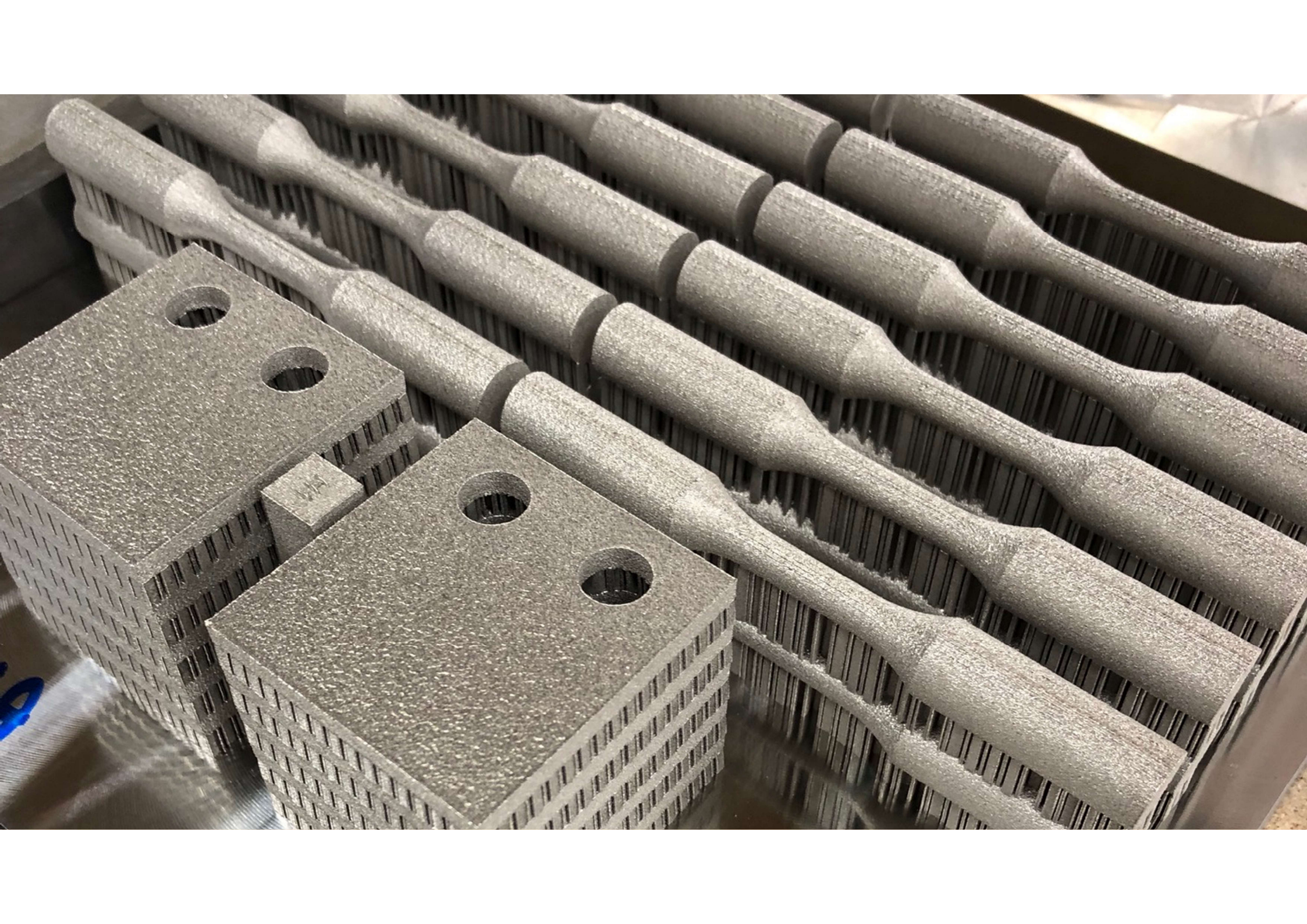
Results

Ti6Al4V (As Built)



The background features a series of blue, three-dimensional, curved shapes that resemble stylized waves or architectural elements. A prominent white diagonal band runs from the top left towards the bottom right, creating a sense of movement and depth. The overall color palette is light blue and white, giving it a clean, modern feel.

Ongoing Work



Fracture Surface Analysis

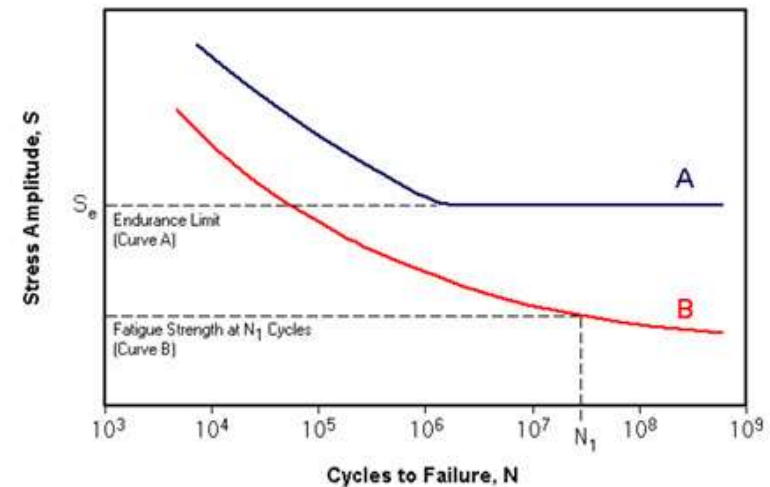
Ti6Al4V Low Cycle Fatigue



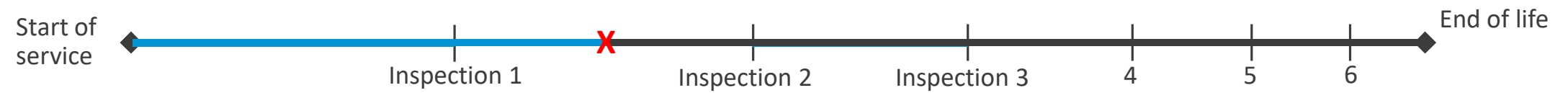
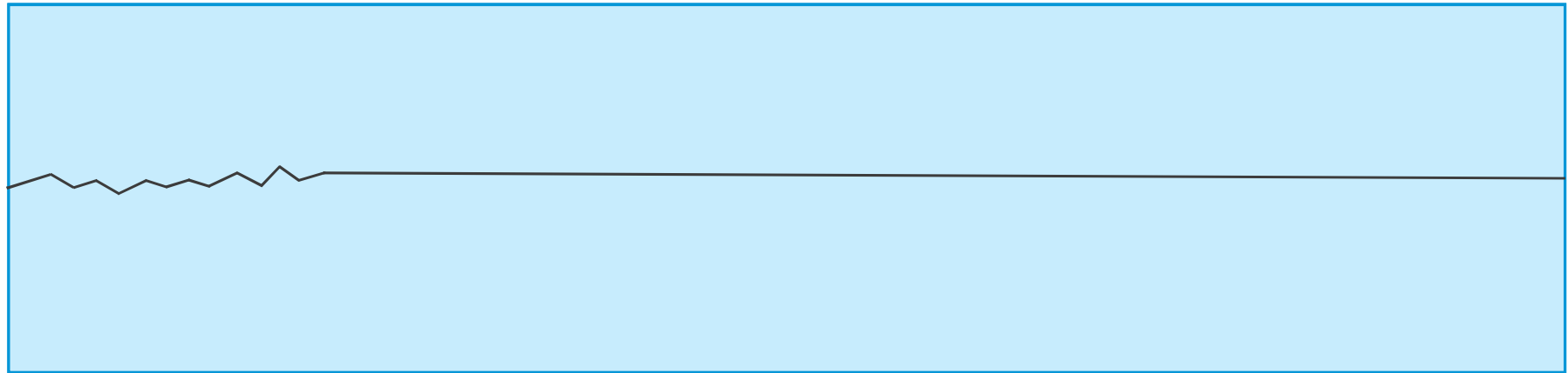
Fatigue Testing

Safe Life and Damage Tolerance

- **Safe Life Fatigue Design** – specifying how long a component should last for. This is dependant on data acquired from SN Curve.
- **Damage Tolerant Design** – This assumes a flaw exists within the component but is designed not to propagate to critical length before the next maintenance inspection.



Damage Tolerant





Concluding Remarks

Design Takeaway

“So what?”

- Additive alloys will exhibit variation in mechanical properties which can significantly deviate from published data values.
- Incorporating lattices and complex geometries for structural features should consider property variation.
- Microstructural anisotropy affects mechanical performance thus build orientation must be considered for structural components with tight property tolerances.
- Fatigue testing data will enable components to be designed with both safe life and damage tolerance approaches without the need for large enveloping volumes.



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