COLIBRIUM ADDITIVE
a GE Aerospace company

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

L-PBF Nickel 625

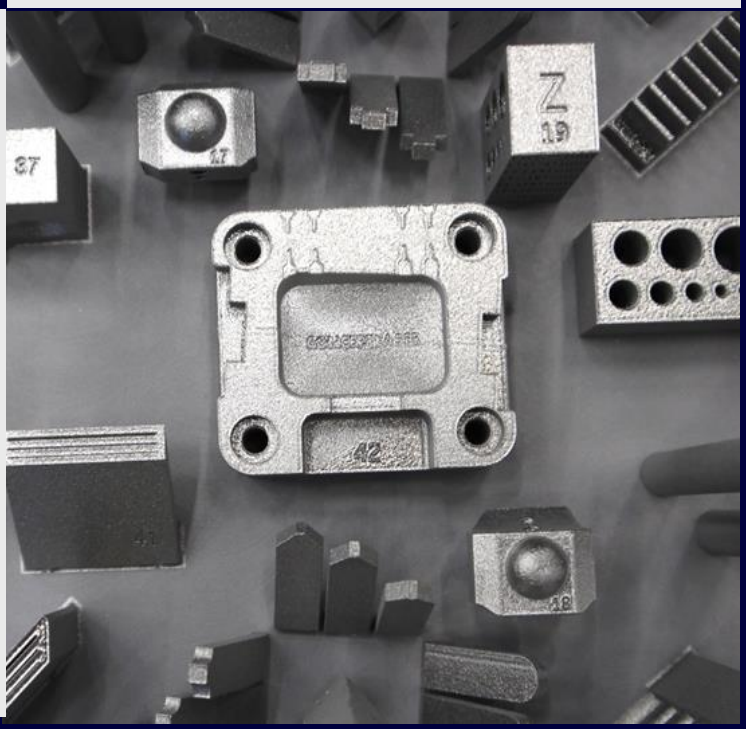
Parameters for Colibrium Additive's M2 Series 5

Nickel 625

Austenitic nickel-chromium superalloy Nickel 625 possesses excellent resistance to oxidation and corrosion combined with high strength over a wide temperature range from cryogenic temperatures to 982°C. The high (creep) strength is derived by solid-solution hardening of the nickel-chromium matrix, thus no age-hardening has to be applied. The alloy can be readily welded, which makes this alloy suitable for additive manufacturing. Typically, Nickel 625 is widely used in aerospace, marine engineering, chemical processing, oil and gas industry as well as power industry applications.

M2 Series 5 Nickel 625

The Nickel 625 parameters for the Colibrium Additive M2 Series 5 are developed leveraging the performance of the previous M2 generations. The base parameter is a 60 µm parameter that produces good surface roughness, while delivering a high productivity with dual lasers. For highest all-around surface quality, particularly within overhang downskin and upskin regions, the surface parameter has been developed. All parameters succeed the minimum tensile properties specified in ASTM F3056 and AMS 7000 for additive manufactured parts in the stress-relieved state.



M2 Series 5 Nickel 625

Machine Configuration

M2 Series 5

Single- or dual-laser architecture

Argon gas

Powder Chemistry

Nickel 625 powder chemical composition according to ASTM F3056 / AMS7000/ UNS N06625

Particle size: 15-53 µm

Thermal States

As-Built (AB)

Stress Relief (SR)

875°C for 0.5 hours in argon

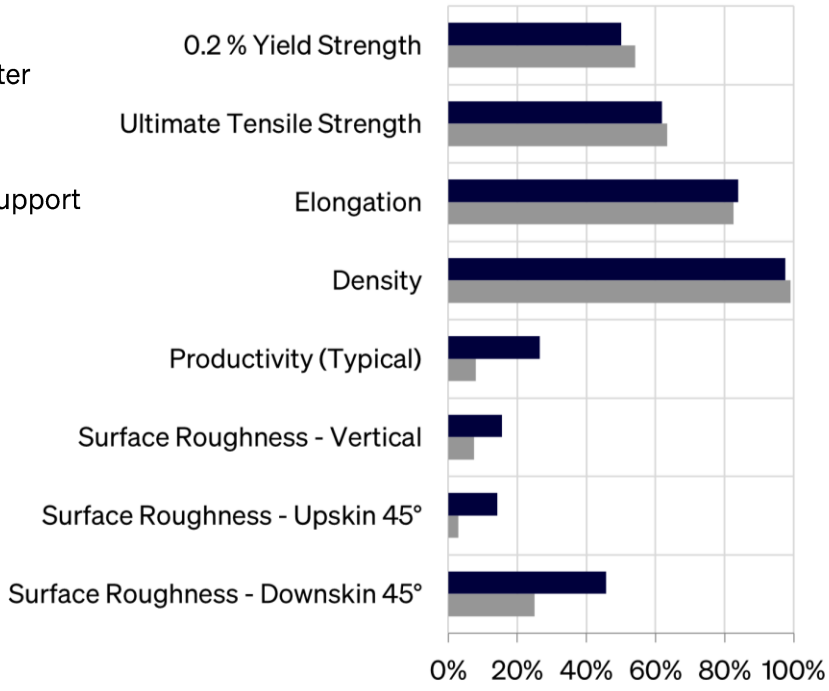
Parameter Availability and Thermal State Comparison

- Balanced Parameter 140 SR

  400 W, 60 µm layer thickness, rubber recoater

- Surface Parameter 169 SR

  400 W, 30 µm part layer thickness/ 60 µm support layer thickness, rubber 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 nickel-based alloys, the ranges are as follows: 0.2%YS: 0-1200 MPa UTS: 0-1500 MPa, Elongation: 0-50%, 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 140 – 400 W / 60 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	19.6
Theoretical melting rate bulk per laser[2]	22.6

[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	178	133	640	575	940	880
SR	178	153	605	590	955	895

Thermal State	Elongation (%)	
	H	V
As-Built	40.0	42.5
SR	40.0	43.5

Physical Properties at Room Temperature

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	10	8	7
Downskin	21	14	8

Surface Roughness, Ra (µm)	
H	13
V	11

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.9	99.9	268
SR	99.9	99.9	278

Surface Parameter 169 – 400 W / 30 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	9.4
Theoretical melting rate bulk per laser[2]	8.6

[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	168	138	710	625	980	890
SR	182	161	670	625	990	905

Thermal State	Elongation (%)	
	H	V
As-Built	37.0	42.5
SR	37.5	44.5

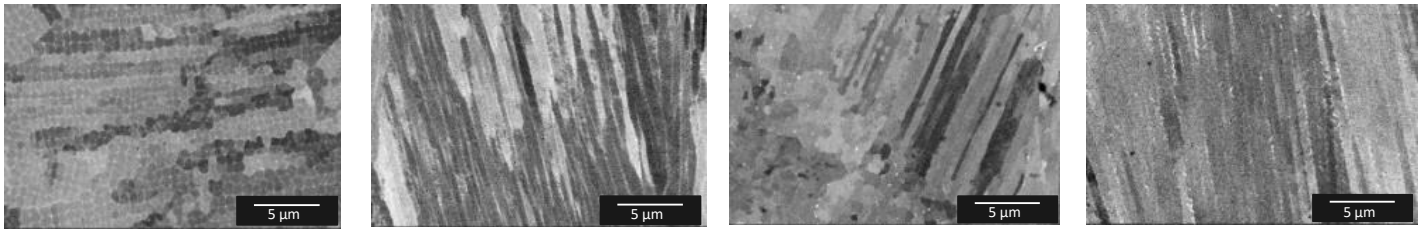
	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	7	6	5
Downskin	14	9	6

	Surface Roughness, Ra (µm)
H	8
V	8

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.9	99.9	292
SR	99.9	99.9	295

Microstructure

As-Built		SR	
H	V	H	V



Scanning electron microscope images in As-Built and Stress Relief (SR) condition as defined previously.

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.