COLIBRIUM ADDITIVE
a GE Aerospace company

13 Al

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

# L-PBF Aluminum Al-Mg-Sc

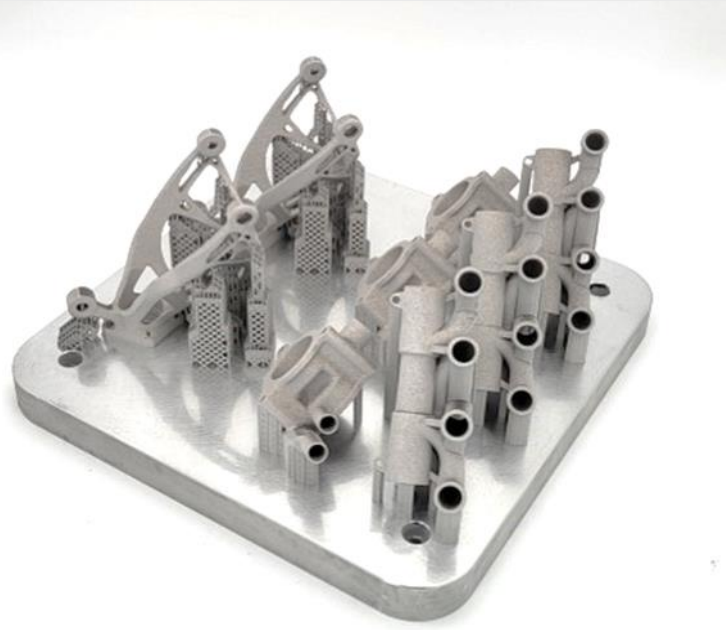
Parameters for Colibrium Additive's M2 Series 5 use of Scalmalloy®* Alloy


**Aluminum Al-Mg-Sc**

Scalmalloy® is an Aluminum-magnesium-scandium (Al-Mg-Sc) alloy specially designed for Laser Powder Bed Fusion (LPBF) and a alloy of APWORKS GmbH. Colibrium Additive found the strength of the heat treated material to be significantly higher compared to AlSi10Mg and is an AM-suitable alternative for conventional 7000-Series Aluminum Alloys, which are considered as highly prone to solidification cracking in LPBF. This material furthermore offers a good corrosion resistance like the 5000 series alloys.

**M2 Series 5 Al-Mg-Sc**

Colibrium Additive developed a novel Al-Mg-Sc parameter for use with the M2 Series 5 machine. The balanced parameter features a layer thickness of 50 µm and offers excellent mechanical properties. The printing parameter for this Material achieves an impressive tensile strength of 515 MPa in the heat-treated state. Additionally, it produces great ductility with an elongation more than 12%. This combination of high strength and excellent ductility makes this parameter particularly versatile and a good choice for high-performing applications. Without additional post-processing such as bead blasting or shot peening, a surface roughness of less than 14 µm is achieved. Another advantage of this Material is its ability to undergo anodization to improve corrosion resistance.



*Scalmalloy® is a registered trademark of APWORKS GmbH. Colibrium Additive is not affiliated with APWORKS GmbH.

# M2 Series 5 Al-Mg-Sc

## Machine Configuration

M2 Series 5

Single- or dual-laser architecture

Nitrogen gas

## Powder Chemistry

Scalmalloy® powder chemical composition as provided by APWORKS GmbH.

Particle size: 20-63 µm

## Thermal States

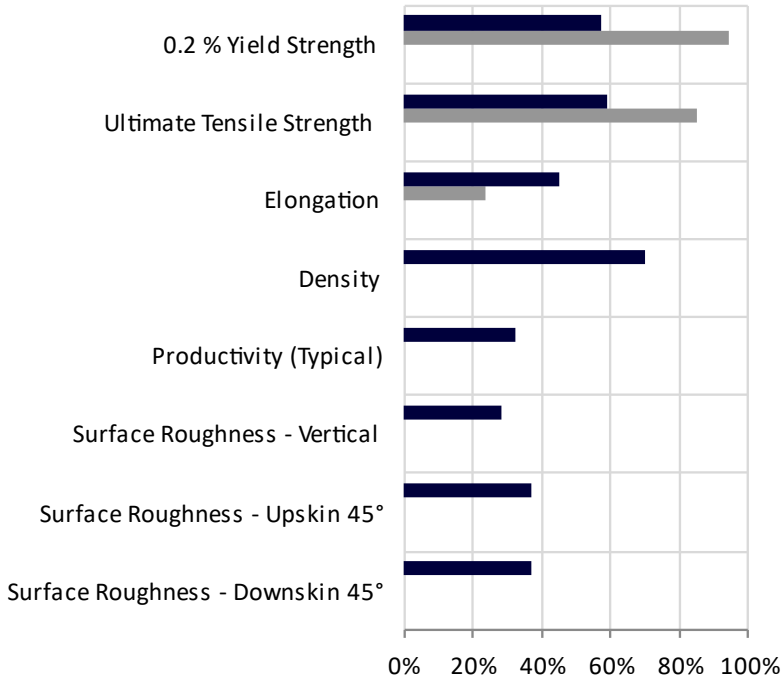
As-Built (AB)

Direct Age (DA)

325°C for 4 hours in argon; furnace cooling until 150°C then cooling on air

## Parameter Availability and Thermal State Comparison

- Balanced Parameter 407 AB
  400 W, 50 µm layer thickness, rubber recoater
- Balanced Parameter 407 DA
  400 W, 50 µm 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 high strength aluminum-based alloys, the ranges are as follows: 0.2%YS: 0-500 MPa UTS: 0-600 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 407 - 400 W / 50 µm

## Typical Build Rate

| | ($cm^3/h$) |
|---|---|
| Typical build rate with coating[1] | 22.9 |
| Theoretical melting rate bulk per laser[2] | 43.2 |

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

## Tensile Performance at Room Temperature

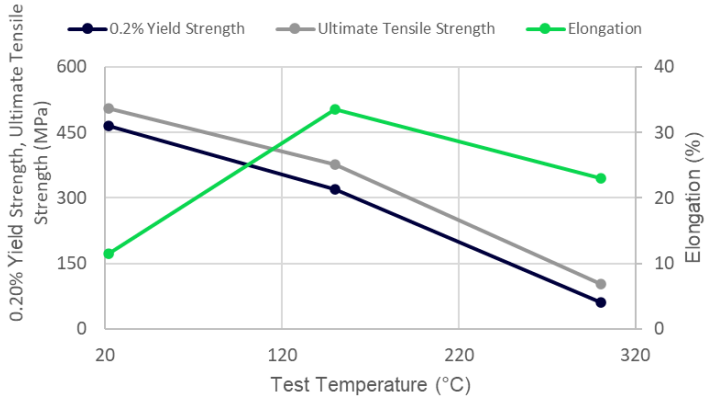
| Thermal State | Modulus of Elasticity (GPa) | | 0.2% Yield Strength (MPa) | | Ultimate Tensile Strength (MPa) | |
|---|---|---|---|---|---|---|
| | H | V | H | V | H | V |
| As-Built | 70 | 70 | 295 | 275 | 355 | 350 |
| DA | 69 | 68 | 475 | 465 | 515 | 505 |

| Thermal State | Elongation (%) | |
|---|---|---|
| | H | V |
| As-Built | 23.0 | 22.0 |
| DA | 12.0 | 11.5 |

## Tensile Performance at Elevated Temperatures in DA Condition

| Test Temp. (°C) | Modulus of Elasticity (GPa) | | 0.2% Yield Strength (MPa) | | Ultimate Tensile Strength (MPa) | |
|---|---|---|---|---|---|---|
| | H | V | H | V | H | V |
| 150 | --- | 47 | --- | 319 | --- | 376 |
| 300 | --- | 29 | --- | 60 | -- | 103 |

| Test Temp. (°C) | Elongation (%) | |
|---|---|---|
| | H | V |
| 150 | --- | 33.5 |
| 300 | --- | 23.0 |

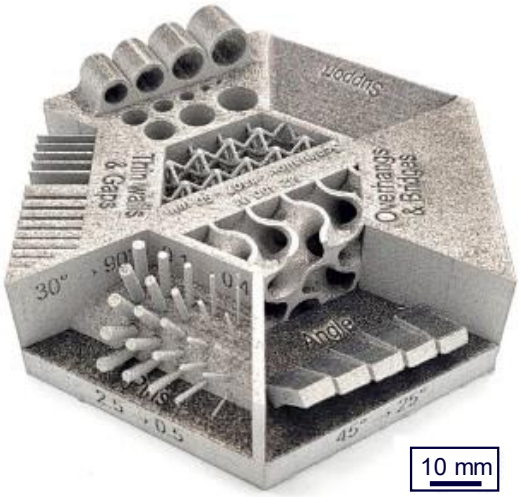


| | Overhang Surface Roughness, Ra (µm) | | |
|---|---|---|---|
| | 45° | 60° | 75° |
| Upskin | 18 | 15 | 13 |
| Downskin | 18 | 13 | 11 |

| Surface Roughness, Ra (µm) | |
|---|---|
| H | 21 |
| V | 15 |

| Thermal State | Relative Density (%) | | Hardness (HV5) |
|---|---|---|---|
| | H | V | H |
| As-Built | 99.7 | 99.7 | 101 |

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) | 0.40 |
| Minimum Gap Width (mm) | 0.62 |
| Minimum Pin Diameter (mm) | 0.12 |
| Minimum Drill Hole Diameter, V (mm) | 0.97 |
| Minimum Drill Hole Diameter, H (mm) | 0.80 |
| Minimum Printable Angle (°) | 30 |
| 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.