COLIBRIUM ADDITIVE
a GE Aerospace company

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

# L-PBF Aluminum Al-Si7-Mg

Parameters for Colibrium Additive's M2 Series 5


**Aluminum Al-Si7-Mg**

Lightweight aluminum alloys for additive manufacturing are traditionally used in many industrial, aerospace and automotive applications. They possess high strength-to-weight ratios, and they also demonstrate good resistance to metal fatigue and corrosion. Due to the geometrically complex structures possible with additive manufacturing, further weight reduction is often possible with little or no compromise in strength and overall performance. One key advantage of aluminum alloy powders is that they typically offer better build rates than other metal powders.

.

**M2 Series 5 Aluminum Al-Si7-Mg**

The parameters for the Colibrium Additive M2 Series 5 are designed to meet a wide range of customer specifications. The surface parameter is a 30 µm parameter that provides highest density and optimized surface roughness. The productivity parameter has a layer thickness of 60 µm and provides nearly double the productivity of the surface parameter, with the trade-off of higher porosity and increased surface roughness.

# M2 Series 5 Al-Si7-Mg

## Machine Configuration

M2 Series 5

Single- or dual-laser architecture

Argon gas

Platform heating: 80°C

## Powder Chemistry

Aluminum Al-Si7-Mg powder chemical composition according to AMS 4289.

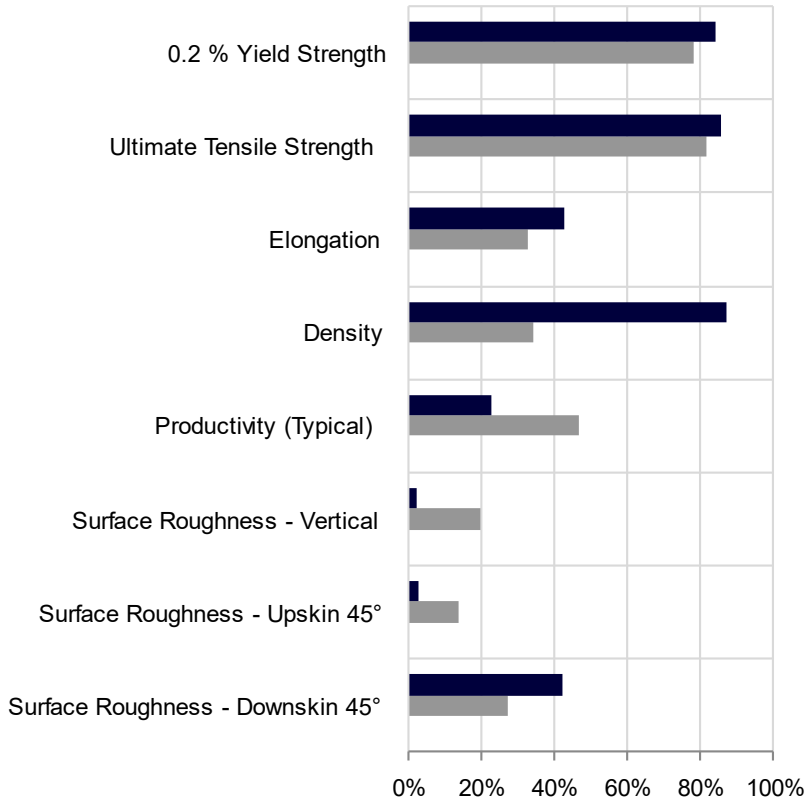
Particle size: 15-63 µm

## Thermal States

As-Built (AB)

## Parameter Availability and Thermal State Comparison

- Surface Parameter 384 AB
  400 W, 30 µm layer thickness, rubber recoater
- Productivity Parameter 387/388 AB
  400 W, 60 µm layer thickness, rubber/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 titanium-based alloys, the ranges are as follows: 0.2%YS: 0-300 MPa UTS: 0-500 MPa, Elongation: 0-30%, 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

# Surface Parameter 384 - 400 W / 30 µm

## Typical Build Rate

| | ($cm^3/h$) |
|---|---|
| Typical build rate with coating[1] | 17.5 |
| Theoretical melting rate bulk per laser[2] | 19.4 |

[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 | 71 | 69 | 260 | 235 | 425 | 425 |

| Thermal State | Elongation (%) | |
|---|---|---|
| | H | V |
| As-Built | 14.0 | 11.0 |

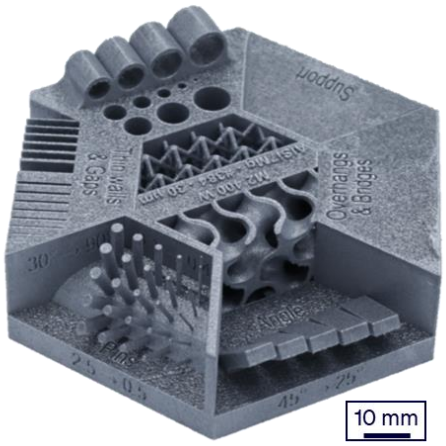
## Physical Properties at Room Temperature

| | Overhang Surface Roughness, Ra (µm) | | |
|---|---|---|---|
| | 45° | 60° | 75° |
| Upskin | 6 | 5 | 5 |
| Downskin | 20 | 8 | 5 |

| Surface Roughness, Ra (µm) | |
|---|---|
| H | 18 |
| V | 6 |

| Thermal State | Relative Density (%) | | Hardness (HV5) |
|---|---|---|---|
| | H | V | H |
| As-Built | 99.8 | 99.8 | 115 |

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) | 0.34 |
| Minimum Pin Diameter (mm) | 0.46 |
| Minimum Printable Angle (°) | 25 |
| Maximum Bridge Length (mm) | 4 |

# Productivity Parameter 387/388 - 400 W / 60 µm

## Typical Build Rate

| | ($cm^3/h$) |
|---|---|
| Typical build rate with coating[1] | 30.6 |
| Theoretical melting rate bulk per laser[2] | 39.3 |

[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 | 71 | 70 | 240 | 220 | 405 | 400 |

| Thermal State | Elongation (%) | | Area Reduction (%) | |
|---|---|---|---|---|
| | H | V | H | V |
| As-Built | 11.5 | 7.5 | 14 | 10 |

## Physical Properties at Room Temperature

| | Overhang Surface Roughness, Ra (µm) | | |
|---|---|---|---|
| | 45° | 60° | 75° |
| Upskin | 10 | 15 | 12 |
| Downskin | 15 | 12 | 10 |

| Surface Roughness, Ra (µm) | |
|---|---|
| H | 13 |
| V | 12 |

| Thermal State | Relative Density (%) | | Hardness (HV5) |
|---|---|---|---|
| | H | V | H |
| As-Built | 99.3 | 99.3 | 110 |

# Hybrid Parameter 385 - 400 W / 30/60 µm

## Typical Build Rate

| | ($cm^3/h$) |
|---|---|
| Typical build rate with coating[1] | 13.9 (13-35)[3] |
| Theoretical melting rate bulk per laser[2] | 36.5 |

[1] Using standard Factory Acceptance Test layout and 2 lasers

[2] Calculated (layer thickness × scan velocity × hatch distance)

[3]The hybrid parameter build rate is strongly dependent on application design, in particular wall thickness. For this parameter, a larger increase in productivity (faster build rate) can be expected for parts having high volume/surface ratios.

## 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 | 69 | 68 | 245 | 225 | 415 | 405 |

| Thermal State | Elongation (%) | |
|---|---|---|
| | H | V |
| As-Built | 11.0 | 6.5 |

## Physical Properties at Room Temperature

| | Overhang Surface Roughness, Ra (µm) | | |
|---|---|---|---|
| | 45° | 60° | 75° |
| Upskin | 6 | 5 | 4 |
| Downskin | 19 | 9 | 6 |

| Surface Roughness, Ra (µm) | |
|---|---|
| H | 15 |
| V | 8 |

| Thermal State | Relative Density (%) | | Hardness (HV5) |
|---|---|---|---|
| | H | V | H |
| As-Built | 99.7 | 99.7 | 109 |

## 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.