COLIBRIUM ADDITIVE
a GE Aerospace company

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

# L-PBF Nickel 718

Parameters for Colibrium Additive's M2 Series 5

**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.

**M2 Series 5 Nickel 718**

The Nickel 718 parameters for the Colibrium Additive M2 Series 5 are developed leveraging the performance of the previous M2 generations. The base parameters deliver good surface quality while maintaining a very good density and productivity. For highest all-around surface quality, the surface parameter has been developed. The hybrid parameter can significantly increase the productivity of parts having a high volume/surface ratio and still meeting highest surface quality requirements. Parameter 316 is optimized for steel recoater and highest productivity. All parameters succeed the minimum tensile properties specified in ASTM F3055 for additive manufactured parts in the heat treated state.

# M2 Series 5 Nickel 718

## Machine Configuration

M2 Series 5 (1 kW)

Single- or dual-laser architecture

Nitrogen gas

## Powder Chemistry

Nickel 718 powder chemical composition according to ASTM B637 UNS N07718

Particle size: 15 - 53 µm

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

## Thermal States

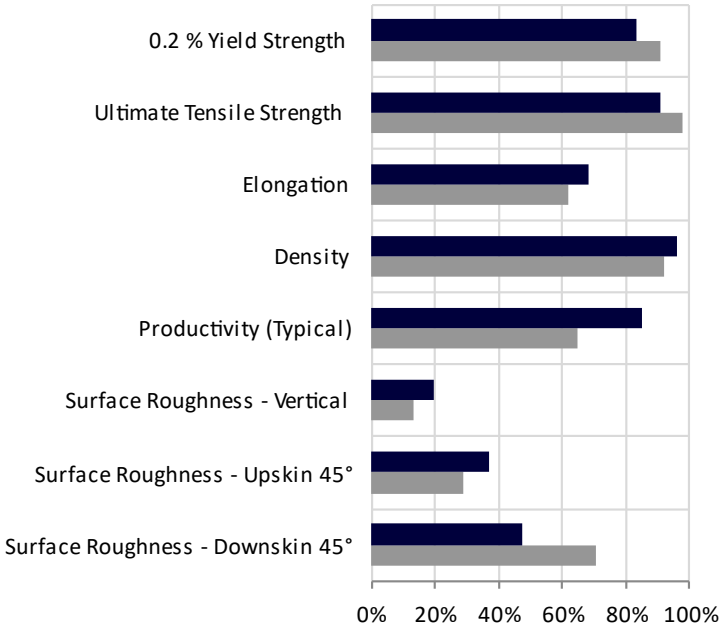
As-Built (AB)

Solution Annealed + Age (SOLN + AGE)

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

## Parameter Availability and Thermal State Comparison

- Productivity Parameter 350 SOLN + AGE
  1 kW, 100µm layer thickness, rubber recoater
- Productivity Parameter 316 SOLN + AGE
  400 W, 100 µm layer thickness, 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 Nickel 718-based alloys, the ranges are as follows: 0.2%YS: 0-1400 MPa UTS: 0-1500 MPa, Elongation: 0-30%, Density: 99-100% (as-built), Productivity: 5-60 cm³/h, Surface Quality (all): 5-55 µm. 0% in the bar plot indicates the lower range value, 100% indicates the upper range value For more details on parameter 316 see data sheet for 400 W parameters

# Productivity Parameter 350 - 1 kW / 100 µm

## Typical Build Rate

| | ($cm^3/h$) |
|---|---|
| Typical build rate with coating[1] | 51.6 |
| Theoretical melting rate bulk per laser[2] | 68.4 |

[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 | 150 | 112 | 555 | 540 | 910 | 905 |
| SOLN+AGE | 151 | 128 | 1145 | 1180 | 1330 | 1395 |

| Thermal State | Elongation (%) | | Area Reduction (%) | |
|---|---|---|---|---|
| | H | V | H | V |
| As-Built | 37 | 34.5 | 51 | 58 |
| SOLN+AGE | 22 | 18.5 | 29 | 24 |

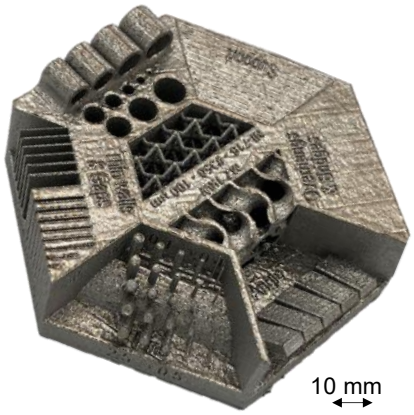
## Physical Properties at Room Temperature

| | Overhang Surface Roughness, Ra (µm) | | |
|---|---|---|---|
| | 45° | 60° | 75° |
| Upskin | 23 | 16 | 10 |
| Downskin | 28 | 20 | 13 |

| Surface Roughness, Ra (µm) | |
|---|---|
| H | 29 |
| V | 14 |

| Thermal State | Relative Density (%) | | Hardness (HV10) |
|---|---|---|---|
| | H | V | H |
| As-Built | 99.9 | 99.9 | 262 |
| SOLN+AGE | 99.9 | 99.9 | 465 |

The minimum feature resolution part was designed to demonstrate parameter capability to produce specific features such as minimum wall thickness, minimum gap width, minimum pin diameter, minimum drill hole diameter (horizontal and vertical), minimum unsupported downskin angle, and maximum unsupported bridge length.




| Feature | Result |
|---|---|
| Minimum Wall Thickness (mm) | 0.33 |
| Minimum Gap Width (mm) | 0.47 |
| Minimum Pin Diameter (mm) | 0.33 |
| Minimum Drill Hole Diameter, V (mm) | 0.43 |
| Minimum Drill Hole Diameter, H (mm) | 0.78 |
| Minimum Printable Angle (°) | 25 |
| Maximum Bridge Length (mm) | 5 |

## 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.

Minimum features have been characterized using a coordinate measuring machine (CMM) and an optical microscope.