



# Gas Atomised Metal Alloy Powders for AM.

Paul A. Davies

Sandvik Additive Manufacturing

Gas atomised metal alloy powders for Additive Manufacturing, including new product developments, such as copper alloys for space technology applications.



Paul Davies, PhD  
Technical Solutions Manager  
Sandvik Additive Manufacturing



Osprey® Online – A new web-shop for AM  
(coming soon to the USA)

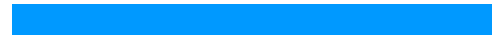
## CONTENTS

- Brief Introduction to Sandvik AM
  - Gas atomization capabilities
  - Metal powder product portfolio
- New Product Developments
  - Titanium alloys, including Ti6Al4V
  - Cobalt chrome
  - Maraging steels, including 18NI300, MAR-60 & MAR-50 Co free
  - Super duplex stainless steel
  - Copper alloys for space technology applications
- Summary

# BUSINESS AREAS – OUR PORTFOLIO

## SANDVIK MINING AND ROCK SOLUTIONS

48%



48%



## SANDVIK ROCK PROCESSING SOLUTIONS

9%



7%



Sandvik Materials  
Technology split out as  
Alleima in 2022



## SANDVIK MANUFACTURING AND MACHINING SOLUTIONS

43%



45%



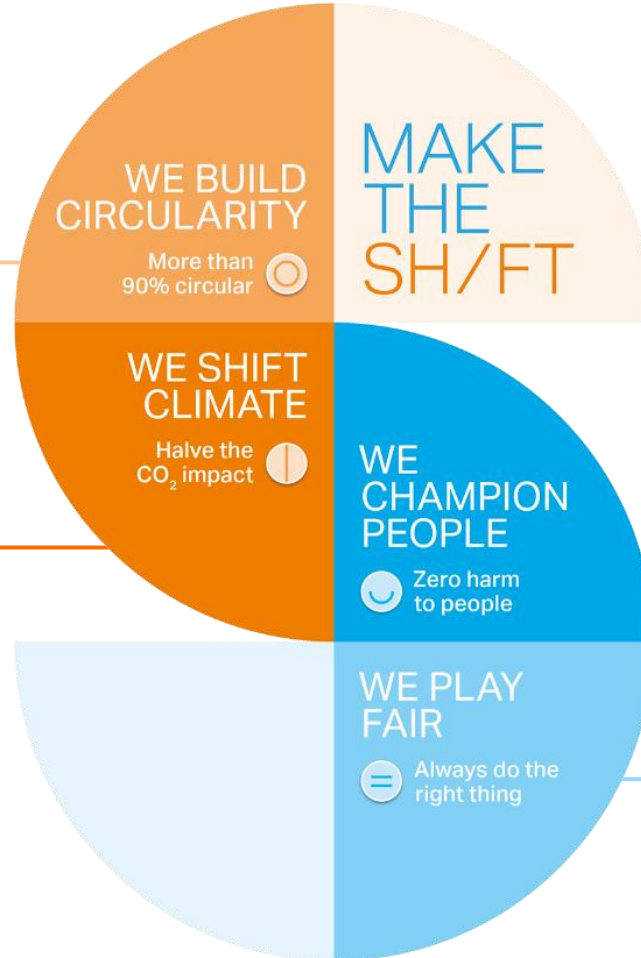
Share of revenues 2021

Share of adjusted EBIT 2021



# FOUR LONG-TERM SUSTAINABILITY GOALS

We build circularity –  
More than 90% circular



We shift climate –  
Halve the CO<sub>2</sub> impact

We champion people –  
Zero harm to people



Fair Play – Always do the right thing



# SANDVIK ADDITIVE MANUFACTURING

## POWDER PRODUCTION AND AM CONSULTANCY & MANUFACTURE



- 10 Inert Gas Atomisation (IGA)
  - 8 fine powder plants for MIM
- Argon & Nitrogen atomising
- Powder sizing; 5 – 80 micron

BEAMIT  
AM Centres



SANDVIKEN  
SWEDEN

NEATH, UK

SANDVIK



Sandvik AM Centre



- 1 Vacuum Gas Atomisation (VIGA)
- 1 EIGA Titanium powder plant
- Argon and Nitrogen Atomising
- Powder sizing; 20 – 200 micron
- AS9100D (Aerospace)
- ISO 13485:2016 (medical certification)

SANDVIK

# SANDVIK A LEADER IN METAL POWDER FOR MIM

## OSPREY® METAL POWDERS

MORE THAN  
**2000**  
GRADES

FIRST YEAR OF  
POWDER SALES  
**1979**

### OUR PROGRAM OF OSPREY® METAL POWDER INCLUDES:

- Stainless steels; 17-4PH & 316L
- Master Alloys - MIM
- Tool steels; M2 & H13
- Maraging steels; 18NI300, Co Free & MAR-60HRC
- Low alloy steels
- Duplex steels
- Copper alloys
- Controlled & low expansion alloys
- Soft magnetic & Binary alloys
- High temperature materials; Fe-Cr-Al-Y
- Nickel-based superalloys; IN718 & IN625
- Nickel free SS; X15 CrMnMoN 17-11-3
- CoCr alloys, including F75
- Titanium alloy; Ti6Al4V, CP-Ti & Ti6242



### POWDER PRODUCTION:

- Inert Gas Atomisation
- Vacuum Inert Gas Atomisation
- Electrode Inert Gas Atomisation

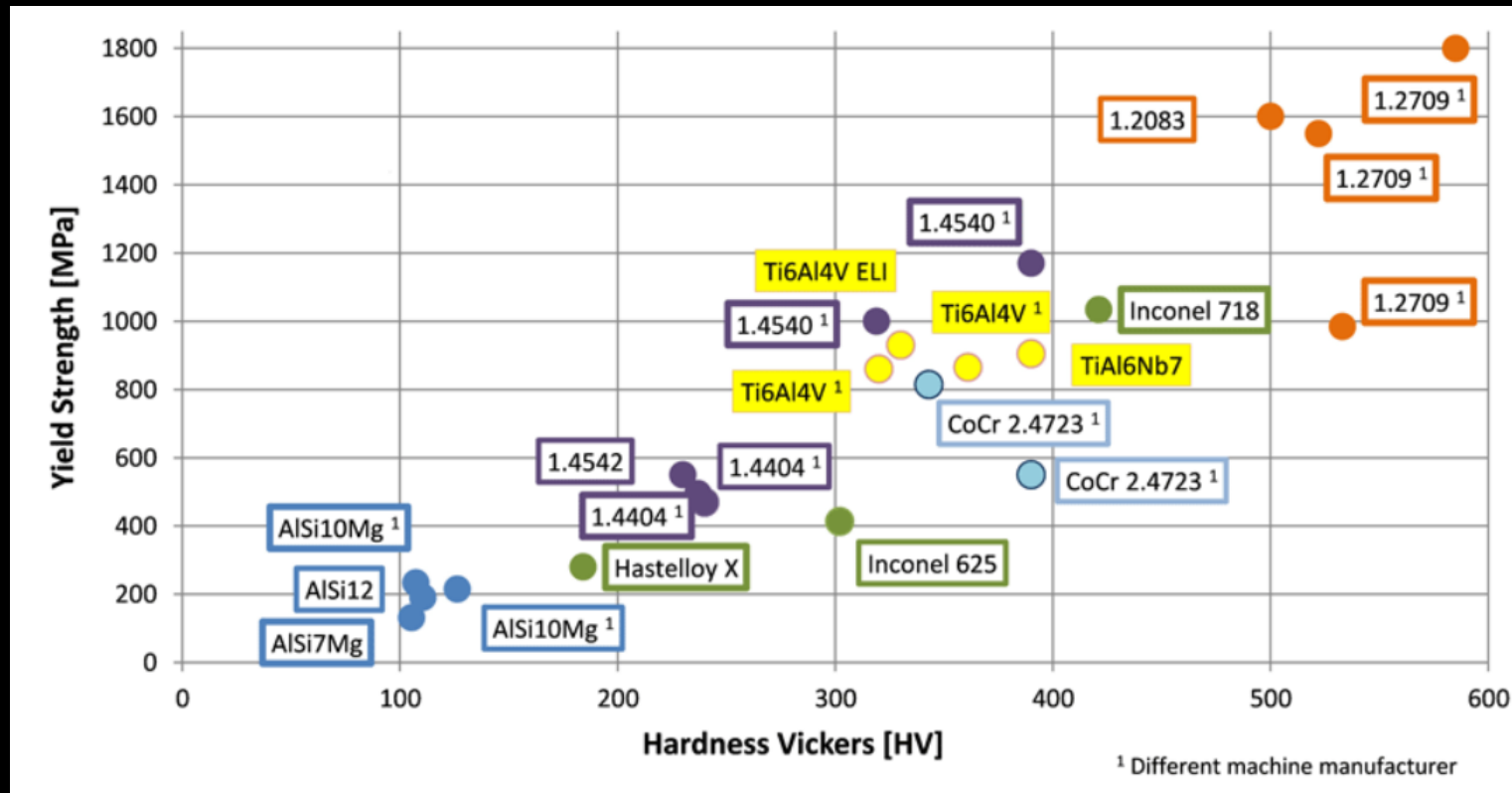
### PRINCIPLE APPLICATIONS INCLUDE:

- Metal Injection Moulding
- Additive Manufacturing:
  - Laser Powder Bed Fusion
  - E-Beam Powder Bed Fusion
  - Direct Energy Deposition
  - Green machining
  - Binder Jet
- Cold Spray
- Hot Isostatic Pressing (HIP)
- Other specialist applications



# AM MATERIAL PERFORMANCE

## DATA FOR LASER – POWDER BED FUSION



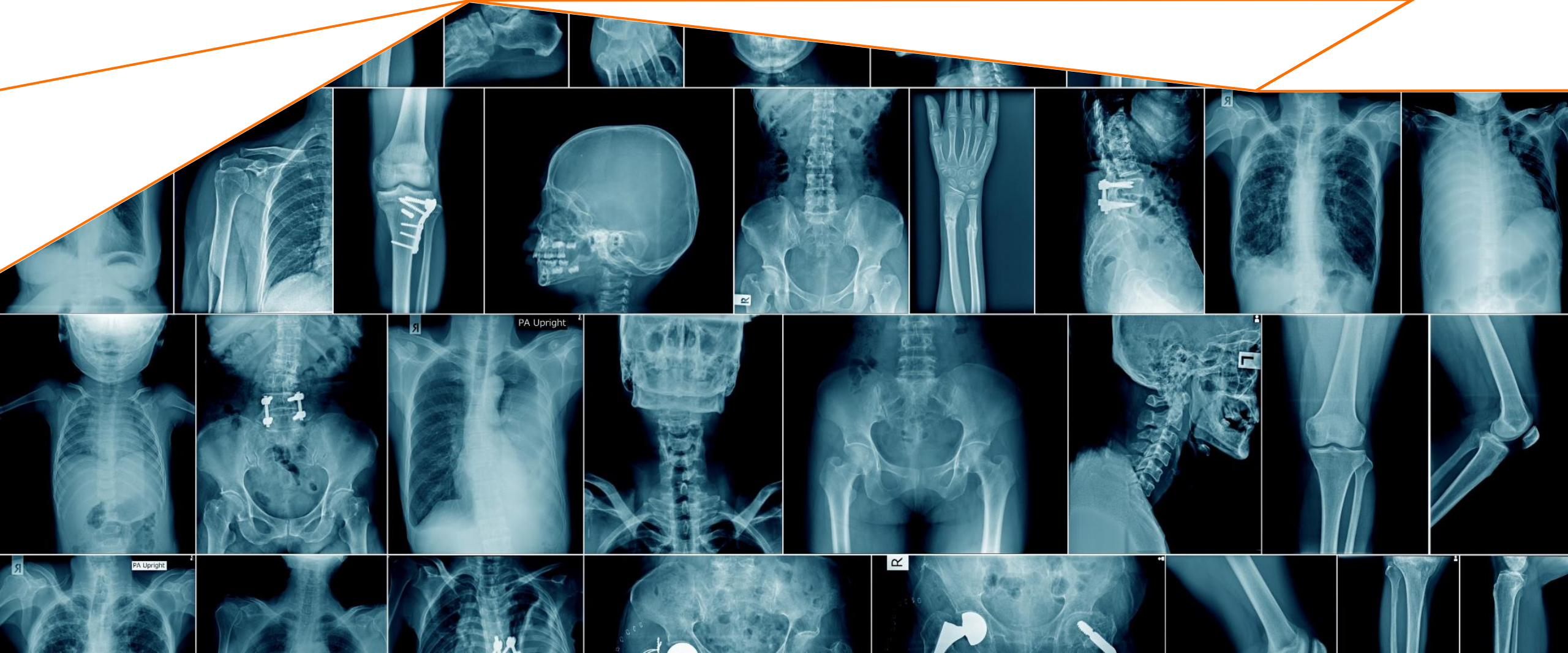
Courtesy of EPMA

# SANDVIK ADDITIVE MANUFACTURING

## OSPREY<sup>®</sup> Ti6Al4V



Paul A. Davies

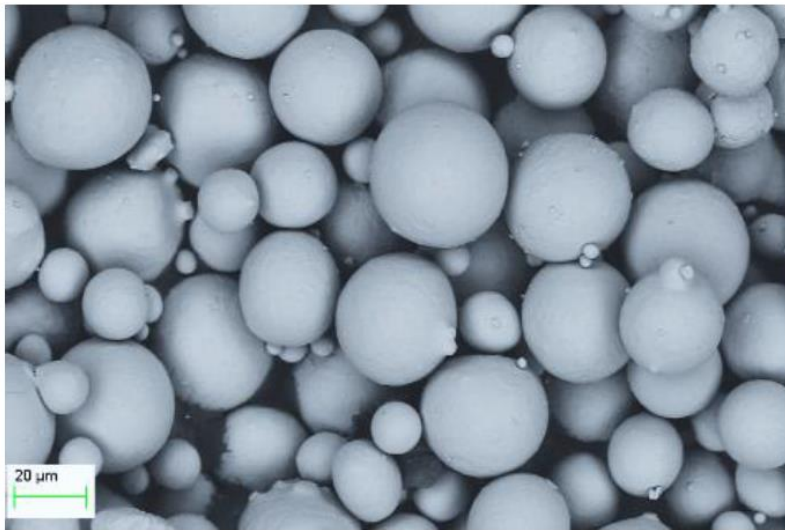


# OSPREY® TI6AL4V ALLOY POWDER

## SPECIFICATION; GRADE 23

Chemical composition (nominal) %

Ti	Al	V	Fe	O	C	N	H	Y	Residuals
Balance	5,50-6,50	3,5-4,5	≤0,25	≤0,13	≤0,08	≤0,05	≤0,012	≤0,005	≤0,10 each ≤0,40 total

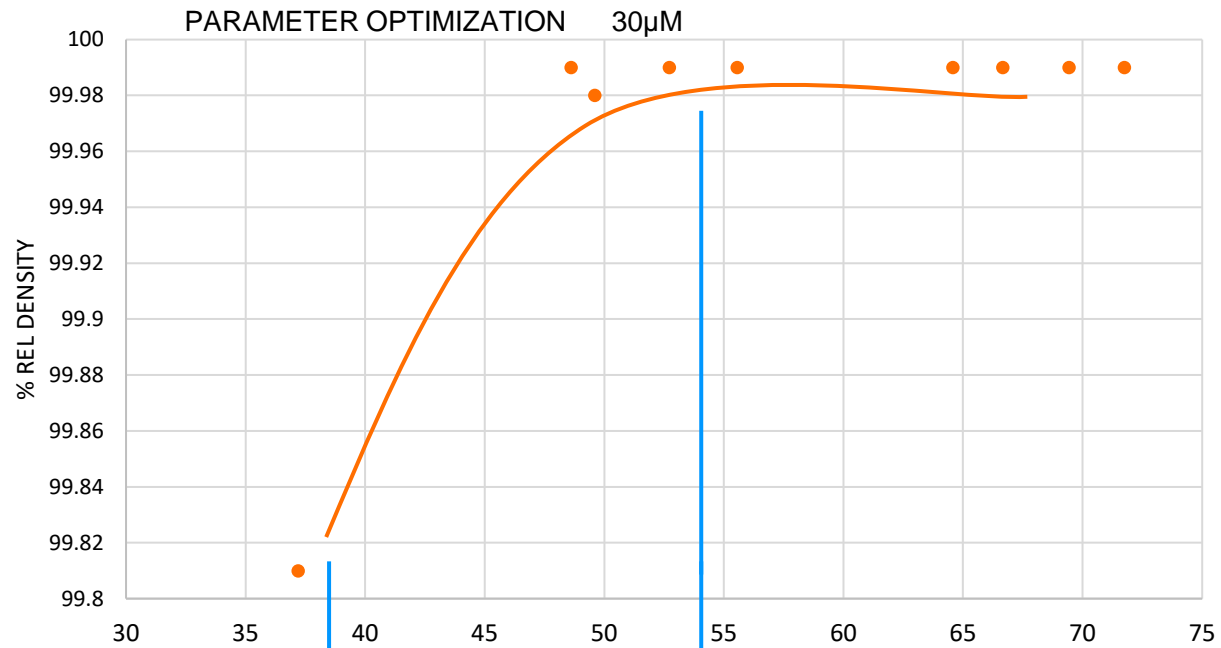


Powder size: -53 +15 microns

**Table 1:** Powder chemistry (O and N), morphology and flow properties.

<i>Powder supplier</i>	<i>Flow time 50g (s)</i>	<i>Size by laser (μm)</i>	<i>O (ppm)</i>	<i>N (ppm)</i>
<b>Osprey (EIGA)</b>	38	d <sub>10</sub> =19.4 d <sub>50</sub> =33.1 d <sub>90</sub> =50.8	1090	165

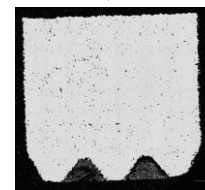
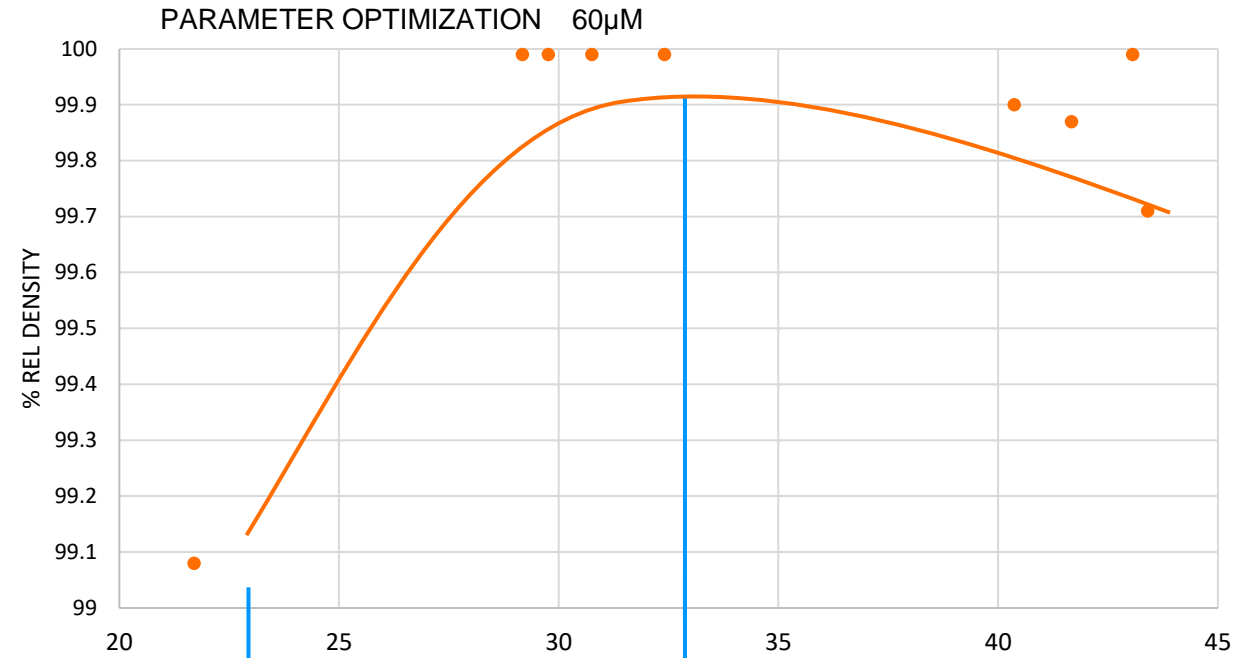
# OSPREY® Ti6Al4V



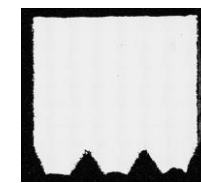
Lack of fusion



Full dense



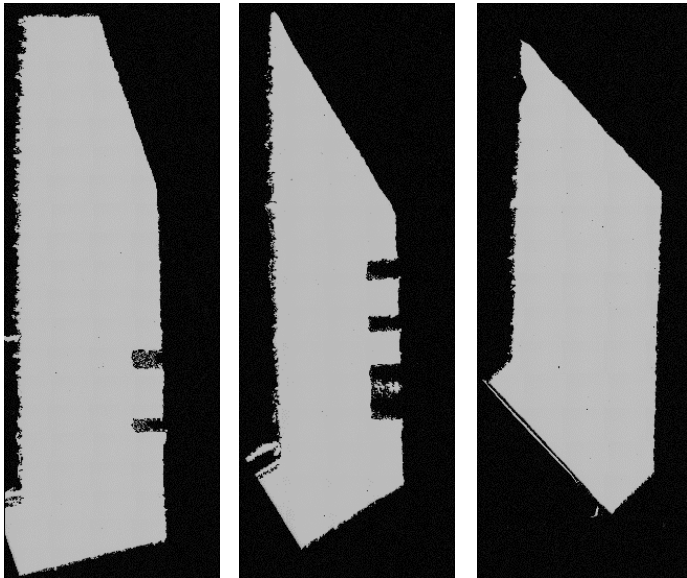
Lack of fusion



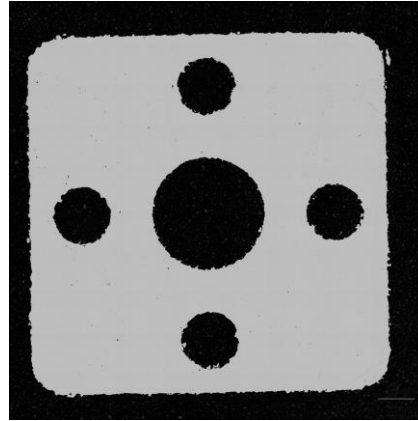
Full dense

# PROCESS CONFIRMATION

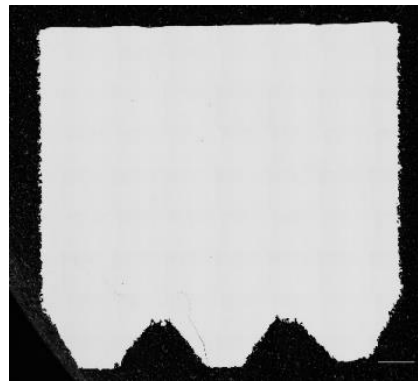
Verification of inclined surface porosity and roughness



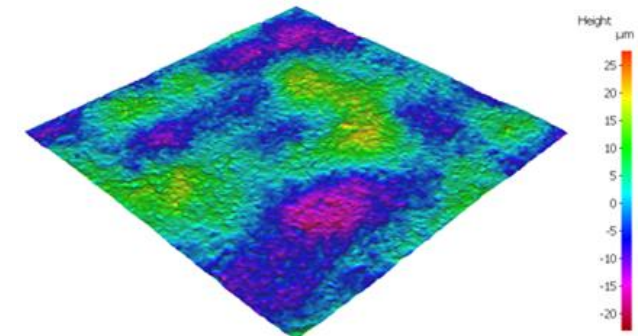
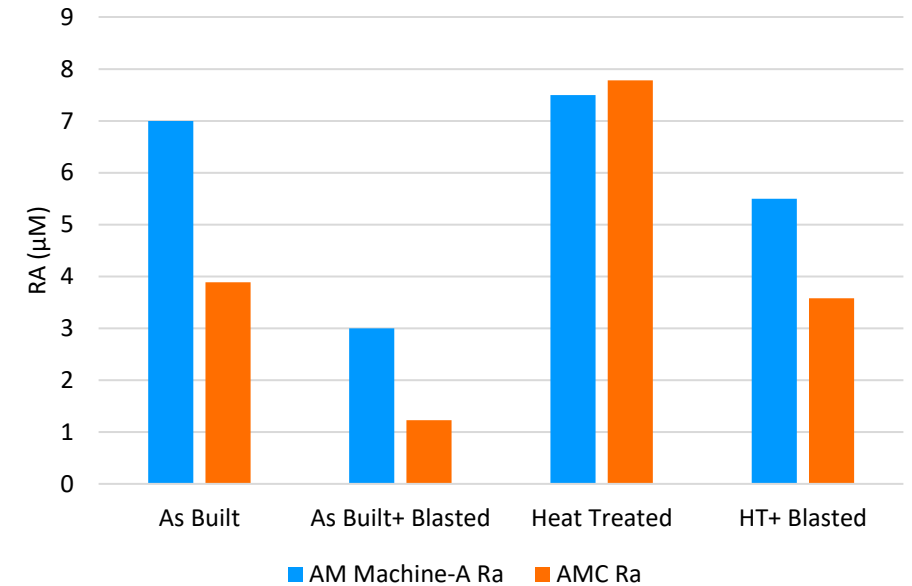
Top view - contour



Side view - bulk

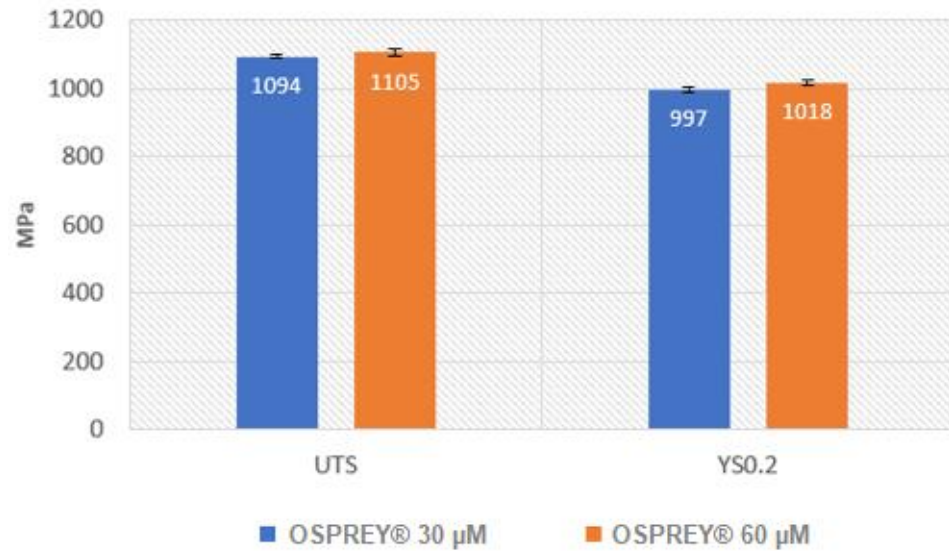


Surface roughness at various conditions

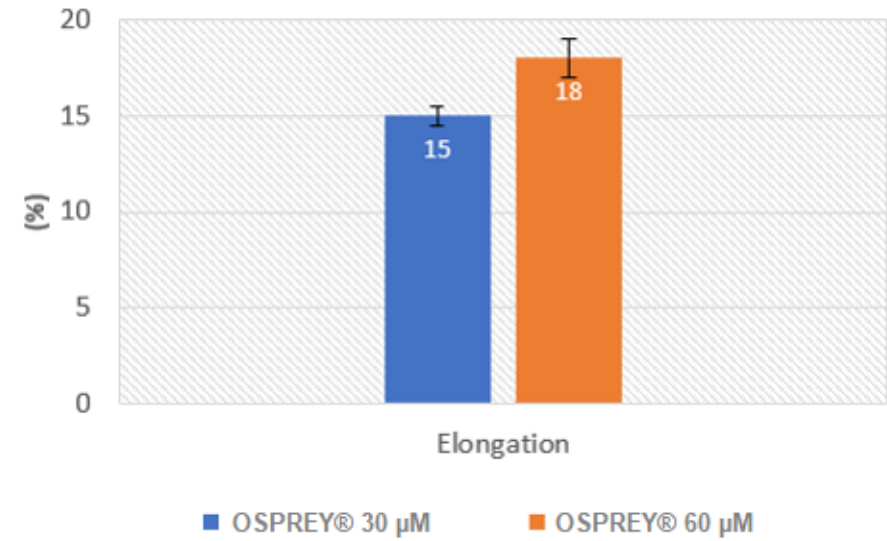


# OSPREY® Ti6Al4V AT 30 & 60 MICRONS

## > Tensile strength

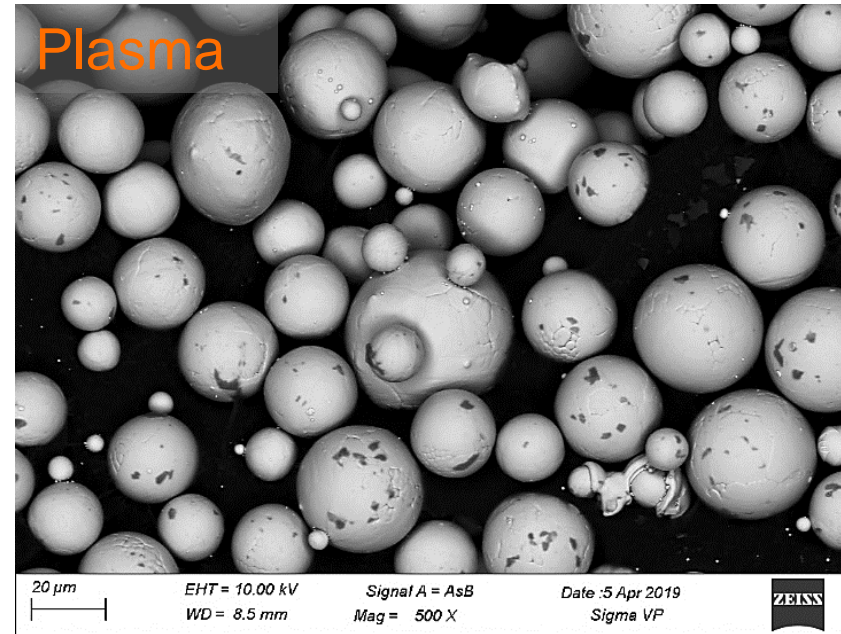
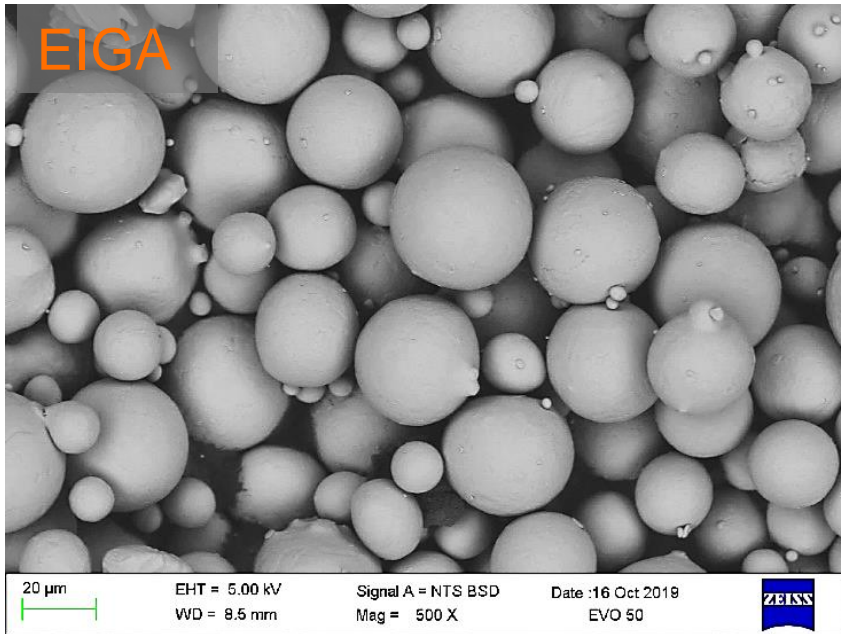


## > Elongation



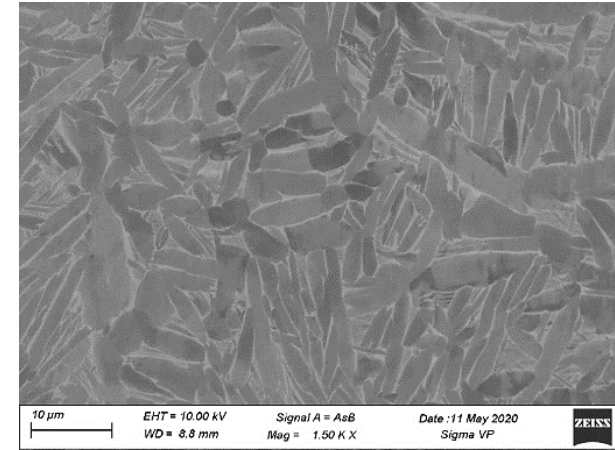
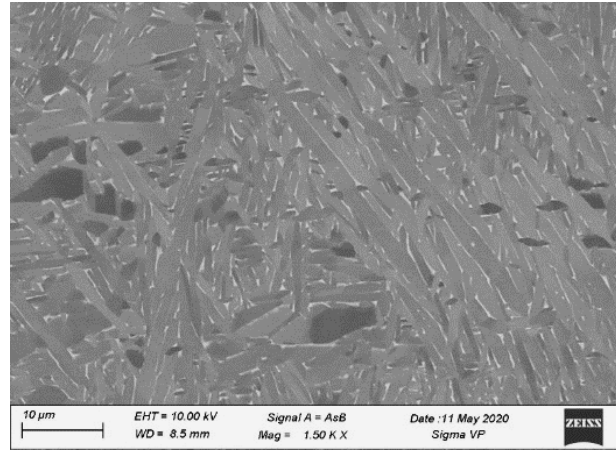
# TITANIUM ALLOY POWDER

Powder type	Flow time 50g (s)	Size by laser ( $\mu\text{m}$ )	O (ppm)	N (ppm)
Osprey® Ti6Al4V EIGA	38	$d_{10}=19.4$ $d_{50}=33.1$ $d_{90}=50.8$	1090	165
PLASMA	30	$d_{10}=21.7$ $d_{50}=34.0$ $d_{90}=45.4$	1100	100

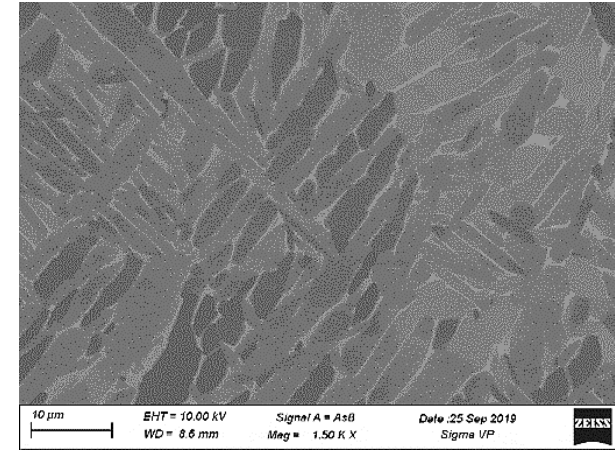
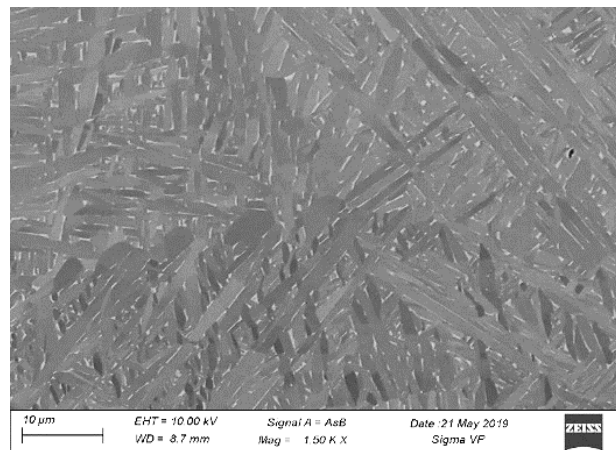


# BEFORE VS. AFTER HIP

OSPREY® Ti6Al4V  
METAL POWDER

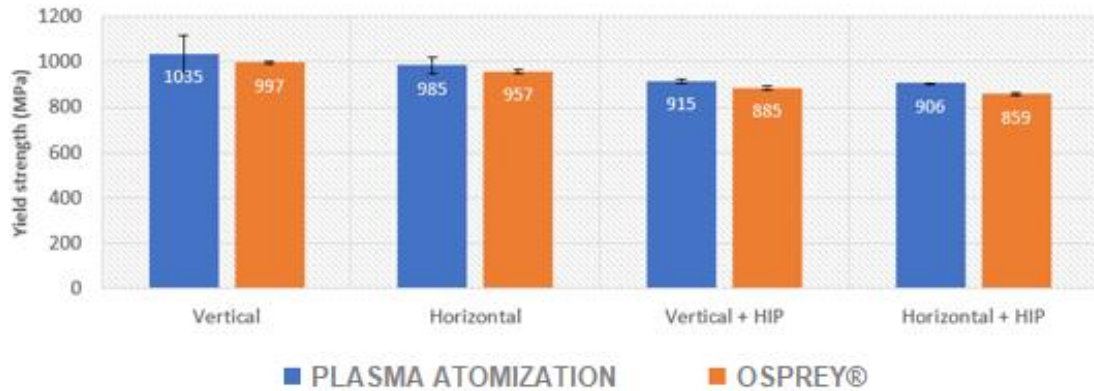


PLASMA  
ATOMIZATION

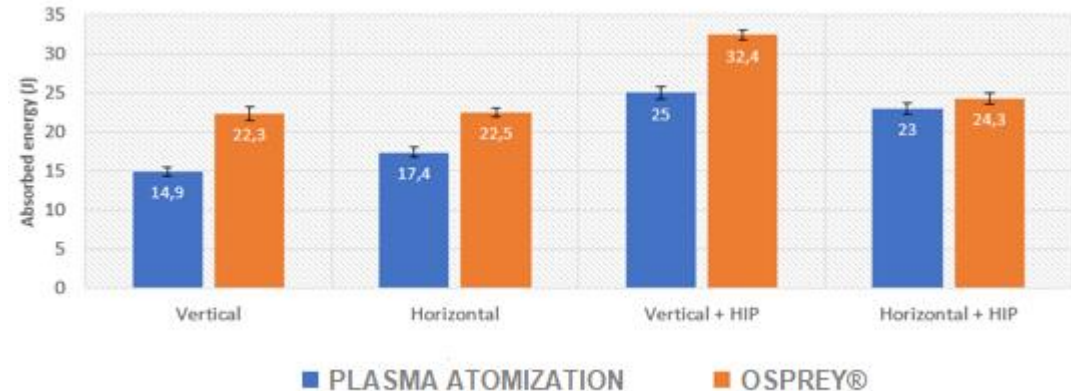


# OSPREY® TI6AL4V AT 30 MICRONS

> Yield strength



> Impact toughness



# PROPERTIES COMPARISON

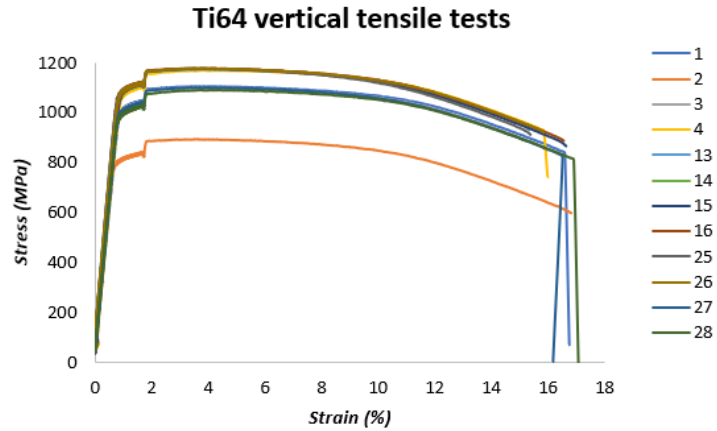


Figure 10 – Stress-strain curve obtained for vertical stress relieved specimens.

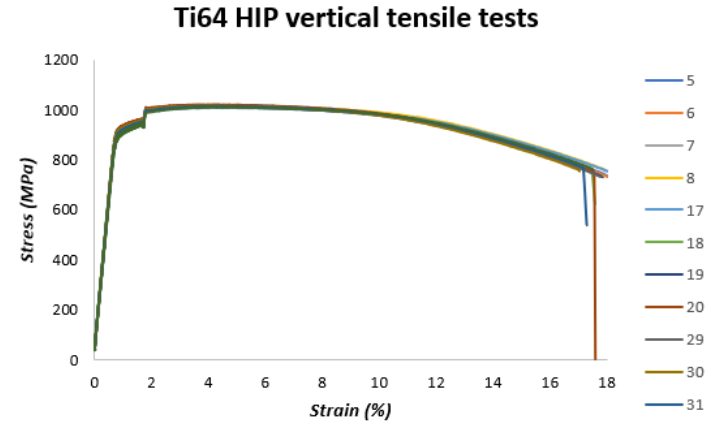


Figure 19 - Stress-strain curve obtained for vertical post-HIP specimens.

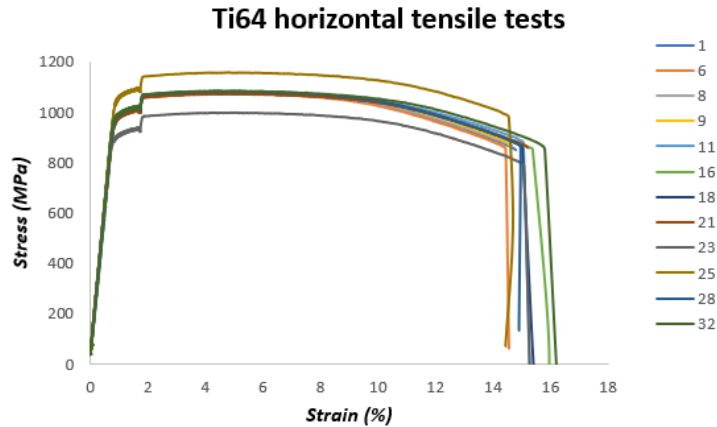


Figure 11 - Stress-strain curve obtained for horizontal stress relieved specimens.

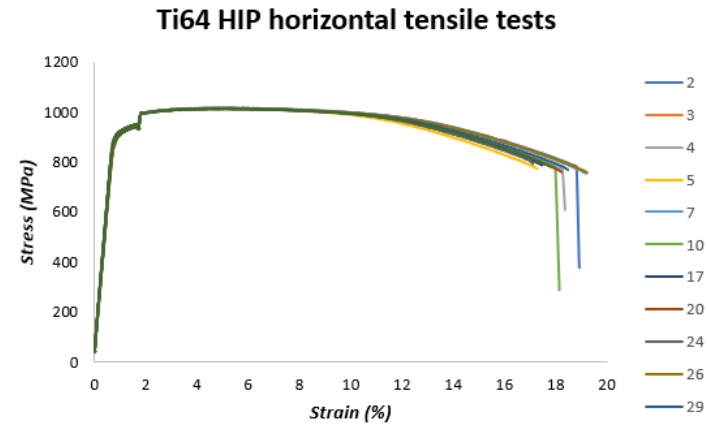
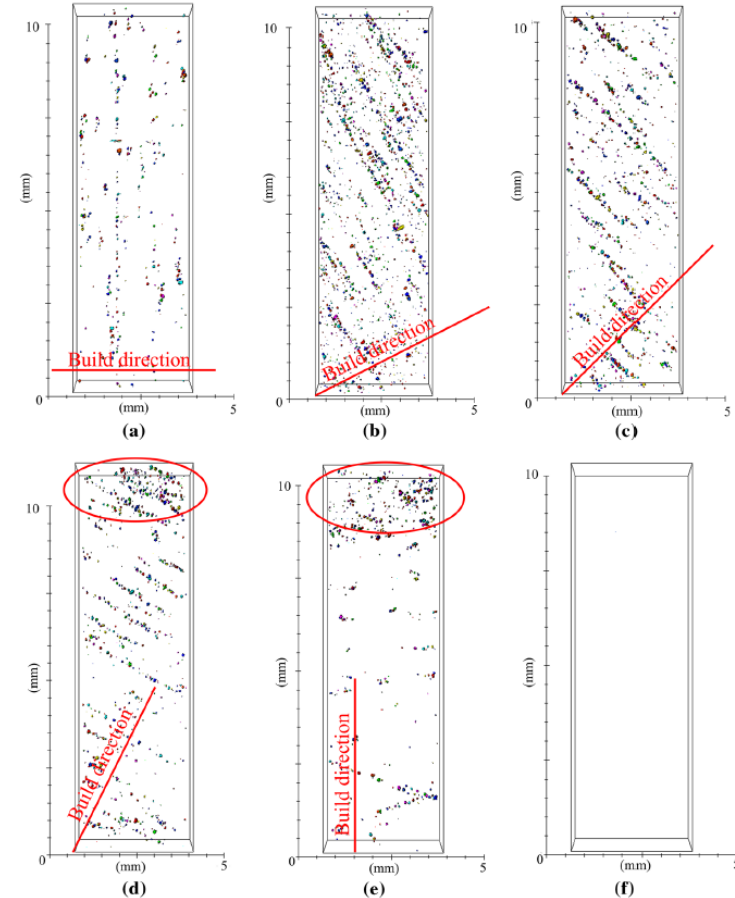


Figure 20 - Stress-strain curve obtained for horizontal post-HIP specimens.

# BUILD ORIENTATION & POROSITY DISTRIBUTION

- Pore distribution of the as-built and HIP-treated specimens with different angles relative to the substrate:
- (a)  $0^\circ$ , (b)  $30^\circ$ , (c)  $45^\circ$ , (d)  $60^\circ$ , (e)  $90^\circ$ , and (f) HIP.
- Red circles indicating powder filled to the L-PBF system during printing, increasing porosity.



Ref: S. Ren, Y. Chen, T. Liu and X. Qu, "Effect of Build Orientation on Mechanical Properties and Microstructure of Ti-6Al-4V Manufactured by Selective Laser Melting," Metallurgical and Materials Transactions A, vol. 50, pp. 4388-4409, 2019.

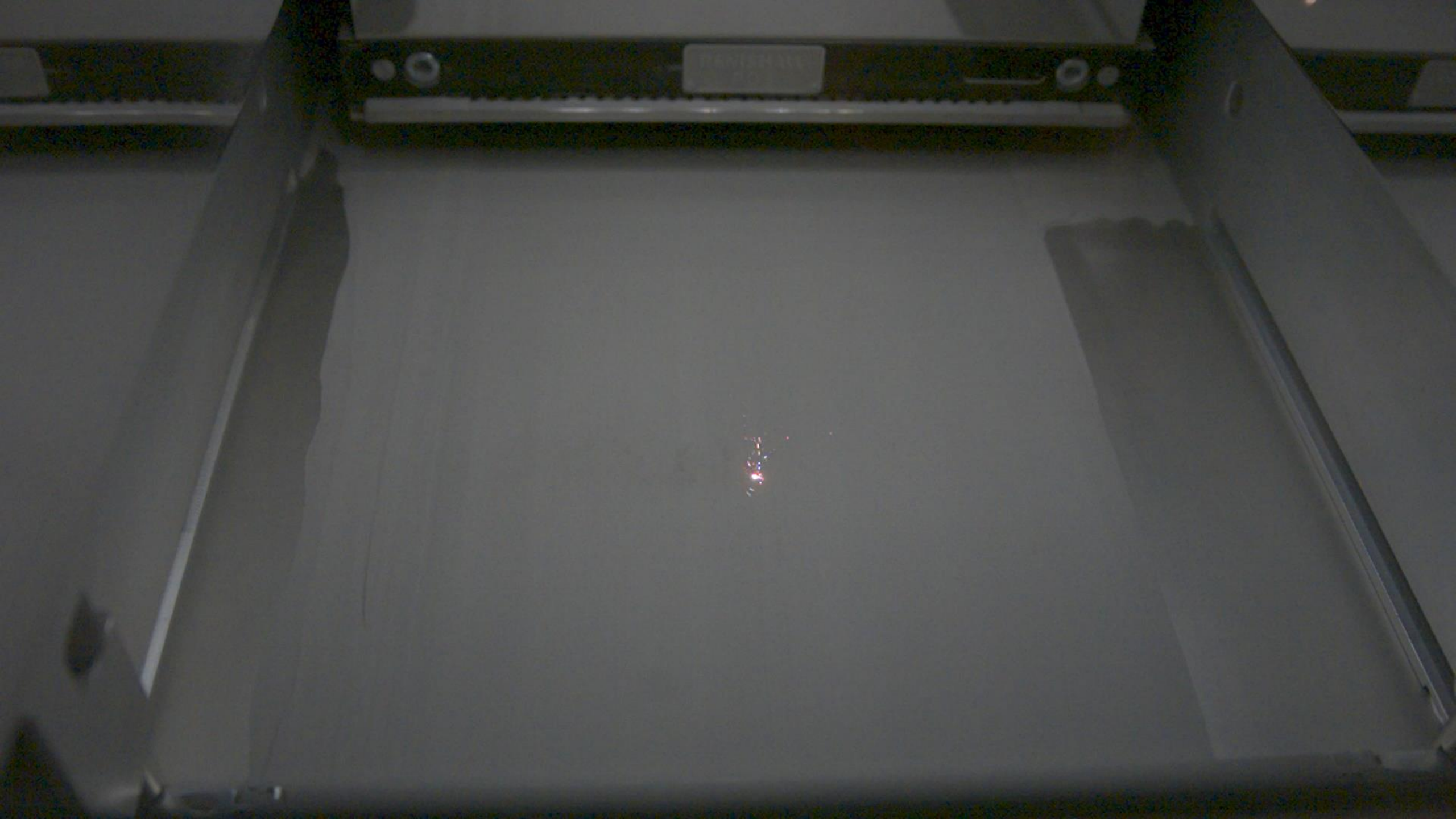
# OSPREY® Ti6Al4V MECHANICAL DATA

	Heat treated		HIP treated	
	Mean	Standard deviation ( $\pm 1\sigma$ )	Mean	Standard deviation ( $\pm 1\sigma$ )
<b>Ultimate tensile strength (UTS)</b>				
Horizontal direction (XY)	1077 MPa	34 MPa	1014 MPa	1 MPa
Vertical direction (Z)	1127 MPa	82 MPa	1015 MPa	4 MPa
<b>Yield strength (Rp0.2)</b>				
Horizontal direction (XY)	984.9 MPa	34.3 MPa	906.4 MPa	2.1 MPa
Vertical direction (Z)	1034.6 MPa	81.2 MPa	914.9 MPa	7.9 MPa
<b>Elongation at break</b>				
Horizontal direction (XY)	14.4 %	0.3 %	17.7 %	0.8 %
Vertical direction (Z)	15.5 %	0.6 %	17.2 %	0.4 %
<b>Modulus of elasticity</b>				
Horizontal direction (XY)	119.0 GPa	3 GPa	125 GPa	3 GPa
Vertical direction (Z)	128 GPa	11 GPa	126 GPa	3 GPa
<b>Impact toughness</b>				
Horizontal direction (XY)	17.4 J	0.6 J	23.0 J	0.7 J
Vertical direction (Z)	14.9 J	0.6 J	25.0 J	0.8 J
<b>Hardness (Vickers)</b>				
Horizontal direction (XY)	356 HV0.5	3 HV0.5	329 HV0.5	4 HV0.5
Vertical direction (Z)	358 HV0.5	3 HV0.5	329 HV0.5	4 HV0.5
<b>Surface Roughness (Ra)</b>				
Horizontal direction (XY)	8.4 $\pm$ 0.9 $\mu$ m			
Vertical direction (Z)	9.0 $\pm$ 0.2 $\mu$ m			

# APPLICATIONS:

## CRANIAL IMPLANTS



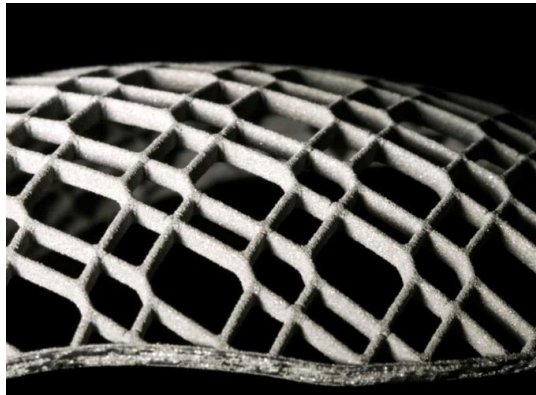


# Ti6Al4V CRANIUM IMPLANT

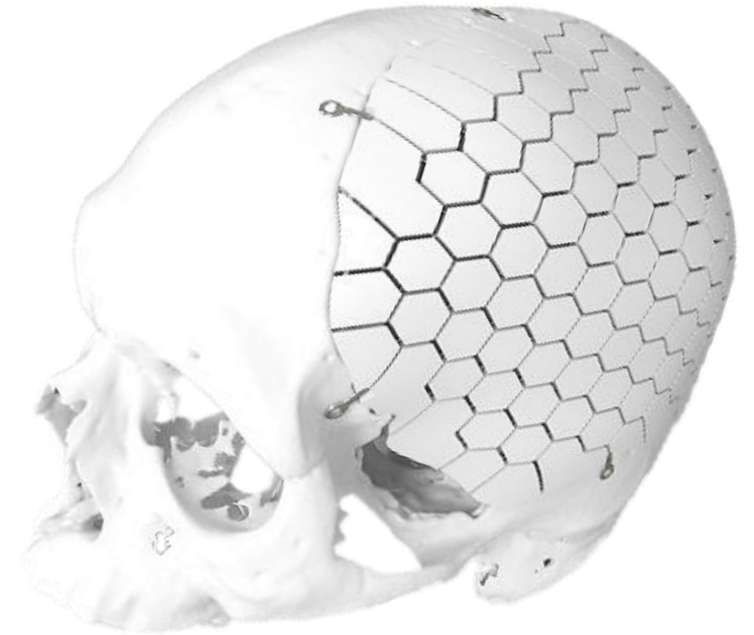
**CRANIAL PSI** (PATIENT SPECIFIC IMPLANT)

**TITANIUM REINFORCED CALCIUM PHOSPHATE**

- **STABILITY AND PROTECTION:**  
Based on 3D printed Titanium skeleton
- **EASY FIXATION:**  
With predesigned fixation arms



Images courtesy of **OSS** DESIGN®



- **PERFECT AESTHETICS:**  
Based on CAD design and 3D printing
- **MOSAIC TILE DESIGN:**  
Transfer load to the Titanium skeleton. Allows for tissue ingrowth

# COBALT-CHROMIUM ALLOYS

## DENTAL APPLICATIONS

Manufacturing cobalt-chromium alloys since 2001

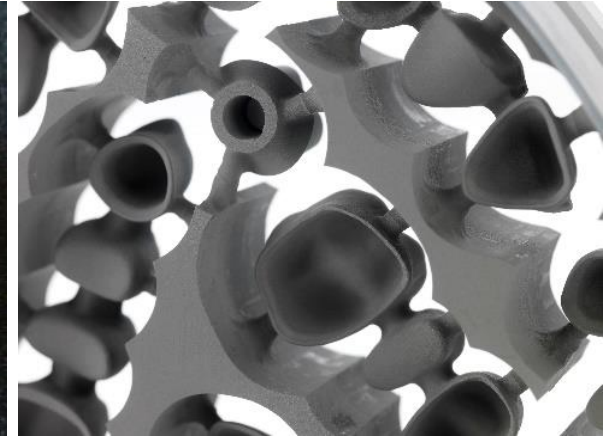
- Metal Injection Moulding
- Laser - Powder Bed Fusion (L-PBF)
- Green machining – Dental Pucks

Co 28%Cr 6%Mo

- Nickel free (<0.05%)
- Range of carbon levels (<0.02%)
- Powder Size:
  - 53 +15 microns
  - 45 +15 microns

Range of Co-Cr-Mo-W alloys

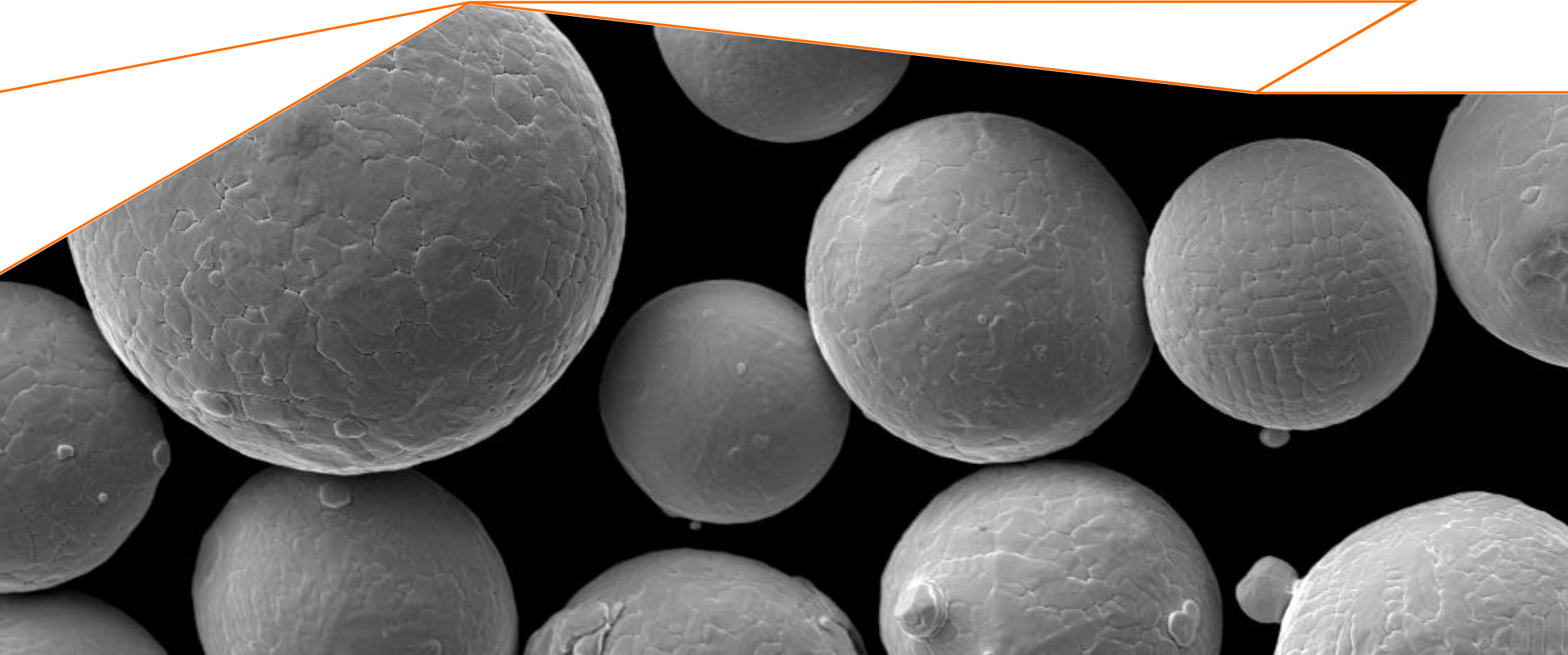
European end users have CE Marks



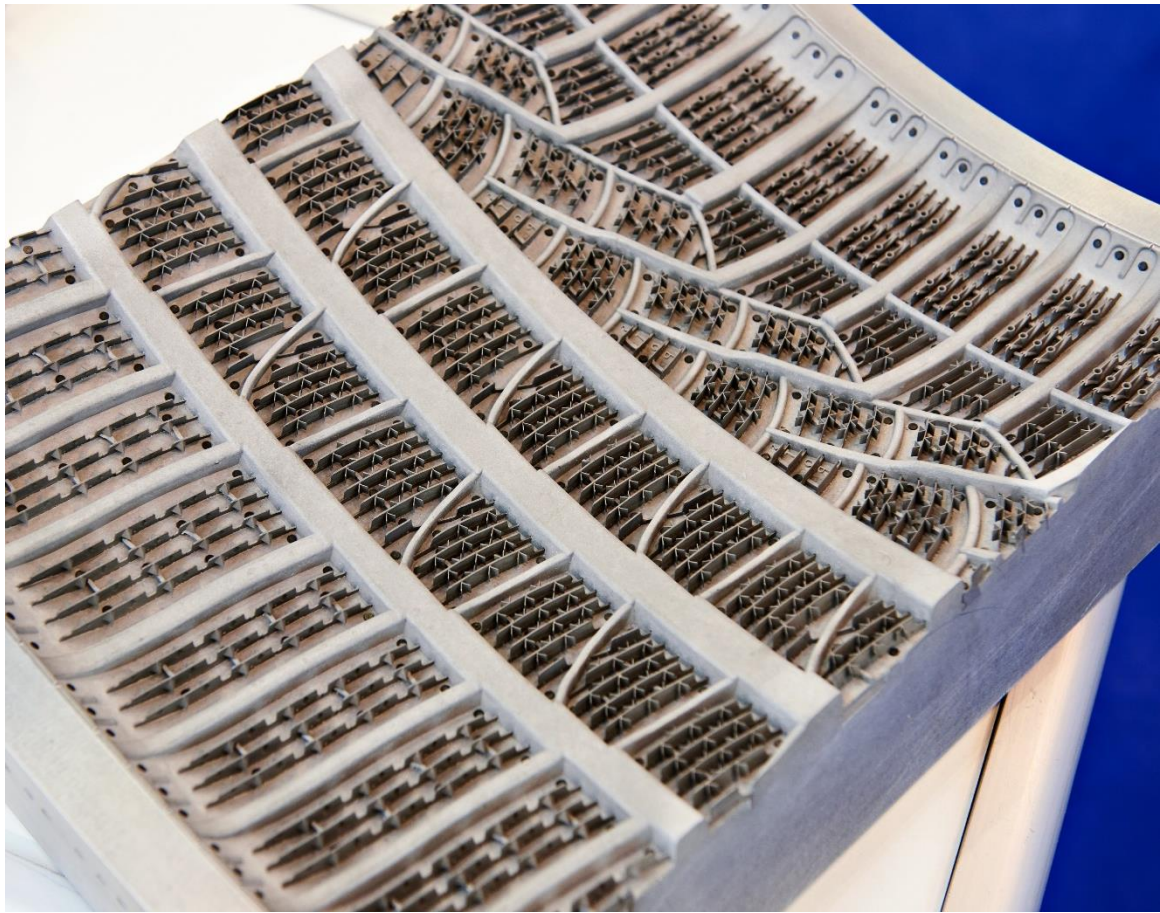
# MARAGING STEELS FOR AM



18NI300, MAR 60 & CO-FREE



# TYRE MOLDS PRODUCED BY AM



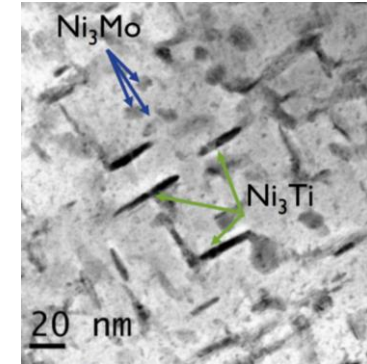
# MARAGING STEEL GRADES

Tool Material	Heat Treatment	Hardness (HRC)	CVN (J)	Tensile strength (MPa)	Elongation (%)
18Ni300 IGA	Homogenized, Solution annealed, and aged	54	13.5	~2111	8.3
18Ni300 IGA	Directly aged	53	12.0	~2050	9.2
18Ni300 VIGA	Homogenized, Solution annealed, and aged	54	14.0	~2100	9.0
18Ni300 VIGA	Directly aged	54	17.0	~2050	7.2
MAR60HRC	As-built	44-45	>35.0J	~1450	17.0
MAR60HRC	Directly aged (5Hrs)	60-61		~2500	2.0
MAR60HRC	Directly aged (10Hrs)	58		~2300	4.0
<b>Osprey® MAR50 Co-free Maraging steel</b>					
Maraging ( C ≤0.03)	Directly aged	Up to 52-53	14.0 @ 51-52 HRC	Up to 1800	

# INTRODUCTION

## MARAGING STEELS (e.g. 18Ni300):

- Ultra-high strength martensitic structure
- Good printability via L-PBF
- Precipitation of nano-sized intermetallic particles during age-hardening



However, traditional maraging steels contain **Cobalt (Co)**

## Co IN MARAGING STEELS:

- Raises the martensite start ( $M_s$ ) temperature
- Increases the supersaturation of Mo in the matrix
- Increases the strength by up to 500 MPa
- Enhances toughness at high strength levels

## Co ISSUES:

- Uncertainty with the supply sources
- Health issues related to Co usage
- Price fluctuations

# MATERIAL REQUIREMENTS

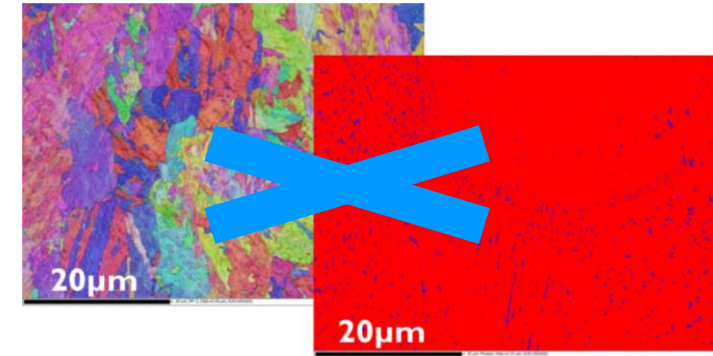
## COMPOSITION AND STRUCTURE:

- Co-free maraging steel
- Fabrication via L-PBF
- Nearly fully Martensitic microstructure in As-built condition
- No need of solution annealing prior aging

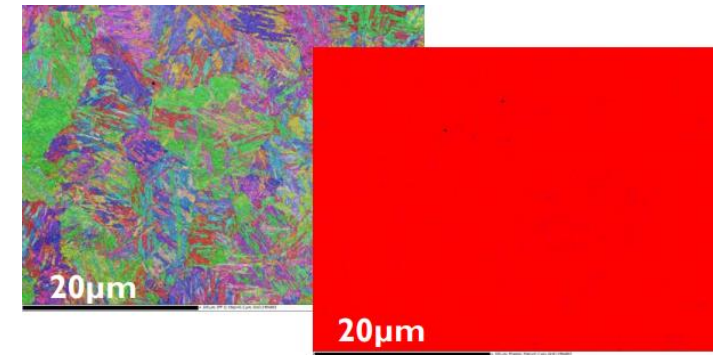
## PROPERTIES AFTER AGING:

- Hardness > 500 HV
- YS > 1550 MPa
- UTS > 1700 MPa
- Elongation > 5%
- Impact toughness 6-15 J

Relatively high amount of Ret. Austenite



Nearly fully Martensitic



# MATERIAL DEVELOPEMNT

## SIMULATION TOOLS USED:

- Thermo-Calc
- DICTRA
- TC-PRISMA
- Models for UTS

Thermodynamic data from Thermo-Calc  
 $M_s$  temperature according to “in-house” model  
Prediction of UTS according to “in-house” model

Numerical optimization using Matlab

## INPUT TO CALCULATIONS:

- Chemistry
- Aging Temperature

Defining composition space:

- 0-20 wt% Ni
- 0 wt% Co
- 0-10 wt% Cr
- 0-6 wt% Mo
- 0-2 wt% Ti

## STRUCTURE AND PROPERTIES CALCULATIONS:

- Equilibrium at aging (phases, compositions, size and fraction)
- Martensite start ( $M_s$ ) temperature
- UTS at a fixed aging temperature and time

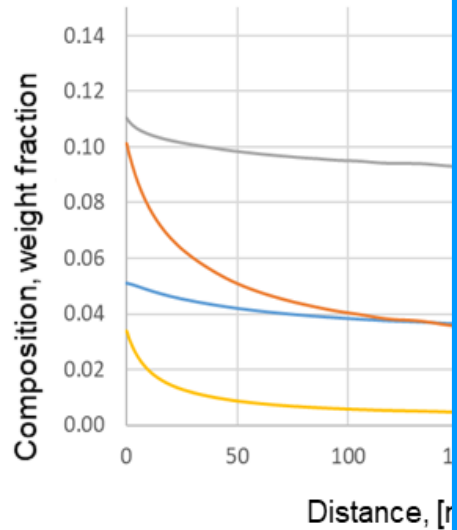
## MATERIAL OPTIMIZATION:

- Defining constraints on optimization (limits)
- Defining target function to optimize

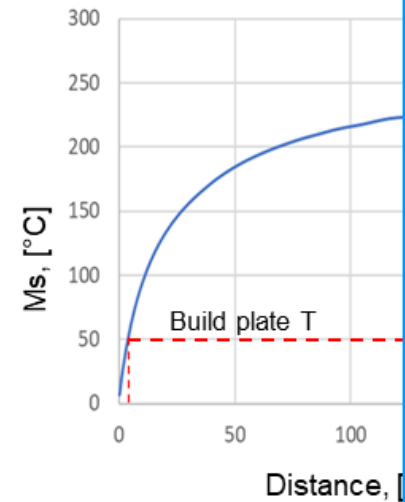
# MATERIAL DEVELOPMENT

4000 ITERATIONS OF COMPOSITIONS...

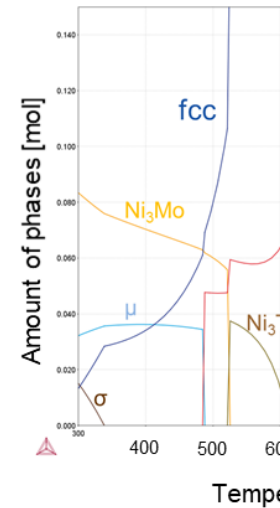
Micro-segregation profile



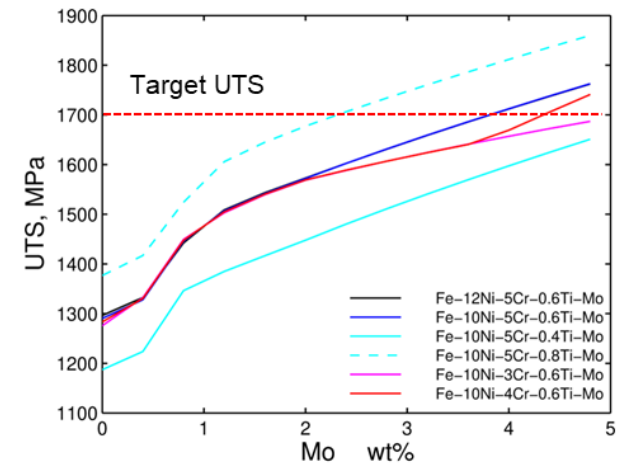
$M_s$  temperature vs. Distance



Equilibrium phase fractions vs. temperature



Predicted UTS vs. Mo content (aging at 500 °C, 3h)



$$\sigma_{UTS} \cong \sigma_0 + \sigma_{martensite} + \sigma_{ss} + \sigma_p$$

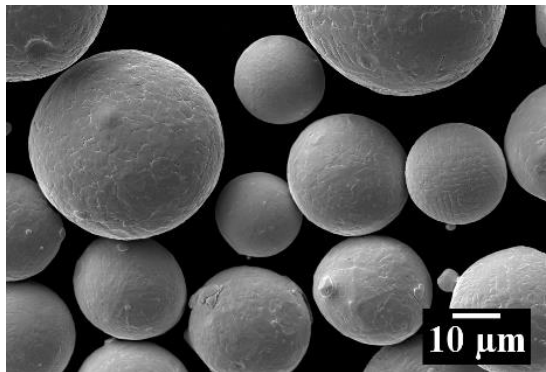
...TO THE FINAL COMPOSITION

# POWDER PRODUCTION & L-PBF

	C	Ni	Cr	Mo	Ti	Si	Mn	Co	Fe
<b>Osprey® MAR50 Co-free Maraging steel*</b>	<b>&lt;0.03</b>	<b>9.0-10.0</b>	<b>3.0-3.5</b>	<b>4.0-4.5</b>	<b>0.7-0.9</b>	<b>&lt;0.4</b>	<b>&lt;0.4</b>	<b>-</b>	<b>Bal.</b>
<b>18Ni300</b>	<0.03	17.0-19.0	<0.25	4.6-5.2	0.6-0.8	<0.1	<0.1	8.5-9.5	Bal.

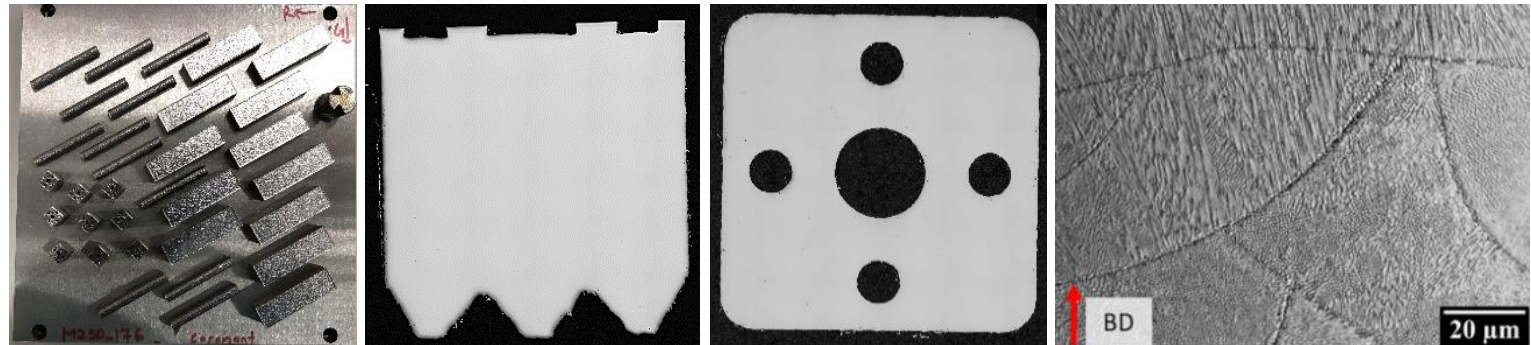
*\*Patent pending*

## GAS ATOMIZED POWDER (-53+15µm)



- Highly spherical particles
- Low Oxygen and Nitrogen levels

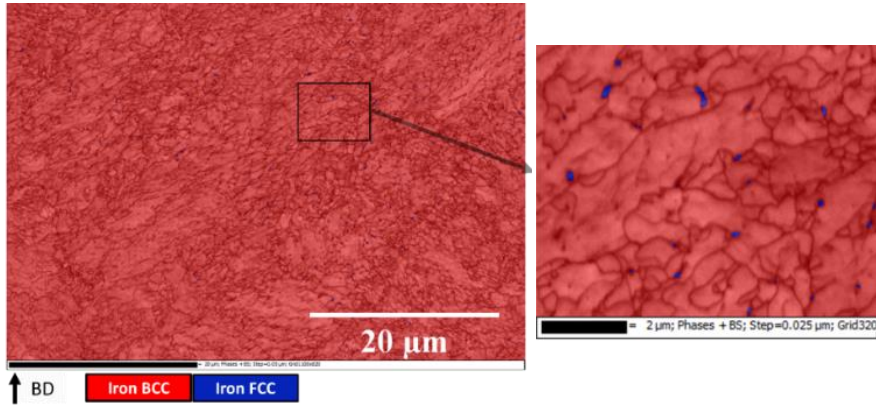
## L-PBF: EOS M290



- Relative density > 99.9 %
- Ultrafine cellular/dendritic solidification structure

# CHARACTERIZATION & TESTING

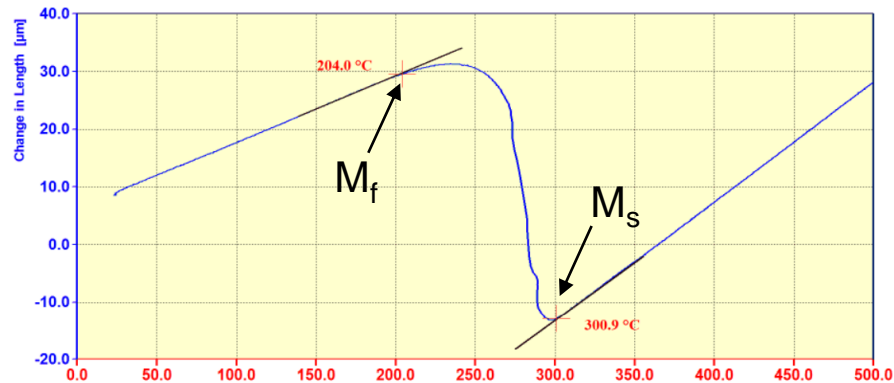
## ELECTRON BACKSCATTER DIFFRACTION (EBSD)



### AS-BUILT:

- Mainly martensite
- Negligible fraction of retained austenite ( $RA_{\text{EBSD}} = 0.2\%$ ,  $RA_{\text{XRD}} = 2.2\%$ )
- No need of Solution Annealing
- Direct Aging

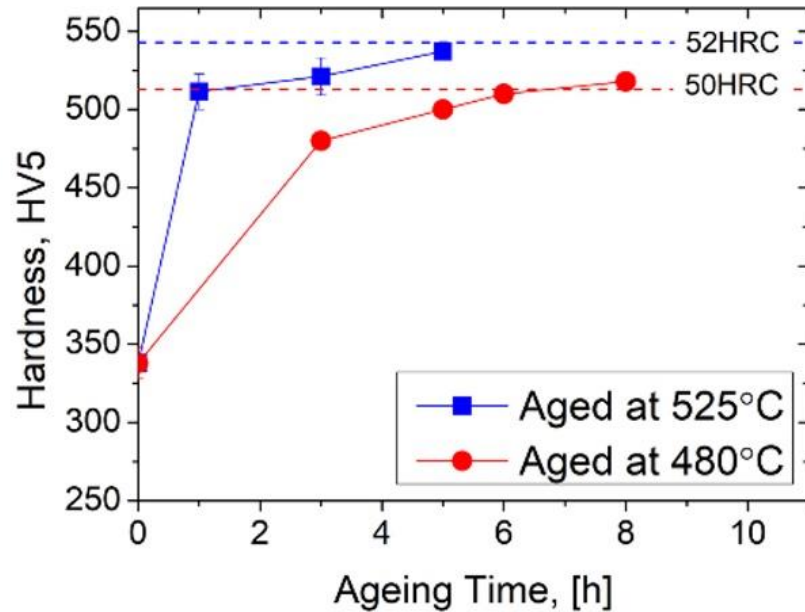
## DILATOMETRY



- $M_s$  temperature  $\sim 300\text{ }^\circ\text{C}$
- $M_f$  temperature  $\sim 200\text{ }^\circ\text{C}$
- No need of Solution Annealing
- Direct Aging

# CHARACTERIZATION & TESTING

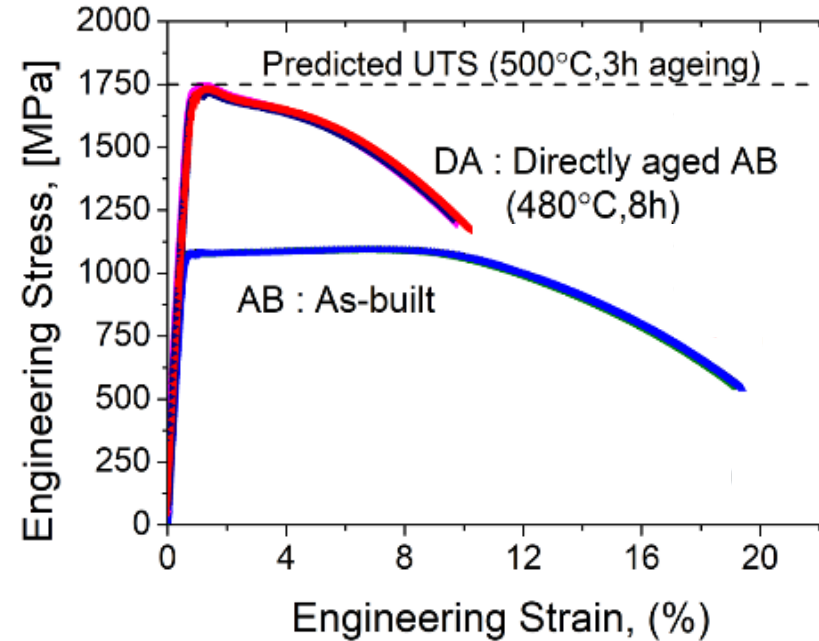
## AGING CURVES



- AS-BUILT:  
Hardness = 340 HV5

- DIRECTLY AGED:  
Max Hardness = 540 HV5  
(525°C for 5 h)

## TENSILE CURVES



- AS-BUILT:  
YS = 1075 MPa  
UTS = 1100 MPa

- DIRECTLY AGED (480 °C, 8h):  
YS = 1700 MPa  
UTS = 1730 MPa

Predicted UTS shows good agreement with the experiments!

# SUMMARY

## CHEMICAL COMPOSITION (wt%)

	C	Ni	Cr	Mo	Ti	Si	Mn	Co	Fe
<b>Osprey® MAR50 Co-free Maraging steel*</b>	<b>&lt;0.03</b>	<b>9.0-10.0</b>	<b>3.0-3.5</b>	<b>4.0-4.5</b>	<b>0.7-0.9</b>	<b>&lt;0.4</b>	<b>&lt;0.4</b>	<b>-</b>	<b>Bal.</b>
<b>18Ni300</b>	<0.03	17.0-19.0	<0.25	4.6-5.2	0.6-0.8	<0.1	<0.1	8.5-9.5	Bal.

*\*Patent pending*

## MECHANICAL PROPERTIES

<b>Osprey® MAR50 Co-free Maraging steel</b>	<b>YS (MPa)</b>	<b>UTS (MPa)</b>	<b>Elongation (%)</b>	<b>Hardness (HV5)</b>	<b>Impact Toughness (J)</b>	<b>Ms (°C)</b>	<b>Retained Austenite (%)</b>
<b>Requirements</b>	>1550	>1700	>5	>500	>6-15J		~ 0
<b>Aged 480 °C/8h</b>	<b>1706 ± 6</b>	<b>1732 ± 11</b>	<b>9.9 ± 0.2</b>	<b>520 ± 4</b>	<b>14 ± 2</b>	<b>305 ± 5</b>	<b>EBS: 0.2</b>

# SUMMARY

## OSPREY® MAR50 CO-FREE MARAGING STEEL:

- Successfully developed via a computational thermodynamic approach
- Co-free and reduced Ni content
- Printed via L-PBF
- Nearly fully martensitic structure in As-built condition
- No need of solution annealing prior aging
- 50-52 HRC can be achieved by direct aging after L-PBF

# MARAGING STEELS FOR AM



DIRECT ENERGY DEPOSITION (DED) BI-MATERIAL



# POWDERS FOR DED

## STAINLESS STEELS

- 316L, 17-4PH \* & 420 \*
- SAF 2507 (SUPER DUPLEX)

## MARAGING STEEL

- 18NI300 \*
- MAR-60HRC \*
- Cobalt free maraging steel \*

## STEELS

- Tool steels: M2, M4, D2, H13, P20, H13 & Optimised H10
- Low alloy & Case Hardened steels
- Other alloys by request

## NICKEL SUPER ALLOYS

- IN718 \*
- IN625

## OTHER ALLOYS

- Ti6AL4V
- Ni-Cr alloys (Si & B)
- CoCr (Stellites) \*

\* Heat-treated/aged to increase hardness

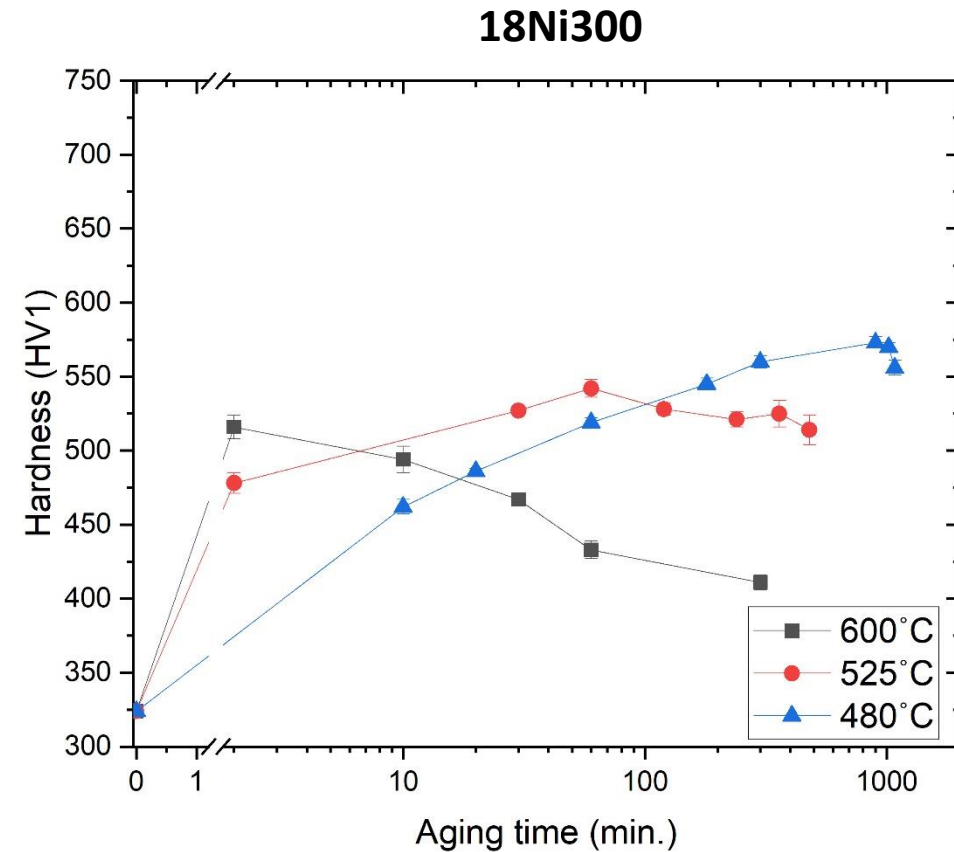
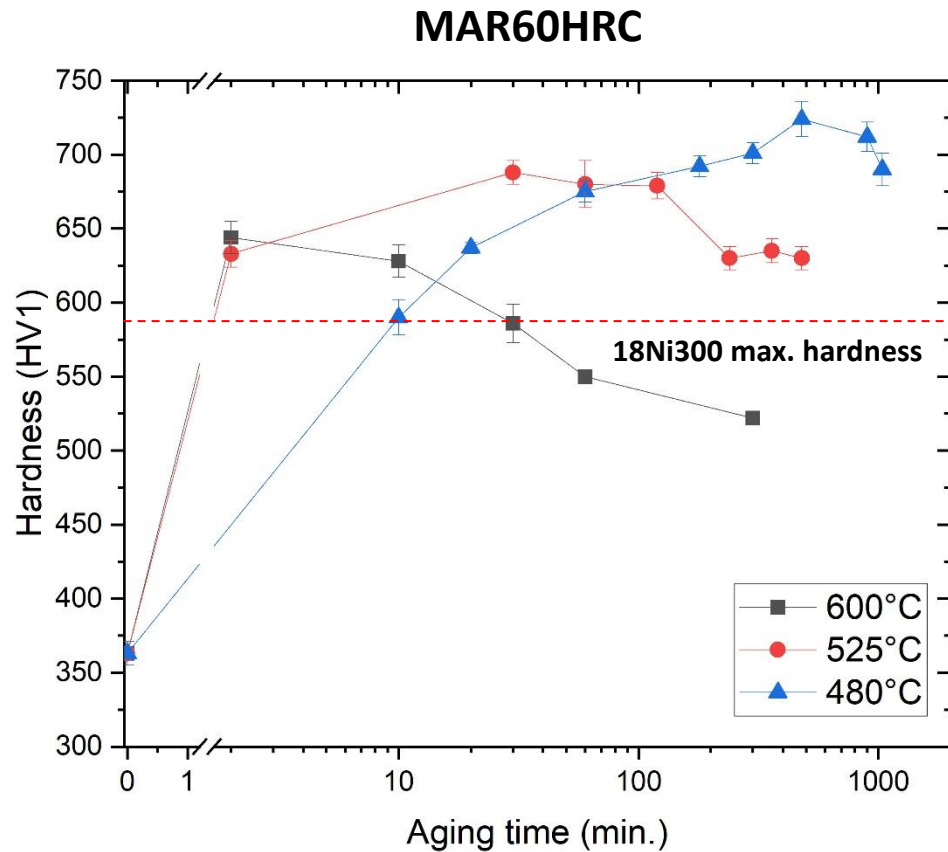
## POWDER SIZE

- 150 to 53 microns - DED
- 90 to 45 microns - DED



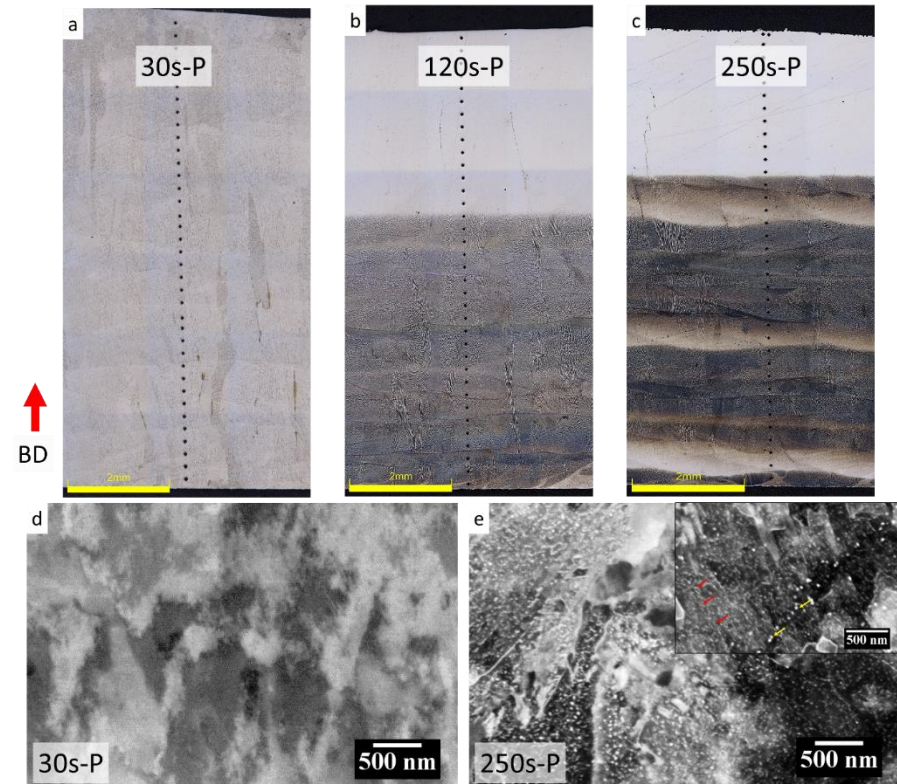
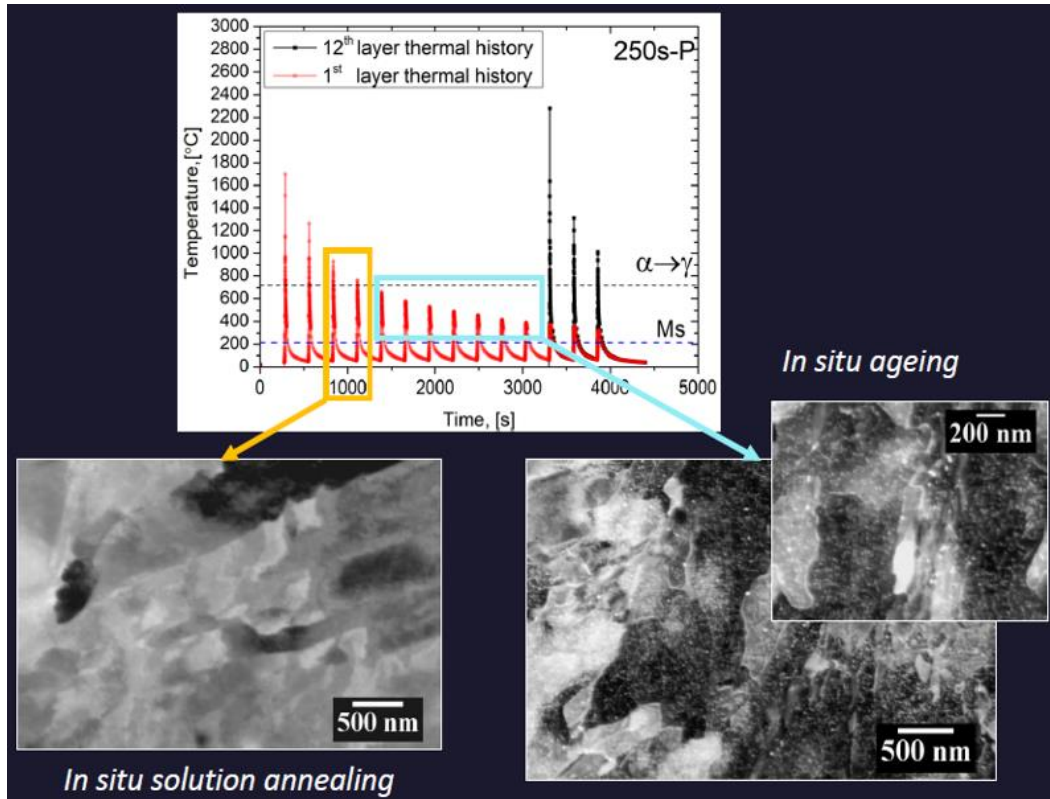
# HEAT TREATMENT BEHAVIOUR

## DIRECT AGING FROM THE AS-BUILT CONDITION



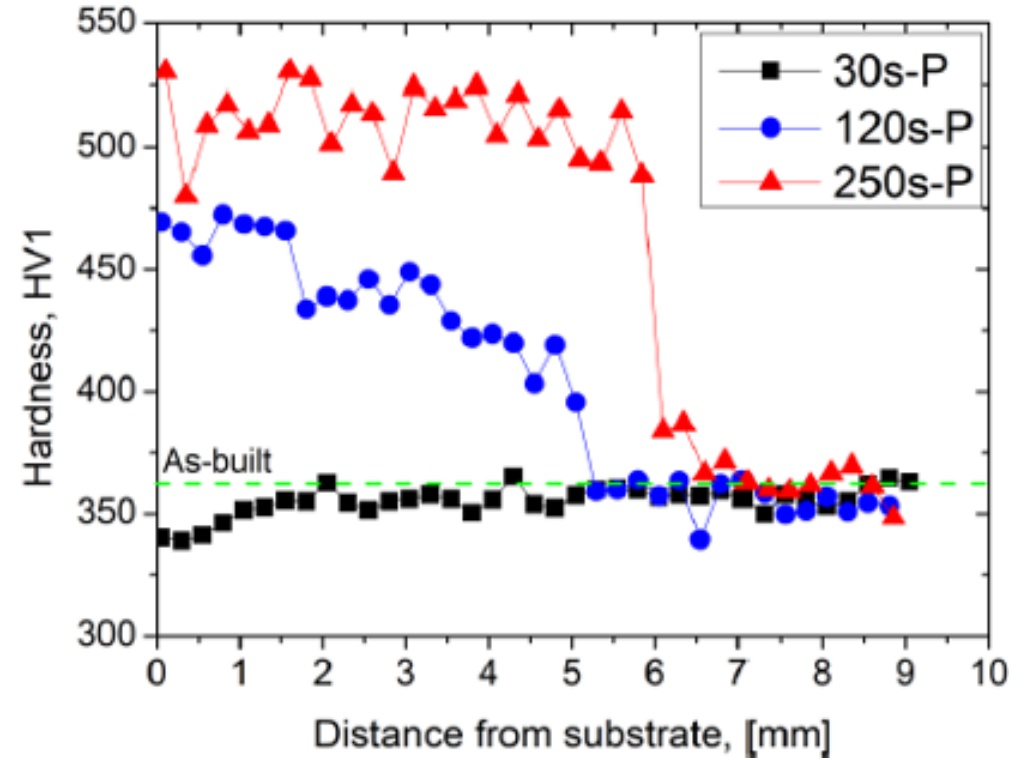
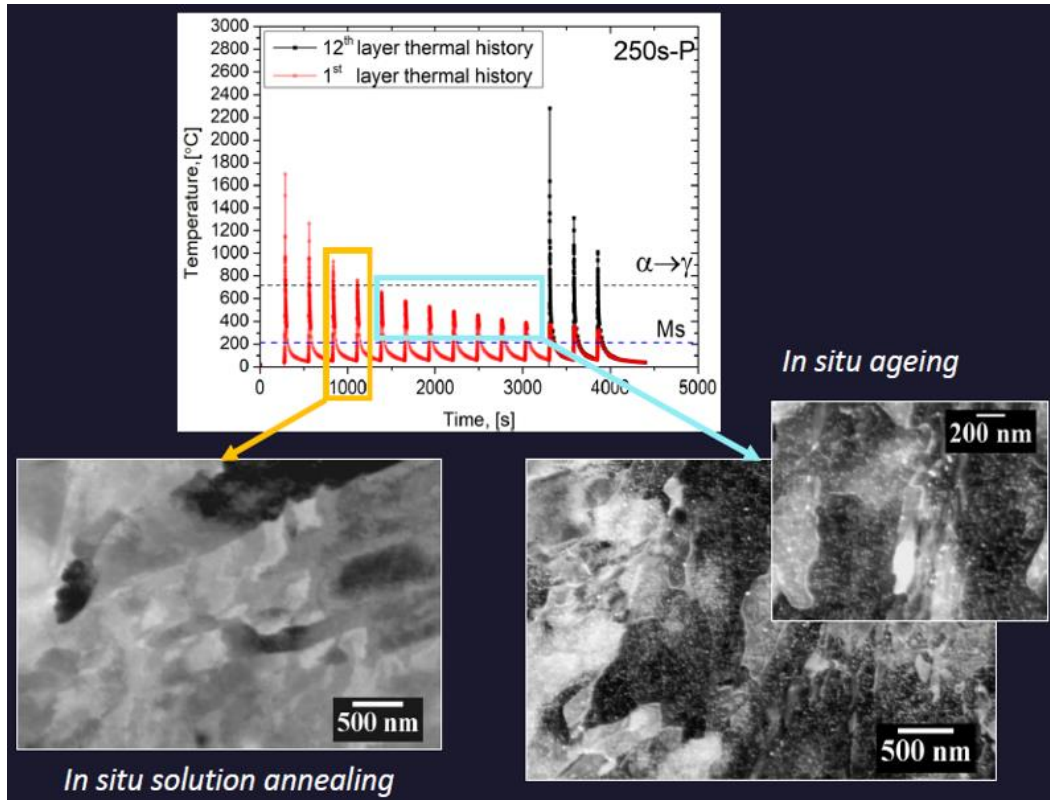
# DEPOSITION STRATEGY & INTRINSIC AGING

## DED - THERMAL HISTORY

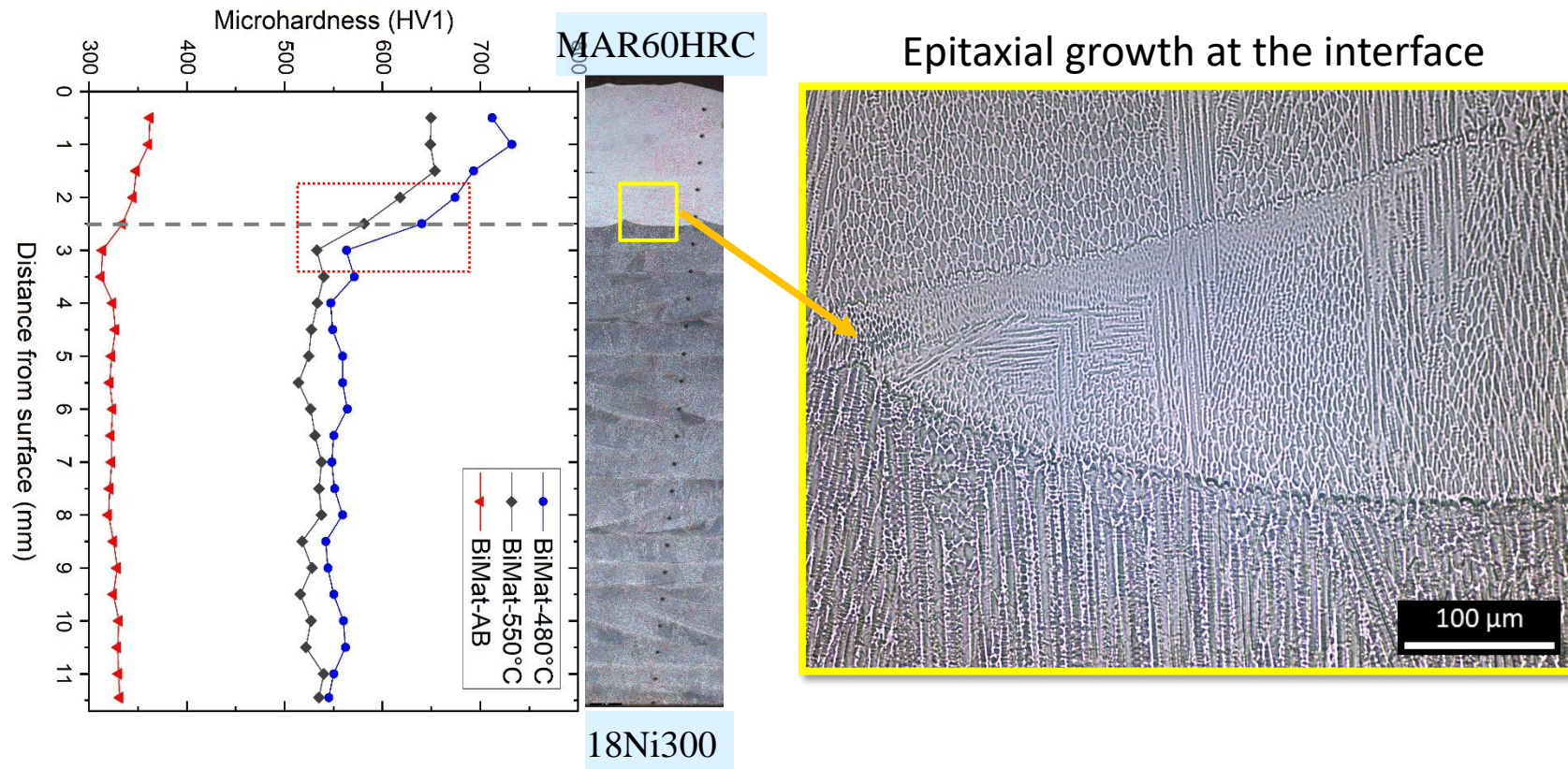


# DEPOSITION STRATEGY & INTRINSIC AGING

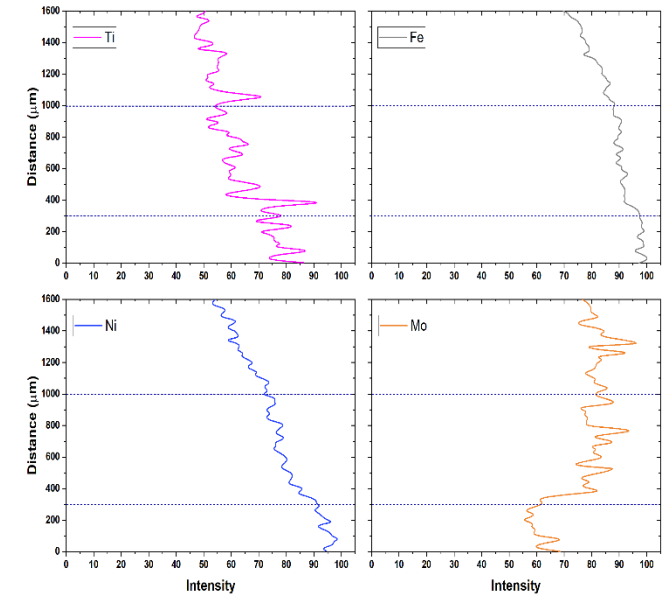
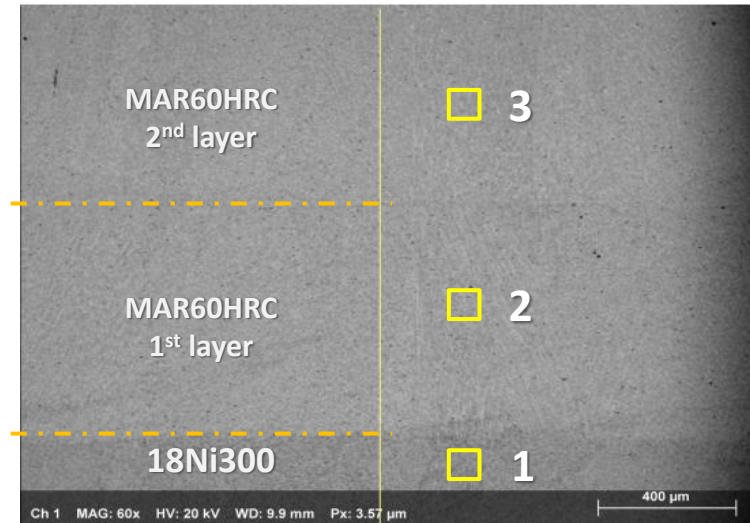
## DED - THERMAL HISTORY



# DEPOSITION OF BI-MATERIAL SPECIMENS

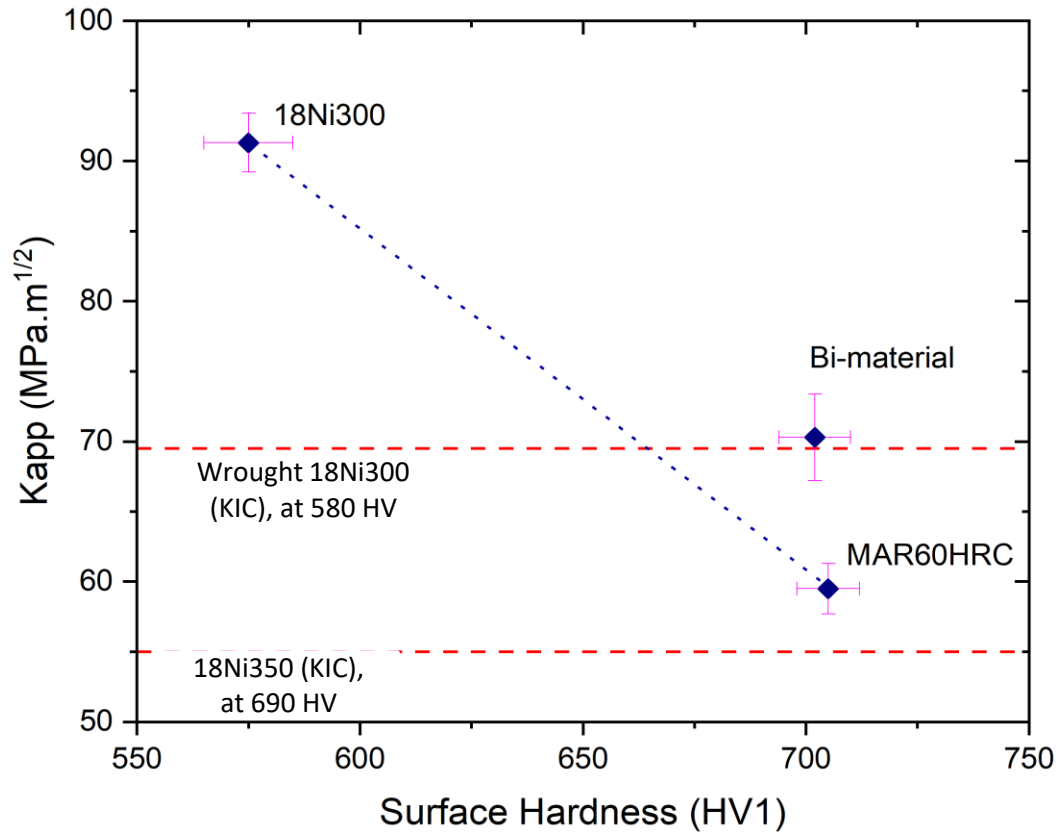


# DEPOSITION OF BI-MATERIAL SPECIMENS



	Ni	Co	Mo	Ti	Fe
MAR60HRC (nominal)	13.0	15.0	10.0	0.2	Bal.
Area 3	12.3	14.9	9.2	0.2	61.8
Area 2	14.3	13.5	7.9	0.3	64.4
Area 1	17.3	9.7	4.9	0.6	65.9
18Ni300 (nominal)	18.0	9.0	5.0	0.6	Bal.

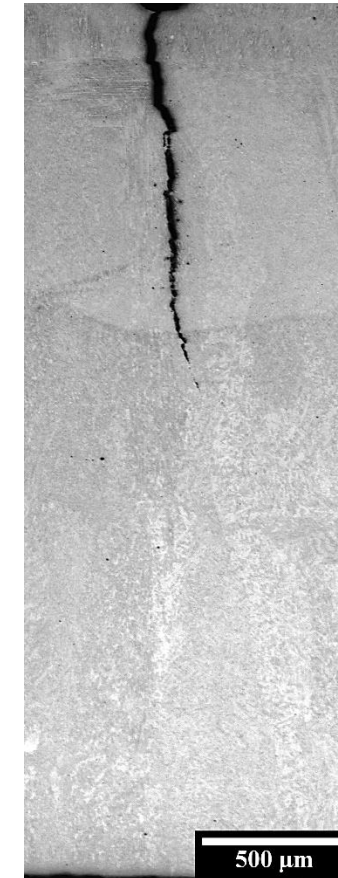
# FRACTURE TOUGHNESS



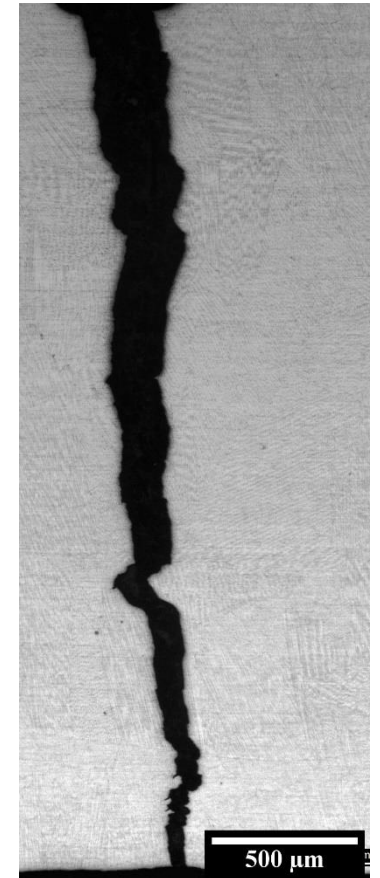
18Ni300



18Ni300



MAR60HRC



# SUPER DUPLEX STAINLESS STEEL



## POWDER FOR L-PBF



# EVOLVING MATERIALS TO SUSTAIN THE WORLD

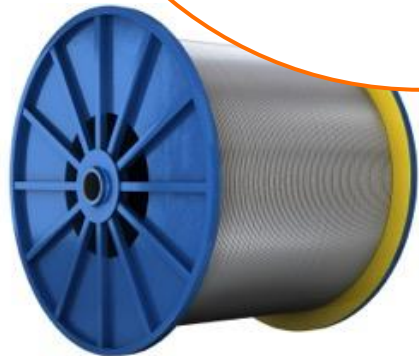
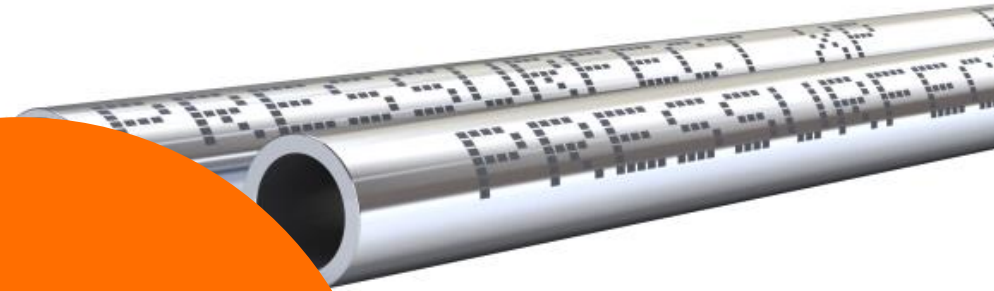


## CUSTOMER REALITY:

Find smarter ways to use energy resources and new ways to become more energy efficient.

## SOLUTION:

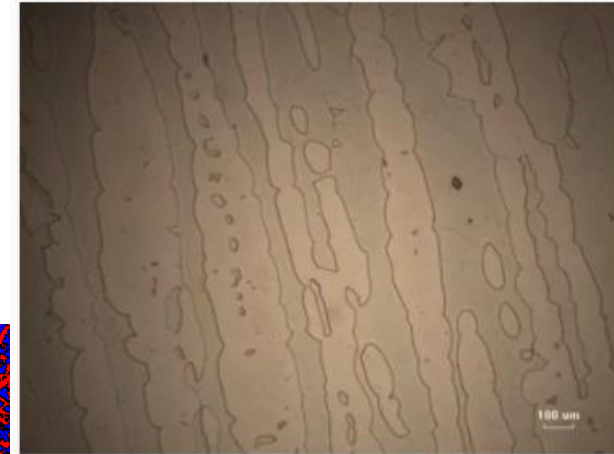
Materials expertise to make industrial processes safer and more energy efficient, yielding greater output while consuming fewer resources.



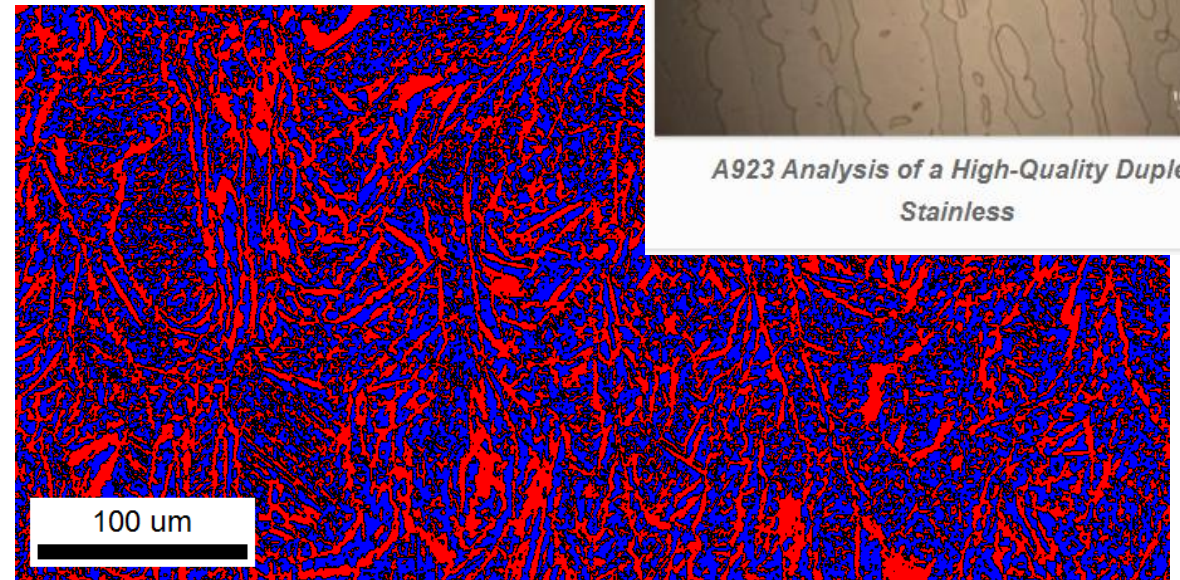
# SUPER DUPLEX STAINLESS STEEL

POWDER BED FUSION - LASER

MICROSTRUCTURE



A923 Analysis of a High-Quality Duplex Stainless

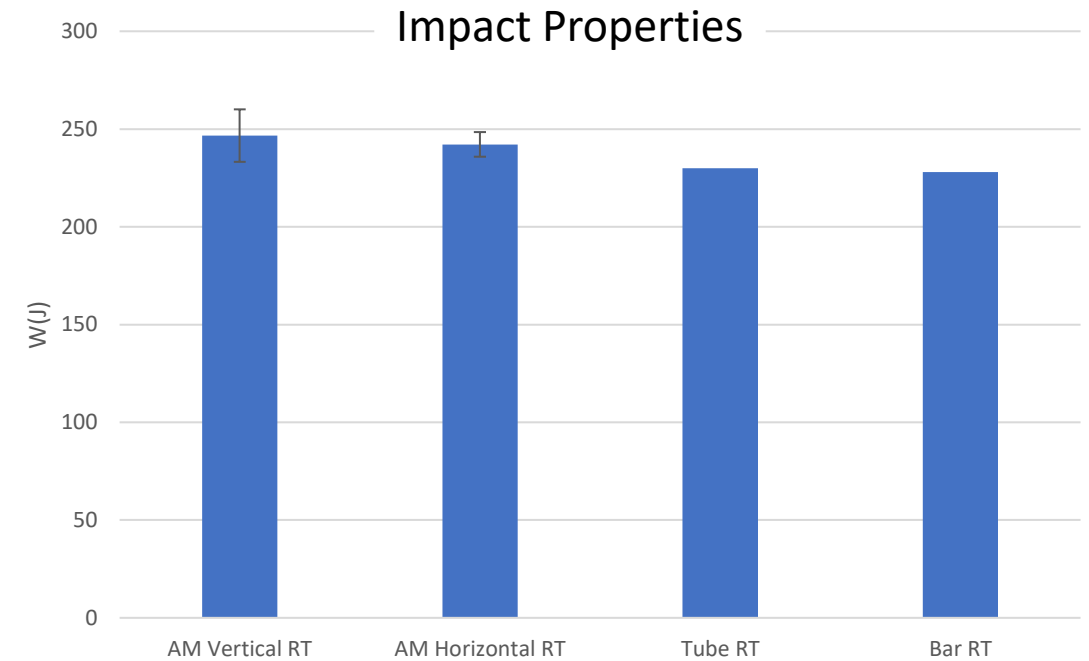
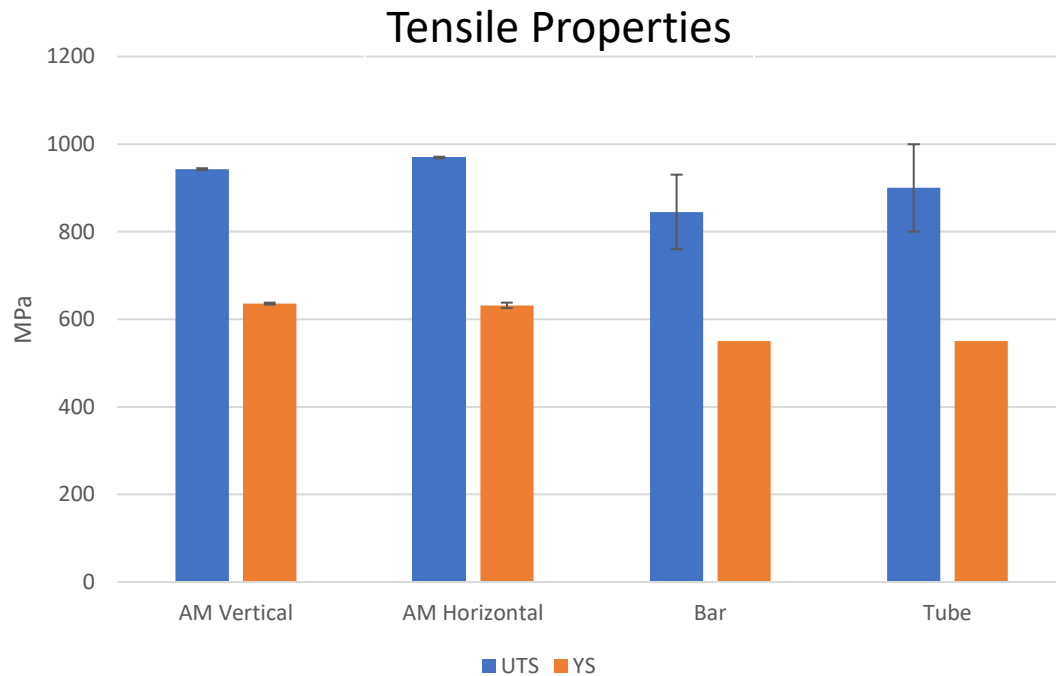


Austenite : 5.3  $\mu\text{m}$   
Ferrite : 21.6  $\mu\text{m}$

Phase	Fraction
Austenite	0.493
Ferrite	0.507

# SUPER DUPLEX 2507 STAINLESS STEEL - AM

## MECHANICAL PROPERTIES: AB-HT (20° C)

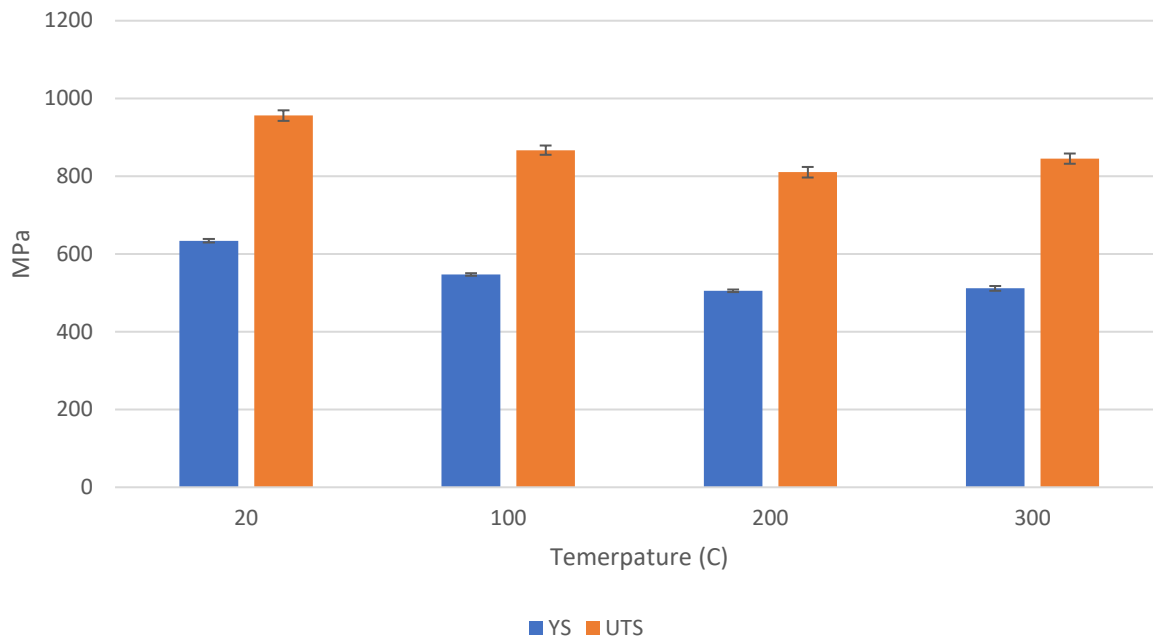


Impact at -46 °C = 200J Min. Required; 45J

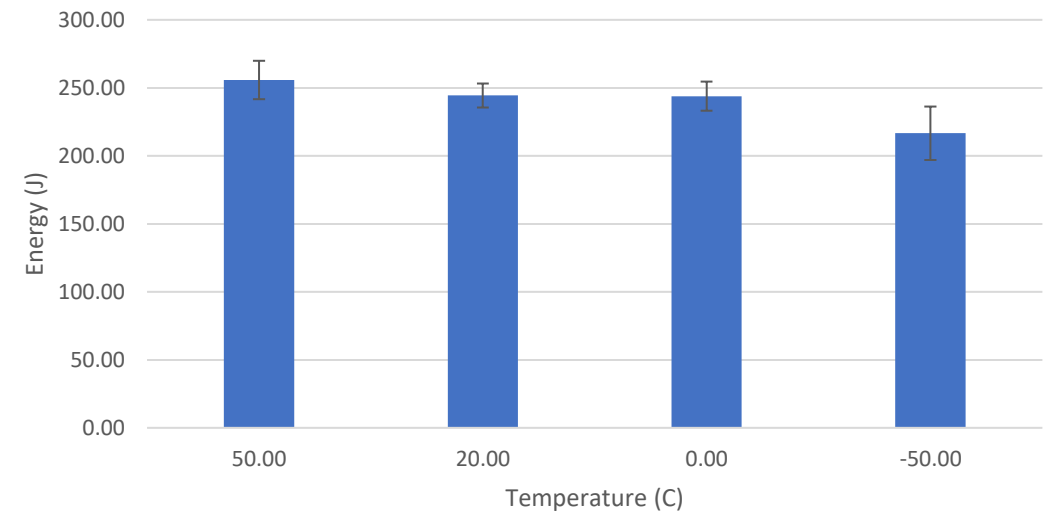
# SUPER DUPLEX 2507 STAINLESS STEEL - AM

## MECHANICAL PROPERTIES: AB-HT

Tensile Properties at Various Temperatures



Impact Energy at Various Temperature



Impact energy Reference: Minimum 45J at -46C.

Tensile Data- Room Temperature Ref Data:  $R_{p0.2} \geq 550$  MPa;  $R_m \geq 750$  MPa;  $A \geq 25$  %.

# SUPER DUPLEX STAINLESS STEEL

## CORROSION PROPERTIES

G150

1M NaCl Environment (Sea water)

CPT >95°C (Ref 70°C)

ASTM G31 (Modified)

50% NaOH Immersion Test

CPT 110°C (Ref 60°C)

G48

CPT 90°C (Ref 60°C)

ASTM G31 (Modified)

10% H<sub>2</sub>SO<sub>4</sub> Immersion Test

CPT 95°C (Ref 60°C)

## PRINTED COMPONENTS

Impeller Dia- 120mm



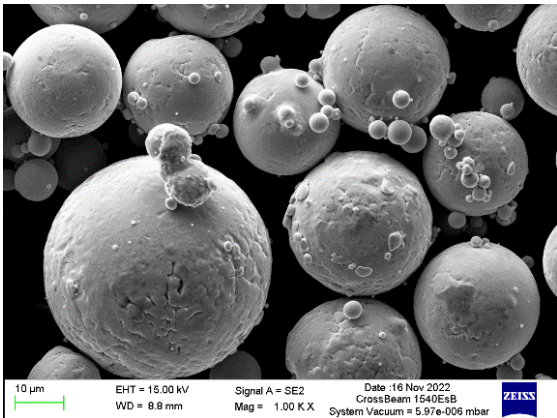
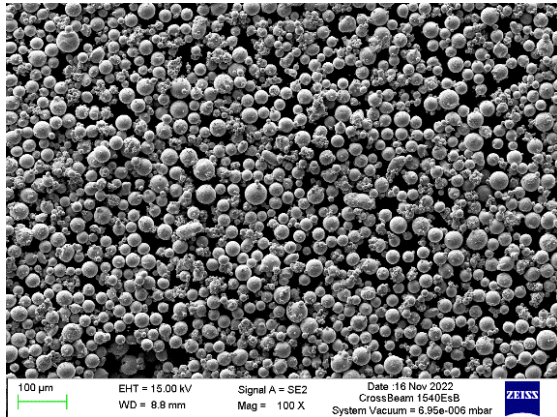
Collaborated with- Swerim AB, Alfa Laval

# COPPER ALLOYS FOR SPACE TECHNOLOGY APPLICATIONS

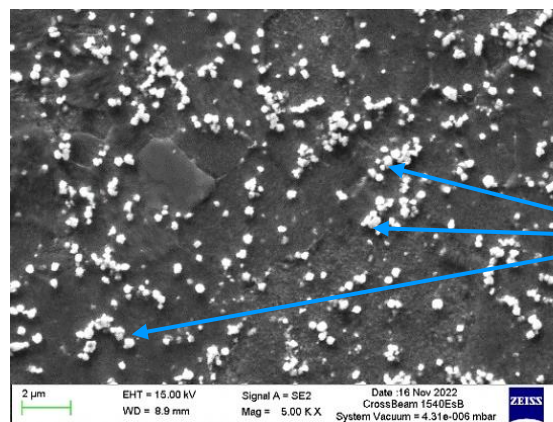
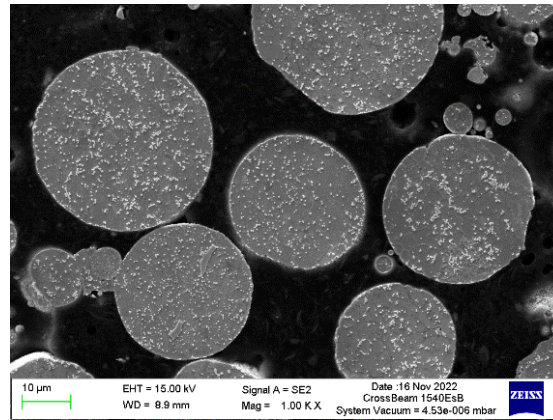


# OSPNEY® GRCOP 42

## Morphology



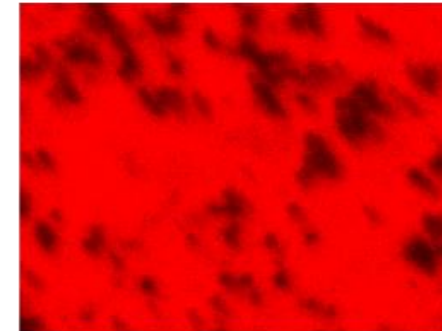
## Cross section



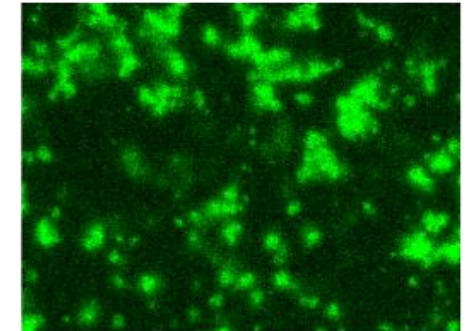
## EDS

### Precipitated Laves Phase ( $\text{Cr}_2\text{Nb}$ )

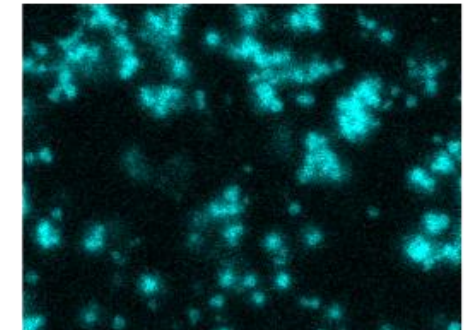
Cu Lα<sub>1,2</sub>



Cr Kα<sub>1</sub>



Nb Lα<sub>1</sub>



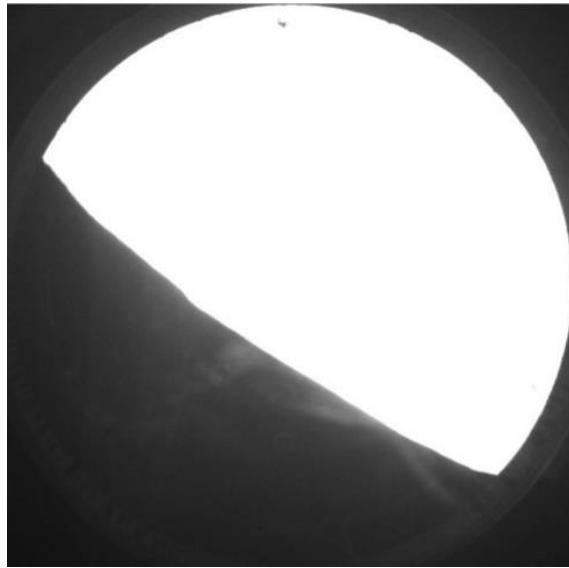
Laves phase  
( $\text{Cr}_2\text{Nb}$ )

# OSPREY® GRCOP 42

## POWDER PROPERTIES

### Rotating Drum\_Mercury Scientific:

Avalanche Energy = 10.5 mJ/kg



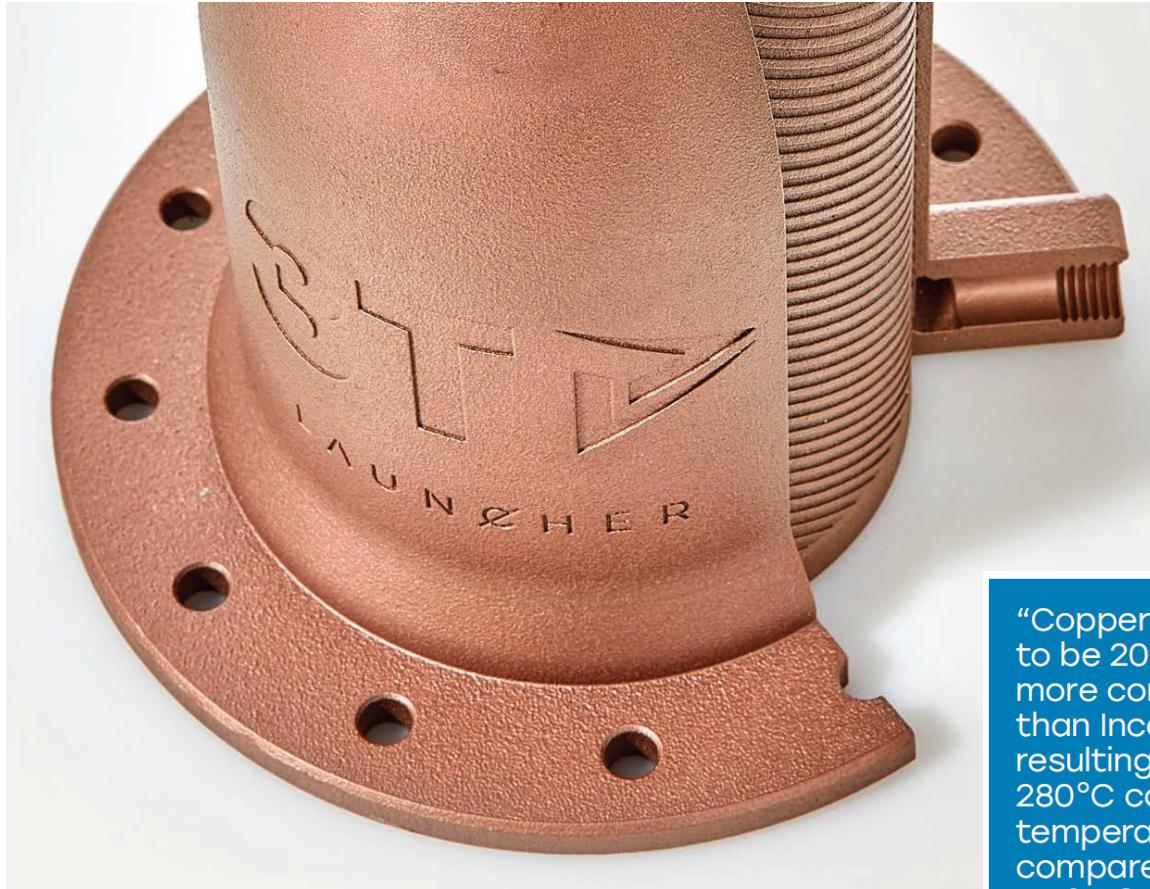
### Flowability:

- Hallflow = 19.9 s

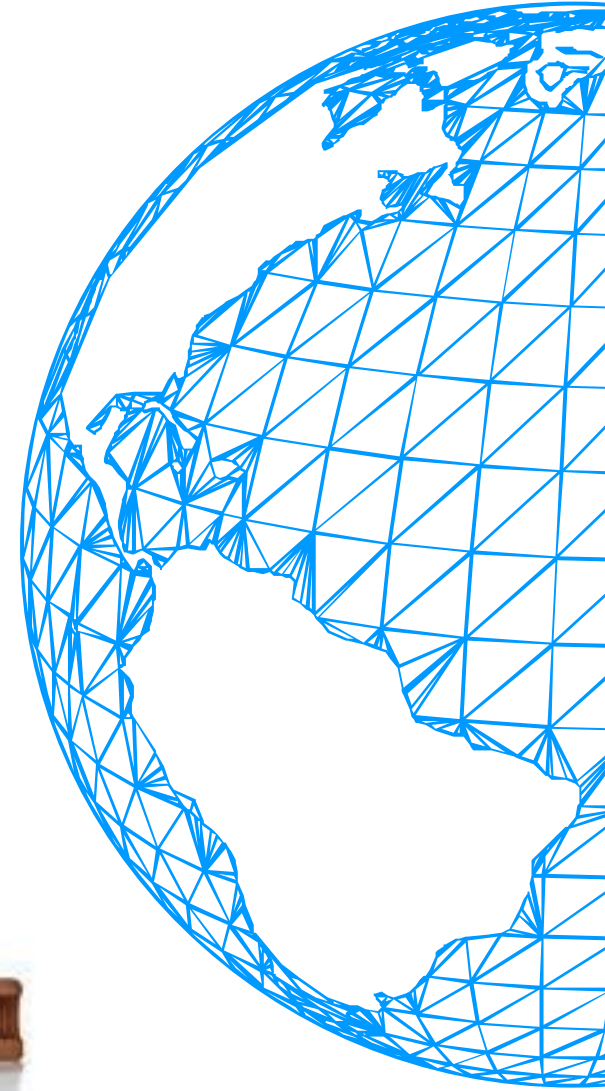
### Particle size distribution (Malvern 3000):

- $d_{10} = 20.5 \mu\text{m}$
- $d_{50} = 31.4 \mu\text{m}$
- $d_{90} = 47.4 \mu\text{m}$

# OSPREY® C18150 (CUCRZR)



“Copper proved to be 20 times more conductive than Inconel, resulting in a 280°C coolant temperature, compared to 153°C for Inconel.”



# OSPREY® C18150 (CUCRZR)

## DESKTOP METAL QUALIFIES COPPER ALLOY C18150

- Chromium zirconium copper, C18150 is a high-strength, high-conductivity copper alloy.
- Commonly used in thermal transfer applications, such as electrical connectors, welding electrodes, as well as other electrical and electronic components.
- A global automaker is now testing a unique 3D printed part design, which is being developed for a future production application.



# OSPREY® C18150 (CUCRZR)

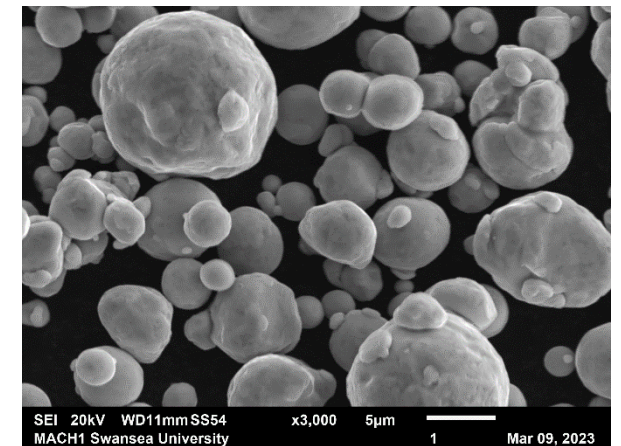
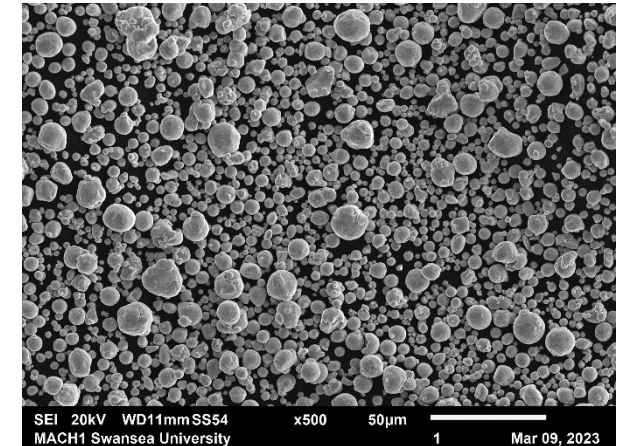
## Nominal composition (wt %)

Cu	Cr	Fe	Si	Zr	O
Bal.	0,50-1,20	0,08 max	0,10 max	0,03-0,30	<0,1

## Powder properties (examples)

	d10 (µm)	d50 (µm)	d90 (µm)	Apparent Density (g/cm <sup>3</sup> )	Tap Density (g/cm <sup>3</sup> )	Hall-Flow (s)
Binder-Jet (90% -18 µm)	4,6	9,5	17,3	4,6	5,2	-
Binder-Jet (90% -25 µm)	5,7	13,0	24,0	4,9	5,2	-
PBF-L (15 - 53 µm)	16,5	30,5	56,9	4,7	5,1	19
PBF-L (20 - 53 µm)	22,3	36,0	57,7	4,9	5,2	16

## Morphology



# CONCLUSION

## NEW METAL POWDER DEVELOPMENTS FOR ADDITIVE MANUFACTURING

- Metal powder based Additive manufacturing processes will provide a positive contribute to a sustainable future.
- Ti6Al4V EIGA powders are comparable in terms of microstructure & mechanical performance to plasma atomised powders.
- Hot Isostatic Pressing reduces variability in mechanical performance.
- Cobalt free maraging steels match performance of existing grades.
- Super Duplex stainless steels provide a combination of mechanical strength & corrosion resistance; better that of wrought materials
- New Copper alloys combined with developments in L-PBF provide opportunities in space technology.



Osprey® Online – A new web-shop for AM  
(coming soon to the USA)

# THANK YOU!



THE  
NEXT  
LEVEL

FOR FURTHER INFORMATION, VISIT OUR  
BOOTH IN BOOTH 1647.

[WWW.METALPOWDER.SANDVIK](http://WWW.METALPOWDER.SANDVIK)

[rapid3devent.com](http://rapid3devent.com)