



We. Spray. Future.

Global technology leader for industrial cold spray

Niobium alloy C-103 for high-performance space propulsion applications using

Cold Spray Additive
Manufacturing – CSAM

Space Tech Expo USA, Long Beach
June 4th, 2025, Ján Kondás



Agenda

- Company Introduction
- Cold Spray – a short overview
- CSAM C-103 characterization
- CSAM C-103 rocket nozzle demonstrator

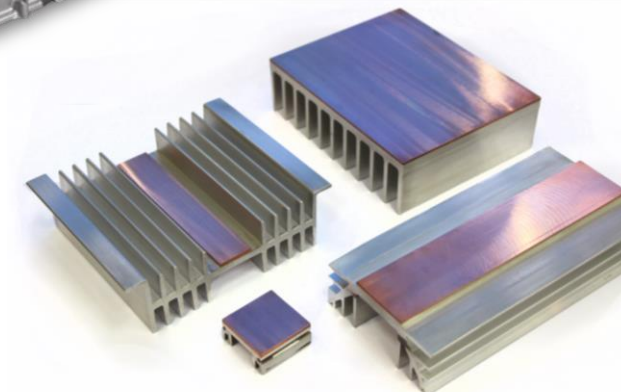
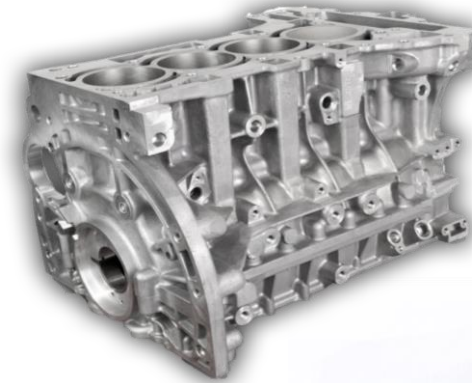
Global technology leader for industrial cold spray

Our Impact on cold spray

- Year of foundation: 2010
- > 20 Years of experience in cold spray technology
- Focus on high pressure cold spray equipment for industrial applications
- > 100 Impact systems installed worldwide
- > 50 Employees
- 1500 m² production area
- 750 m² office space



Impact

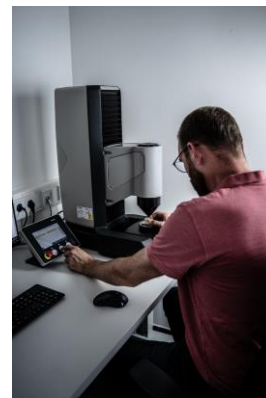


In-house R&D facility & CS system

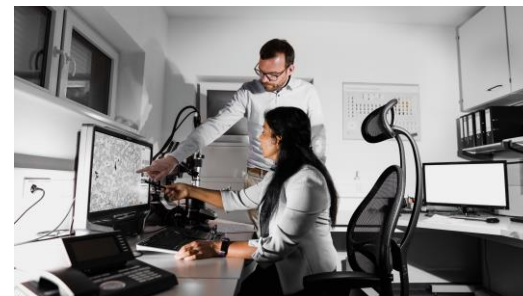


Overview of material experience

Ni-base	Fe-base	Cu-base	Al-base	Refractory	Ti-base	Co-base	Precious metals	Other
Ni	M152	CuCrZr	Al 99.99%	Ta	Ti	Haynes 188	Ag99.99%	Sn
Inconel 625	SS 316L	CuAgZr	F357	Nb	Ti-6-4	Stellite 6	AgCu20%	Zn
Inconel 718	SS 304L	Cu99.95%	Al2024	V	Ti-5555		AgCu70%	Al-FeNdB
Inconel 738	SS 430L	Cu99.99%	Al2219	Cr	Ti-WC			PEEK
Hasteloy-X	H13	CuSn10	Al5063	Zr-702	Ti-TiC			
Waspaloy	M3/2	CuAl10Fe3Mn2	Al6061	Zr-705				
NiCr20	SS 420	CuSn12Ni2	Al7010	C-103				
Monel	A286	Cu-Cr	Al7050	Ta-W				
NiAl4.75	H10	Cu-W	Al7075	W-Ti				
NiCrAlY	8620		ScAlmalloy	W-Cr				
	Invar36			Mo-Ti				
	Fe99%							
	Crofer22APU							
	FeCr30							



Cold Spray R&D cell & material analysis laboratory



EvoCSII cold spray system - Ready for industry and 24/7 operation

A wide range of system configurations possible

Operation of 2 guns in parallel

Up to 4 powder feeders

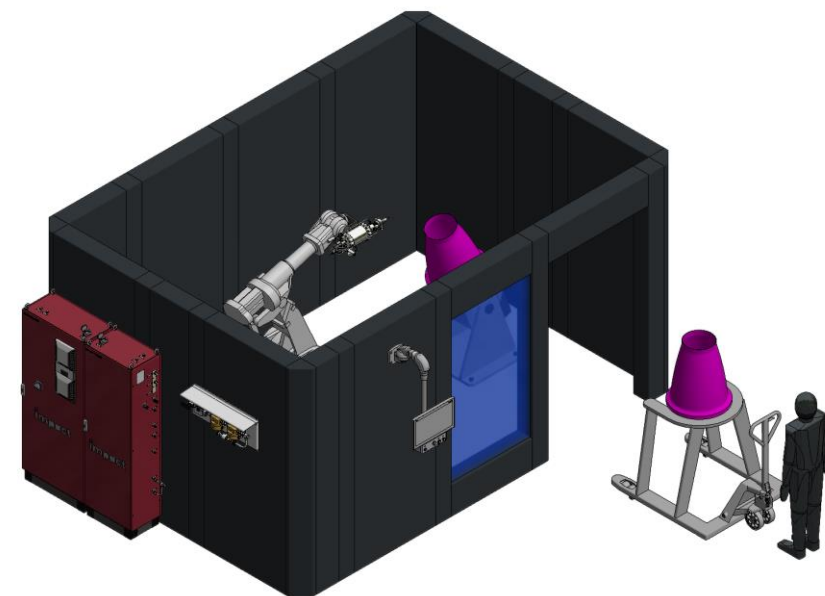
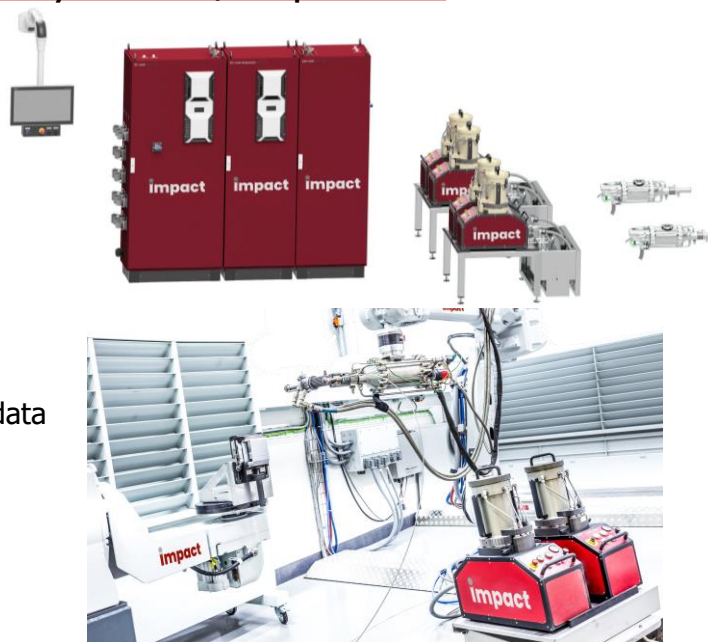
Various interfaces for integration in production lines and higher level controls

Monitoring of more than 150 process parameters and system data

Closed loop process control

Preventive maintenance

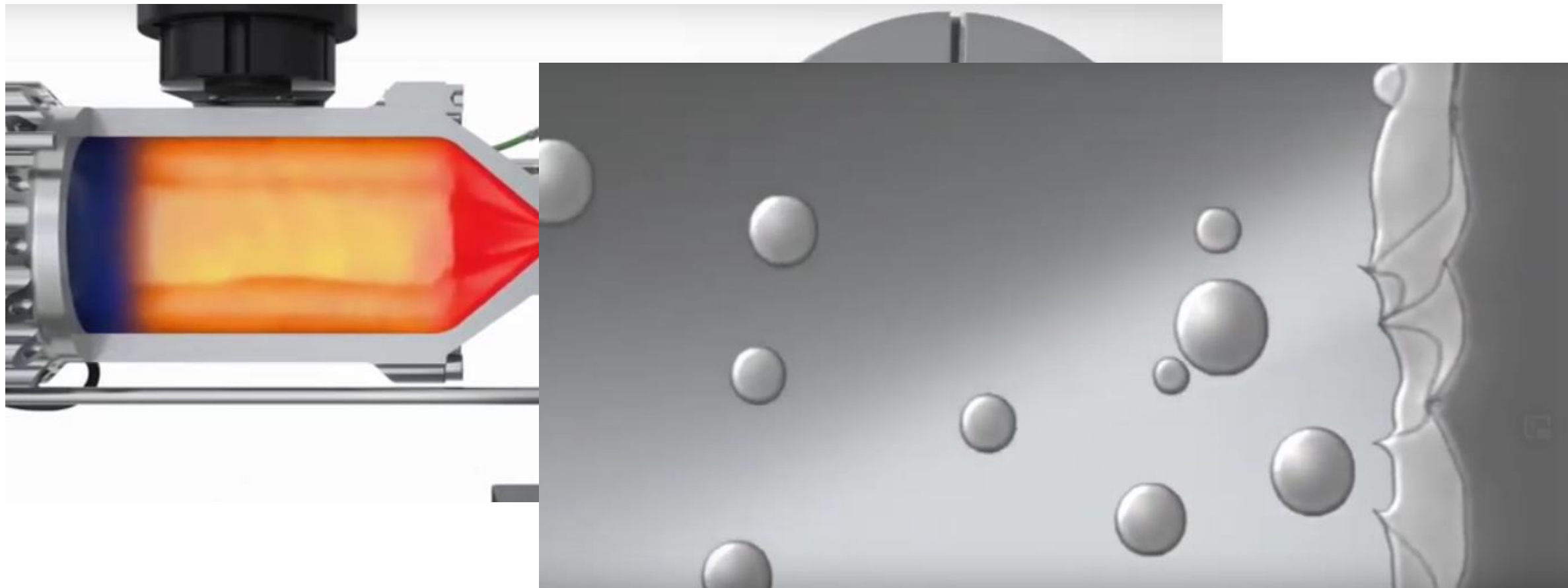
Machine learning





Impact Spray Process principle

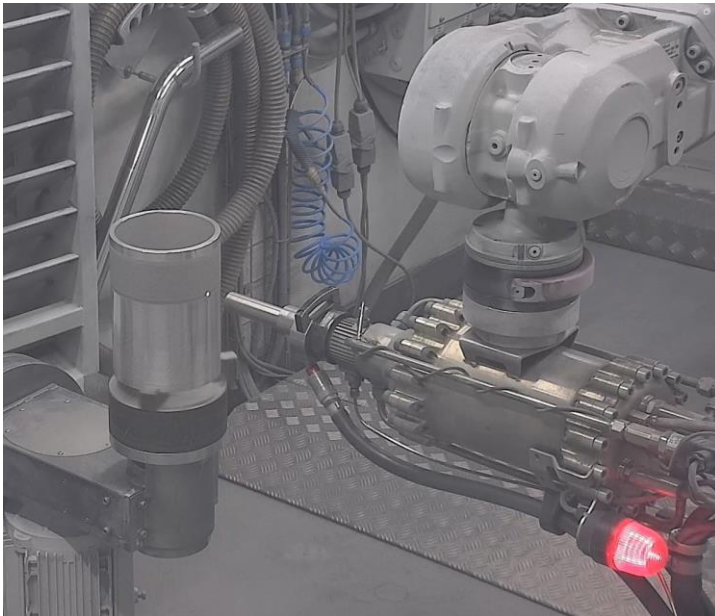
impact



C-103 alloy test part with flange



- Test of three different powders from two different suppliers with different PSD
- Optimise:
 - Temperatur
 - Pressure
 - Feed rate
- Samples 1.1.1 to 1.6.1 show the results for different parameter sets



As-deposited C-103 with a flange on one end

Dimensions:
Diameter: ~ 140 mm
Length: ~ 125 mm
Thickness: ~ 2 mm (as-deposited)

Flange:
Length: ~4 mm
Height: ~8 mm

Cold Spray corner stone data:

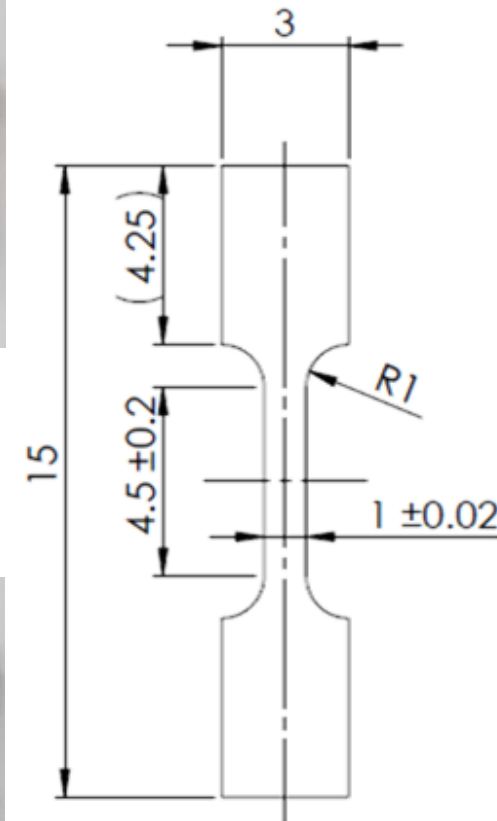
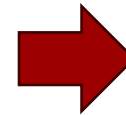
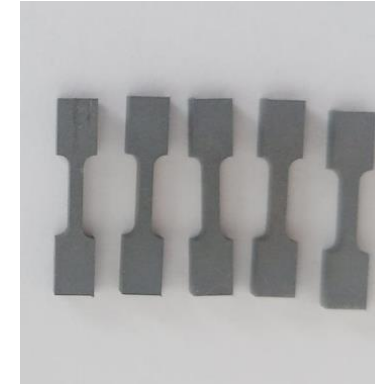
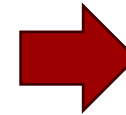
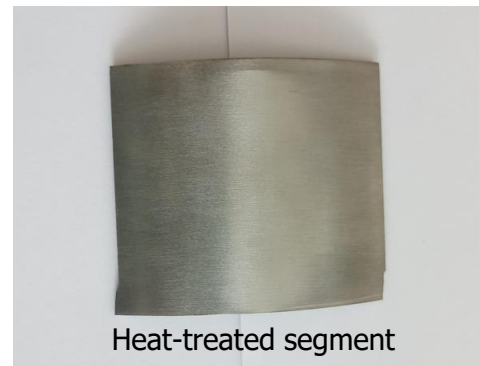
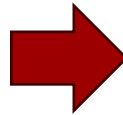
- | | |
|-------------------------------|------------------------|
| • Deposition Efficiency (DE): | 92,4% |
| • Powder feed rate: | 4,83 kg/h → 80 g/min |
| • Deposition Rate (DR): | 4,46 kg/h → 74,3 g/min |
| • Hardness Vickers: | ~235 HV 0,3 |



C-103 alloy test part – MTT extraction



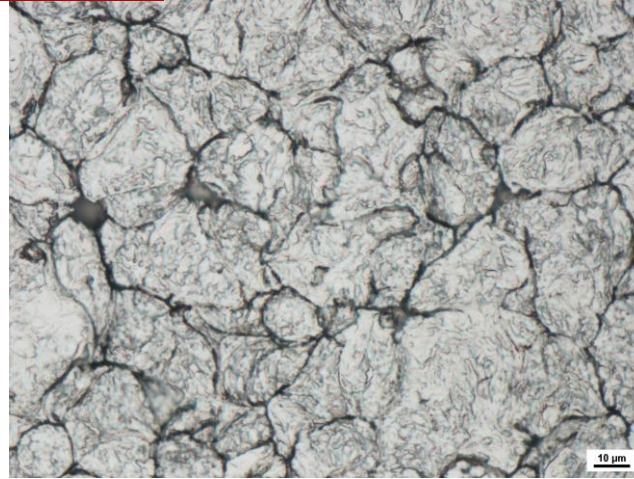
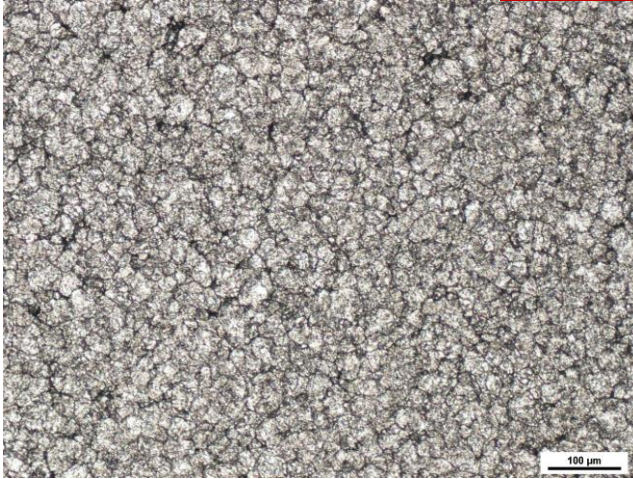
MMT = micro-tensile test specimens



C-103 alloy cross-section analysis

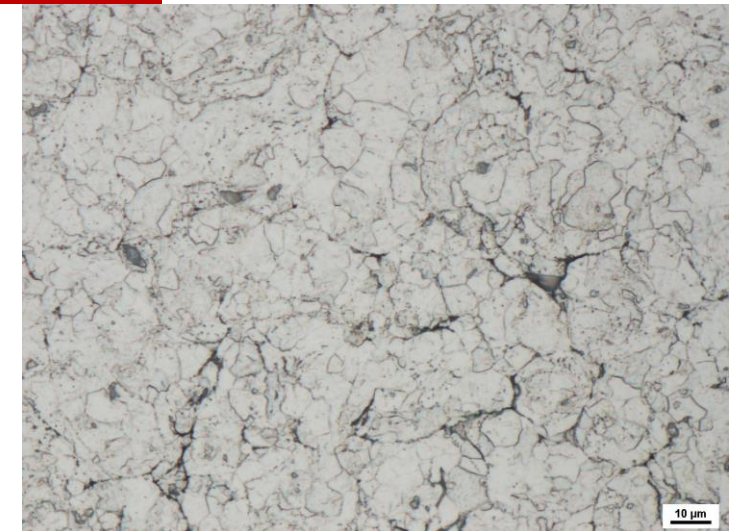


As-deposited



Homogeneous, fine microstructure, originating from the fine particles deposited

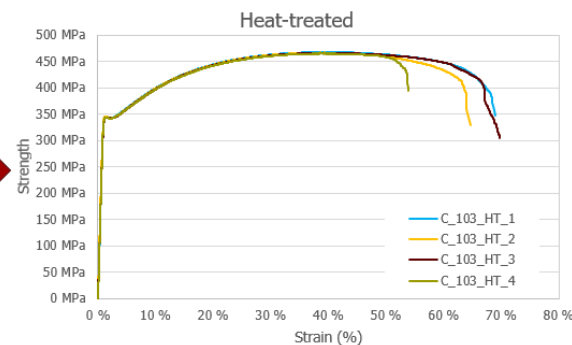
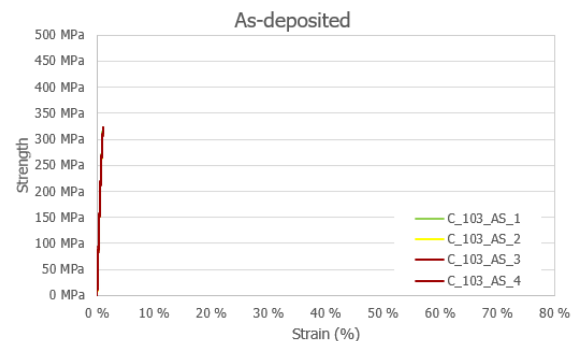
Heat-treated



Finer grained microstructure after HT, showing small precipitates inside and at grain boundaries

C-103 alloy test part – tensile specimen

Both tested at room temperature



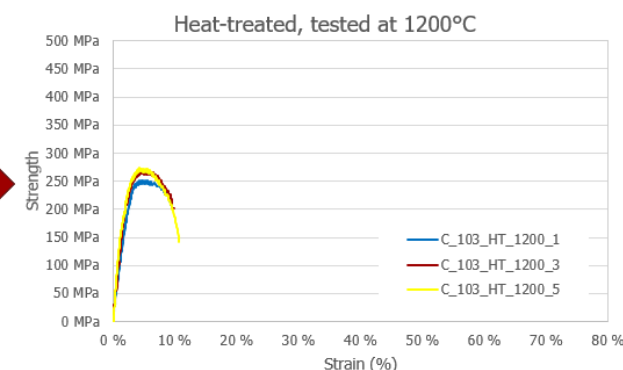
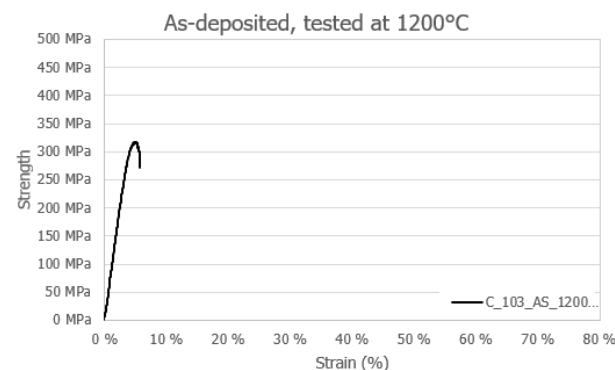
Link	Sample	Temp. °C	E GPa	R _{p02} MPa	R _m MPa	A _g %	A %	Z %
C_103_AS_1	C_103_AS_1	23	86.2	-	322.6	0.0	0.0	1.6
C_103_AS_2	C_103_AS_2	23	87.2	-	315.8	0.1	0.1	0.0
C_103_AS_3	C_103_AS_3	23	89.6	-	297.5	0.0	0.0	0.7
C_103_AS_4	C_103_AS_4	23	92.6	-	323.6	0.1	0.1	1.0
	Average	-	88.9	-	314.9	0.1	0.1	0.8
	Stdeva	-	2.87	-	12.08	0.02	0.02	0.67

Link	Sample	Temp. °C	E GPa	R _{p02} MPa	R _m MPa	A _g %	A %	Z %
C_103_HT_1	C_103_HT_1	23	95.7	345.3	467.8	15.5	27.2	39.0
C_103_HT_2	C_103_HT_2	23	102.1	346.3	466.9	15.3	25.6	36.4
C_103_HT_3	C_103_HT_3	23	93.0	343.8	466.3	15.8	27.5	36.6
C_103_HT_4	C_103_HT_4	23	95.2	343.1	465.1	14.8	21.3	34.4
	Average	-	96.5	344.6	466.5	15.3	25.4	36.6
	Stdeva	-	3.92	1.42	1.12	0.43	2.88	1.88

Room temperature tensile testing

1200°C tensile testing

Both tested at 1200°C



Sample	Temp. °C	E GPa	R _{p02} MPa	R _m MPa	A _g %	A %	Z %
C_103_AS_1	1200	8.2	273.9	317.8	1.1	5.8	-
Average	-	-	-	-	-	-	-
Stdeva	-	-	-	-	-	-	-

Sample	Temp. °C	E GPa	R _{p02} MPa	R _m MPa	A _g %	A %	Z %
C_103_HT_1	1200	8.2	273.9	317.8	1.1	5.8	-
	1200	8.1	218.4	251.4	2.1	9.6	-
	1200	11.5	185.6	269.2	2.2	8.2	-
Average	-	11.2	189.8	264.7	2.2	9.3	-
Stdeva	-	2.95	26.71	11.66	0.14	0.92	-

Collaborative project for CSAM C-103 demonstration:



Project proposal, design, CSAM



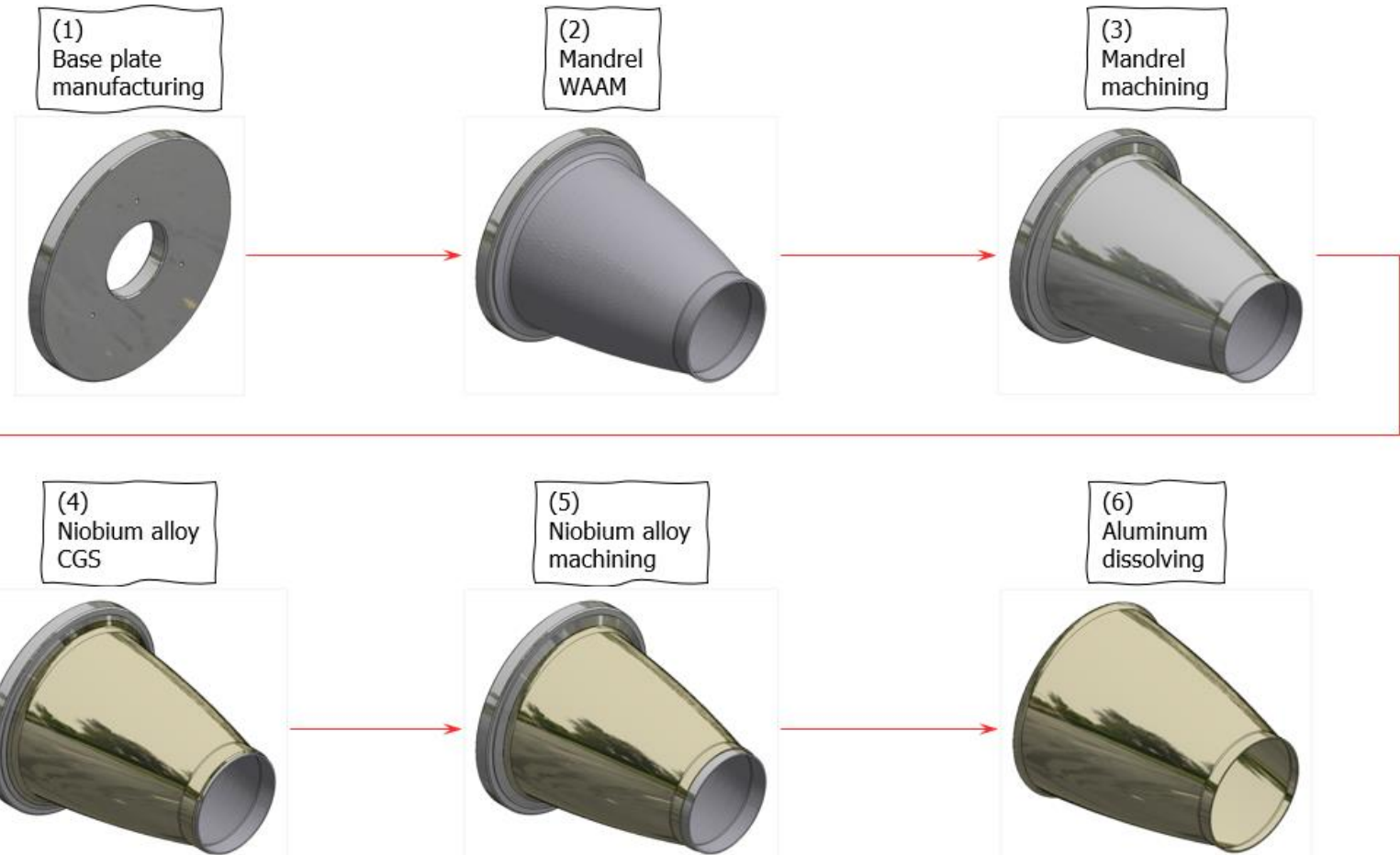
C-103 Powder supply



Characterization: tensile, microstructure

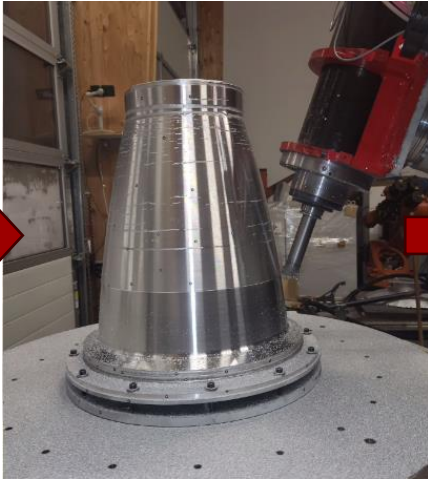


WAAM mandrel manufacturing



Rocket nozzle C-103 demonstrator

WAAM 3D printed Al alloy mandrel



Starting the CSAM process



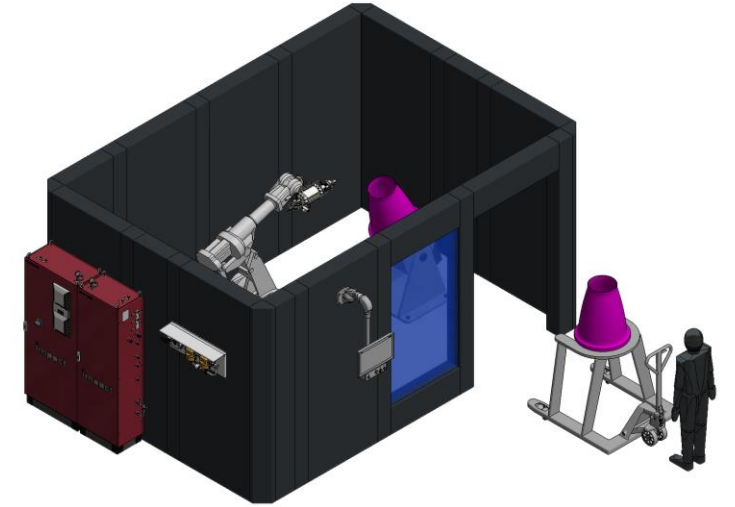
Impact

- 2h20min deposition time
- 10.5kg powder used
- 9.5kg nozzle net weight
- Wall thickness 1mm

Summary

- CSAM feasibility of C-103 alloy confirmed
- 92% deposition efficiency at 4kg/h deposition rate
- Tensile properties tested:
 - at room temperature => high strength and elongation
 - At 1200°C => moderate strength and elongation => further heat treatment development is ongoing
- CSAM C-103 rocket nozzle demonstrator manufactured with 1mm wall thickness and 9.5kg final weight

 **Impact**





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