COLIBRIUM ADDITIVE
a GE Aerospace company

13 Al | 22 Ti | 24 Cr | 26 Fe | 27 Co | 28 Ni | 29 Cu

L-PBF Steel 316L

Parameters for Colibrium Additive's X Line 2000R

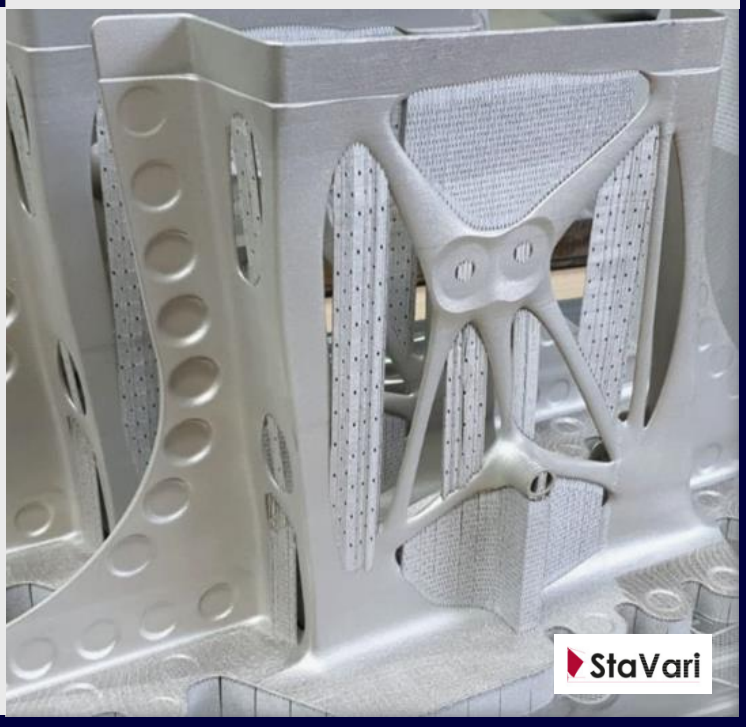
Stainless Steel 316L

316L is a chromium-nickel-molybdenum austenitic stainless steel having a higher corrosion resistance compared to the most common stainless steel 304 without any significant disadvantages in costs. By the addition of molybdenum this steel is suitable for components within harsh chemical environments containing chlorides and other halides. Typical applications can be found across a wide range of industries like plant engineering, oil & gas industry, automotive industry, medical technology, jewelry and components for molds. Besides 316L is easily weldable, offers excellent ductility and high creep strength at elevated temperatures.

X Line 2000R Steel 316L

The 316L Parameter for the Colibrium Additive X Line 2000R is developed leveraging the performance of the previous X Line generations. The balanced parameters deliver good surface quality while maintaining a very good density, mechanical strength and productivity.

Moreover, the parameter succeeds the minimum tensile properties specified in ASTM F3184 for additive manufactured parts in the stress relieved state.



X Line 2000R Steel 316L

Machine Configuration

X Line 2000R

Dual-laser architecture

Nitrogen gas

Powder Chemistry

Steel 316L powder chemical composition according to ASTM F3184 - UNS S31603 / ASTM A276

Particle size: 15-45 µm

Thermal States

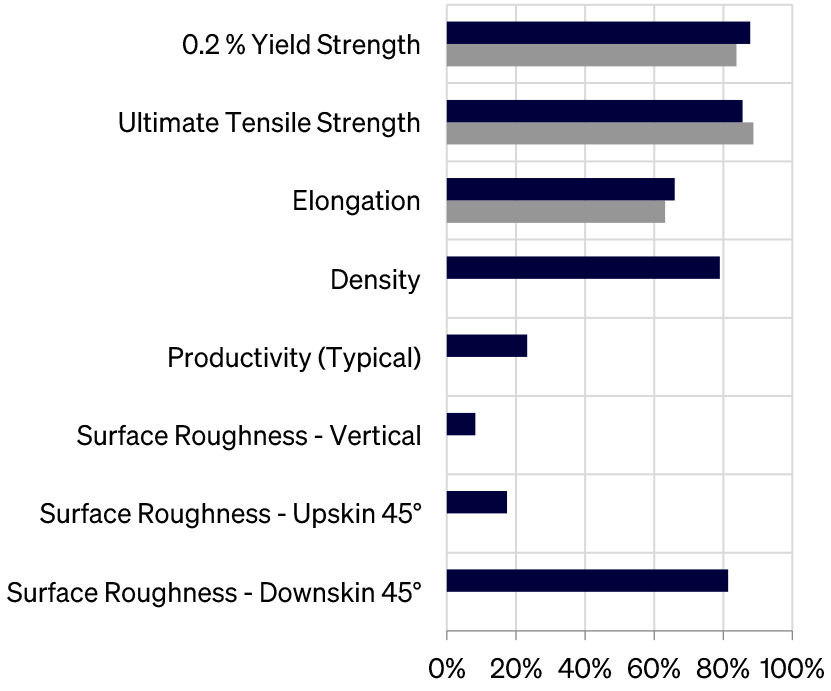
As-Built (AB)

Stress Relief (SR)

550°C for 6 hours in argon, cooling in air

Parameter Availability and Thermal State Comparison

- Balanced 154 AB
  400 W, 50 µm layer thickness, carbon brush
- Balanced 154 SR
  400 W, 50 µm layer thickness, carbon brush



Bar plot is generated by normalizing typical material data (containing both horizontal and vertical data) against a range defined for each material family. For steel-based alloys, the ranges are as follows: 0.2%YS: 0-600 MPa UTS: 0-750 MPa, Elongation: 0-60%, Density: 99-100%, 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 154 - 400 W / 50 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	17.5
Theoretical melting rate bulk per laser[2]	23.4

[1] Using standard Factory Acceptance Test layout and 2 lasers
[2] Calculated (layer thickness × scan velocity × hatch distance)

Tensile Performance at Room Temperature

Thermal State	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)	
	H	V	H	V	H	V
As-Built	190	131	575	475	695	585
SR	196	168	550	455	715	610

Thermal State	Elongation (%)	
	H	V
As-Built	35.0	44.0
SR	32.5	43.0

Physical Properties at Room Temperature

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	12	9	8
Downskin	34	23	9

Surface Roughness, Ra (µm)	
H	21
V	8

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.7	99.7	211
SR	---	---	212

Data Sheet Nomenclature and Notation

H: Horizontal, perpendicular to build direction.
V: Vertical, parallel to build direction.
Other angles are measured from horizontal.

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.