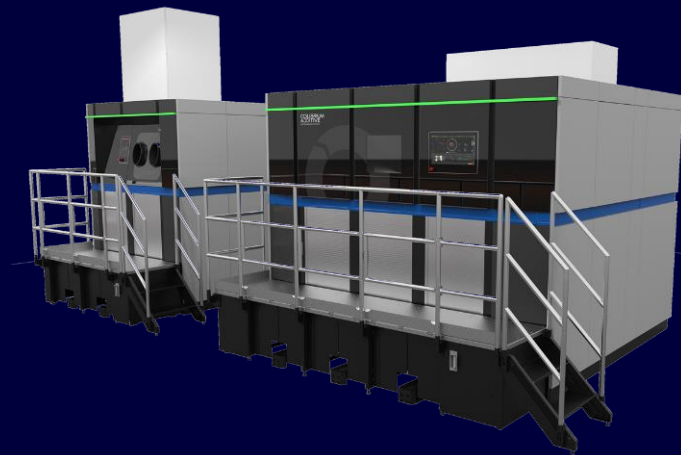


L-PBF Nickel 718

Parameter for Colibrium Additive's M Line

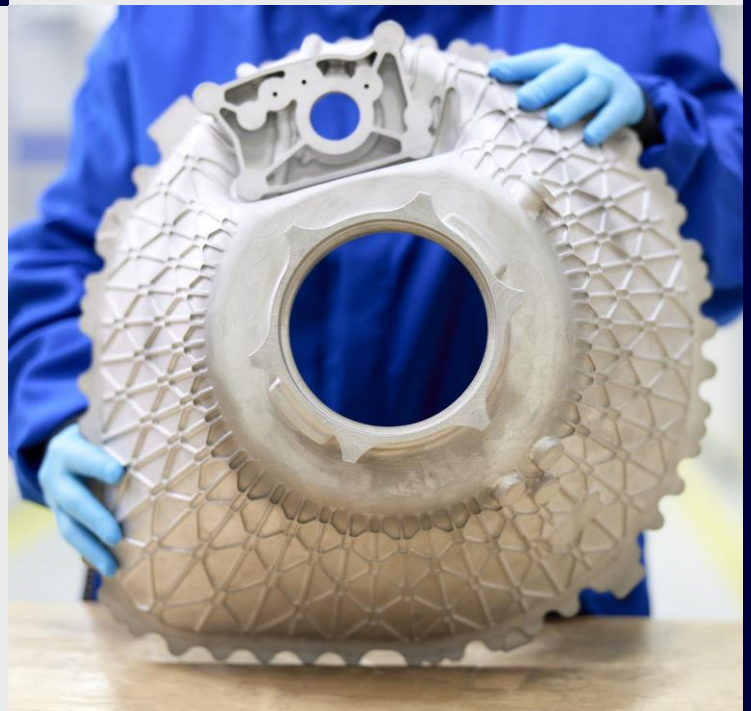


Nickel 718

Nickel chromium superalloys like Nickel 718 are often used in high-stress and high-temperature environments. The excellent high temperature strength and creep resistance derive from precipitation hardening of finely dispersed precipitates. Next to that Nickel 718 is a metal that is also highly resistant to the corrosive effects of hydrochloric acid and sulfuric acid. The favorable weldability of Nickel 718 makes this alloy suitable for additive manufacturing as well. Typical applications are high-quality components designed for thermally challenging environments such as rocket engines, gas-turbine hot sections, and heat exchangers.

M Line Nickel 718

The Nickel 718 parameter for the Colibrium Additive M Line is developed leveraging the performance of the previous machine generations. The balanced parameters deliver good surface quality while maintaining a very good density. The parameter has been optimized for use of a steel blade recoater and meets the minimum tensile properties specified in ASTM F3055 for additive manufactured parts in the heat treated state.



M Line Nickel 718

Machine Configuration

M Line

Quad-laser architecture

Nitrogen gas

Powder Chemistry

Nickel 718 powder chemical composition according to ASTM B 637 UNS N07718.

Particle Size: 15-53 μm

For additional information on Nickel 718 powder, visit: www.advancedpowders.com

Thermal States

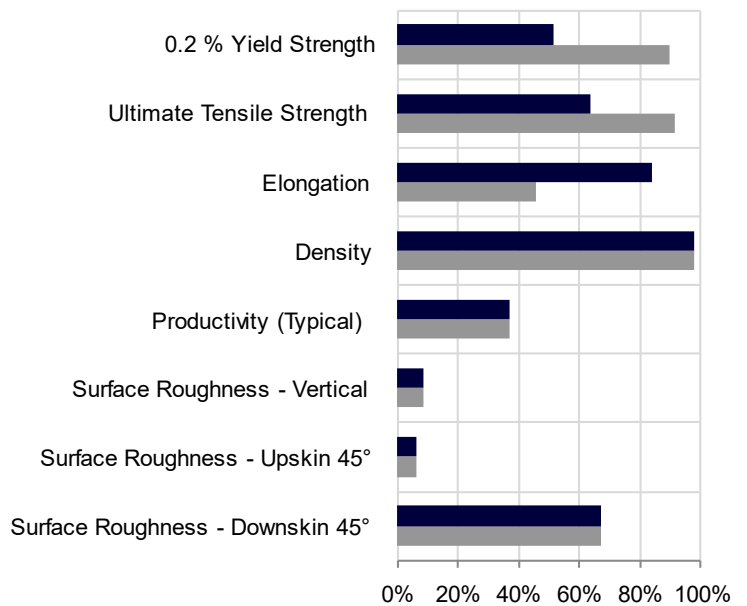
As-Built (AB)

Solution + Age (SOLN+AGE)

SOLN: 980 °C, 1 hour in argon; AGE: 720 °C, 8 hours, furnace cooling down to 620 °C, 8 hours, cooling in air

Parameter Availability and Thermal State Comparison

- Balanced Parameter 330/381 As-Built
 - Balanced Parameter 330/381 SOLN
- 400 W, 50 μm layer thickness, rubber or steel recoater



Bar Plot is generated by normalizing typical material data (containing both horizontal and vertical data) against a range defined for each material family. For this Nickel alloy, the ranges are as follows: 0.2% YS: 0-1400 MPa, UTS: 0-1600 MPa, Elongation: 0-40 %, Density: 99-100 % (As-Built), Productivity: 5-60 cm^3/h , Surface Quality (all): 5-40 μm . 0% in the Bar Plot indicates the lower range value, 100% indicates the upper range value

Balanced Parameter 330/381 - 400 W / 50 μ m

Typical Build Rate

	(cm ³ /h)
Typical build rate with coating ¹	25.2
Theoretical melting rate bulk per laser ²	20.5

¹ Using standard Factory Acceptance Test layout and 4 lasers

² Calculated (layer thickness \times scan velocity \times hatch distance)

Tensile Performance at Room Temperature

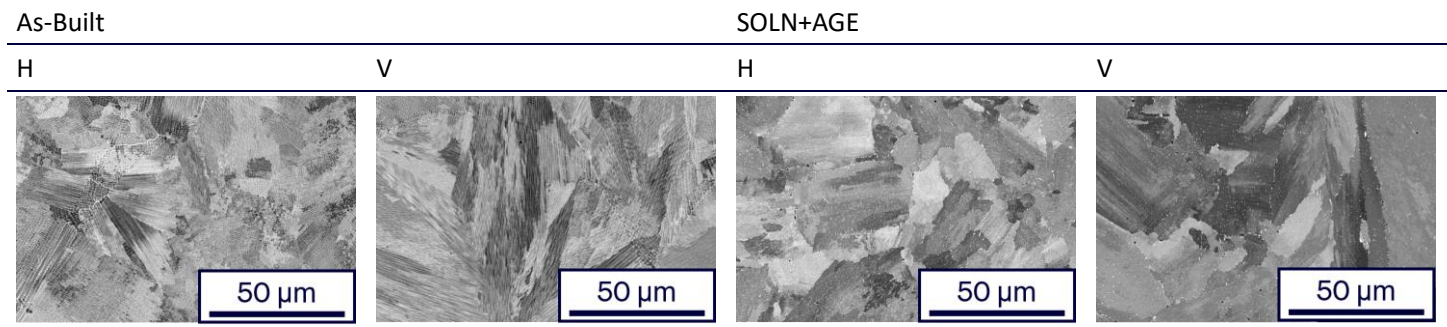
Thermal State	Sample Size	YM (GPa)	0.2% YS (MPa)	UTS (MPa)	Elongation (%)	Area Reduction (%)
As-Built H	12	210	765	1050	31.0	47.5
As-Built H - ST	12	203	760	1045	30.5	47.5
As-Built V	64	180	670	975	36.0	52.0
SOLN+AGE H	12	211	1285	1505	17.5	24.0
SOLN+AGE H - ST	12	206	1275	1495	16.0	23.0
SOLN+AGE V	36	210	1220	1425	19.0	30.5

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	8	7	5
Downskin	29	16	9

Surface Roughness, Ra (µm)	
H	---
V	9

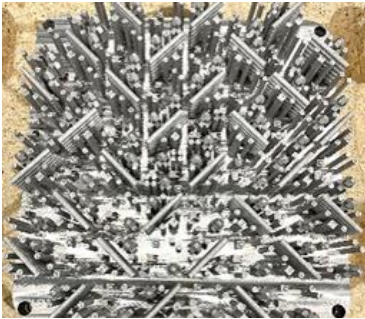
Thermal State	Relative Density (%)		Hardness (HV10)
	H	H	H
As-Built	99.9	99.9	283
SOLN+AGE	---	---	473

Microstructure

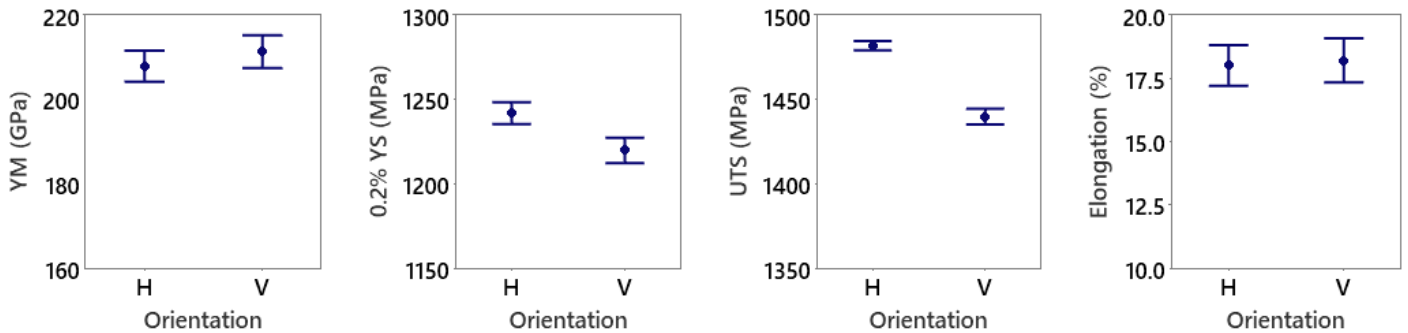


Scanning electron microscope images in As-Built and Solution + Aged (SOLN+AGE) condition as defined previously.

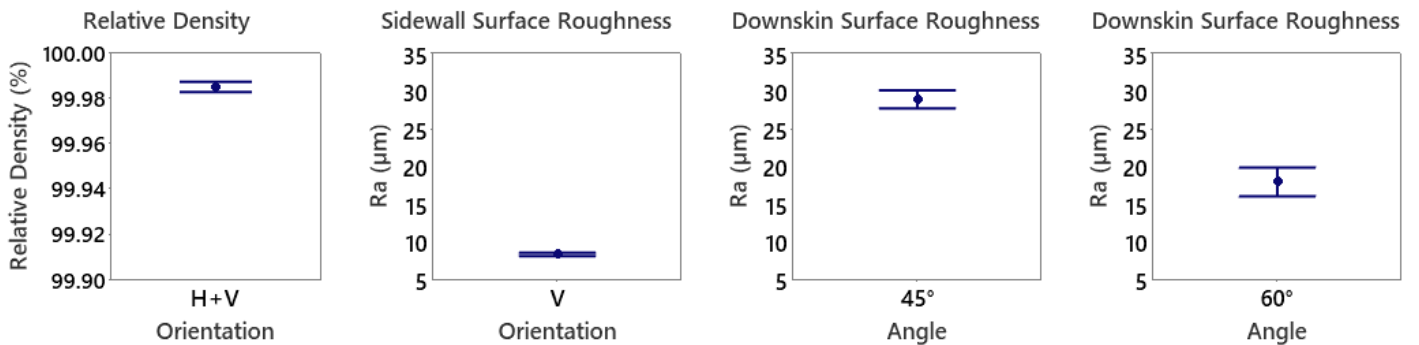
The platform stability build evaluates relative density, roughness and tensile properties across different positions and orientations. To illustrate the position dependency of the M Line, the samples were homogenously distributed across the platform on 30 different positions. Regarding surface quality all sides of the specimen, so all orientations with respect to gas flow and optical system, are included in the analysis. Data shown below are dependent on part & print layout as well as batch chemistry variations and thus might deviate from “typical values” given on previous pages.

		Sample Size	Mean	Std. Dev.		Sample Size	Mean	Std. Dev.
	YM (GPa) H/V - SOLN	30/29	207/211	10/11	Rel. Density (%)	60	99.98	0.01
	0.2% YS (MPa) H/V - SOLN	30/29	1240/1219	18/20	Sidewall Roughness Ra (µm)	120	8.5	1.5
	UTS (MPa) H/V - SOLN	30/29	1481/1439	8/13	45° Downskin Roughness Ra (µm)	120	29.0	7.0
	Elongation (%) H/V - SOLN	30/29	18/18	2.5/2.5	60° Downskin Roughness Ra (µm)	120	18.0	10.5

Results Platform Stability: Mechanical properties in SOLN condition



Results Platform Stability: Relative Density and Surface Quality



Data Sheet Nomenclature and Notation

H: Horizontal, X or Y.

V: Vertical, Z.

Other angles are measured from horizontal.

ST: Stitched, parts built by multiple optical systems

Roughness measurements have been performed according to DIN EN ISO 4287 and DIN EN ISO 4288. In general analysis of the surface quality is strongly dependent on the methodology used and therefore deviations might be observed depending on methodology used. Vertical and horizontal sidewalls have been characterized using a tactile system, overhangs using an optical system.

Tensile evaluations were performed according to ASTM E8 or E21, depending on test temperature.

All figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.