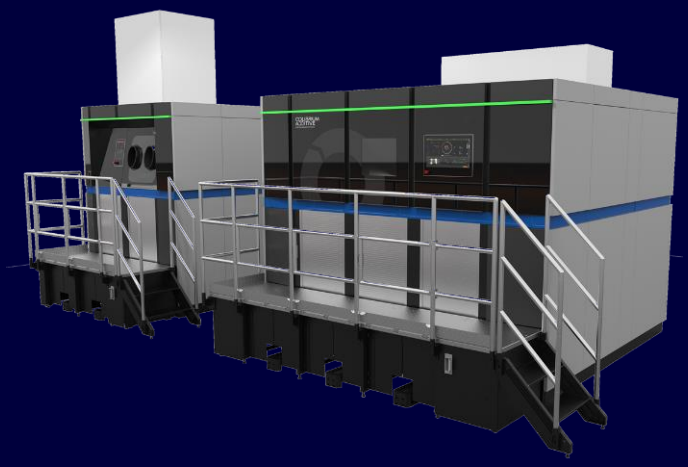
COLIBRIUM ADDITIVE
a GE Aerospace company

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 M Line



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.

M Line Aluminum Al-Si7-Mg

The Al-Si7-Mg parameter for the Colibrium Additive M Line is developed leveraging the performance of the previous machine generations. The balanced parameters deliver good surface quality while maintaining a very good density. The parameter has been optimized for printing complex thin-walled parts with rubber as well as steel blade recoater. For those seeking high productivity, our productivity parameter achieves 45 cm^3/h with a quad-laser system with a 75 µm layer thickness. All parameters succeed the minimum tensile properties specified in AMS 4289 for the heat treated state.

M Line Al-Si7-Mg

Machine Configuration

M Line

Quad-laser architecture

Nitrogen gas

Platform heating: 100°C

Powder Chemistry

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

Particle size: 15-53 µm

Thermal States

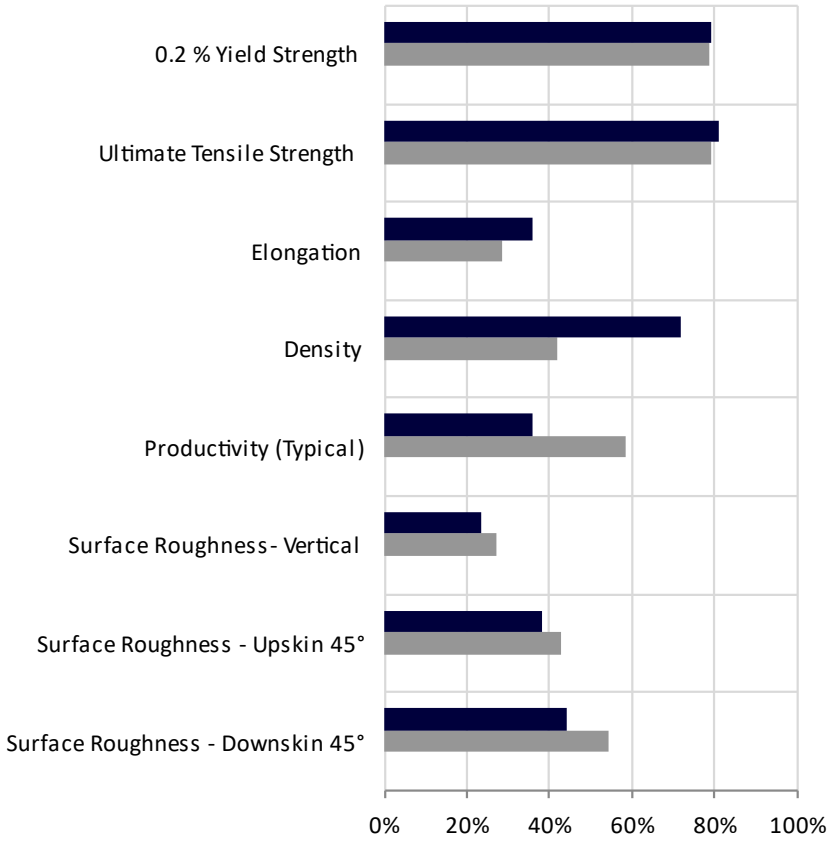
As-Built (AB)

T6 Solution Annealed + Age (T6 SOLN + AGE)

Please contact Colibrium Additive for more details regarding the heat treatment.

Parameter Availability and Thermal State Comparison

- Balanced Parameter 429 AB
  400 W, 50 µm layer thickness, rubber/steel recoater
- Productivity Parameter 430 AB
  400 W, 75 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 aluminum-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

Balanced Parameter 429 - 400 W / 50 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	30.1
Theoretical melting rate bulk per laser[2]	24.8

[1] Using standard Factory Acceptance Test layout and 4 lasers
[2] Calculated (layer thickness × scan velocity × hatch distance)

Tensile Performance at Room Temperature

Thermal State	Sample Size	YM (GPa)	0.2% YS (MPa)	UTS (MPa)	Elongation (%)	Area Reduction (%)
As-Built H - SL	8	70	245	405	13	13.5
As-Built H - ST	8	70	245	405	12	13.5
As-Built V	24	67	230	400	8.5	11.5
T6 SOLN + AGE H - SL	8	70	240	315	12	22.5
T6 SOLN + AGE H - ST	8	68	245	315	10.5	21
T6 SOLN + AGE V	16	69	230	300	12.5	24.5

Physical Properties at Room Temperature

Parameter 429

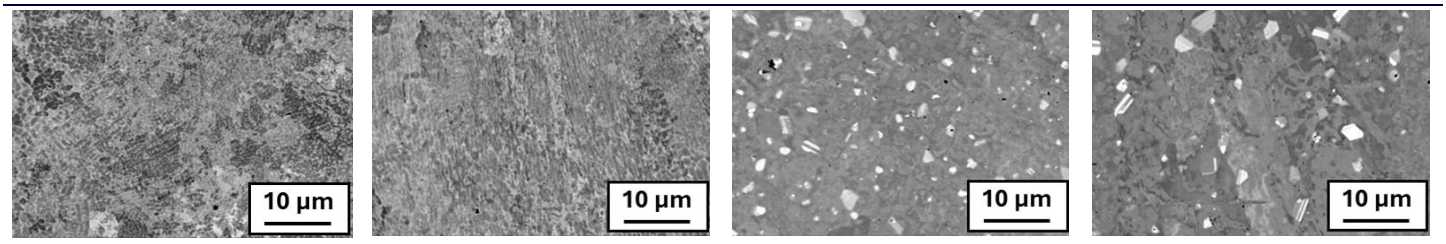
	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	19	16	13
Downskin	21	13	10

Surface Roughness, Ra (µm)	
H	--
V	14

Thermal State	Relative Density (%)		Hardness (HV5)
	H	V	H
As-Built	99.7	99.7	110
T6 SOLN + AGE	--	--	97

Microstructure

As-Built		T6 SOLN + AGE	
H	V	H	V



Scanning electron microscope images in As-Built and T6 SOLN + AGE condition as defined previously.

Productivity Parameter 430 - 400 W / 75 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	45.0
Theoretical melting rate bulk per laser[2]	37.3

[1] Using standard Factory Acceptance Test layout and 4 lasers
[2] Calculated (layer thickness × scan velocity × hatch distance)

Tensile Performance at Room Temperature

Thermal State	Sample Size	YM (GPa)	0.2% YS (MPa)	UTS (MPa)	Elongation (%)	Area Reduction (%)
As-Built H - SL	8	69	240	400	11	12
As-Built H - ST	8	69	240	395	9.5	12
As-Built V	24	69	230	390	6	8.5
T6 SOLN + AGE H - SL	8	69	245	315	10.5	18
T6 SOLN + AGE H - ST	8	70	245	315	9.5	17
T6 SOLN + AGE V	16	69	230	300	9.5	16

Physical Properties at Room Temperature — Parameter 430

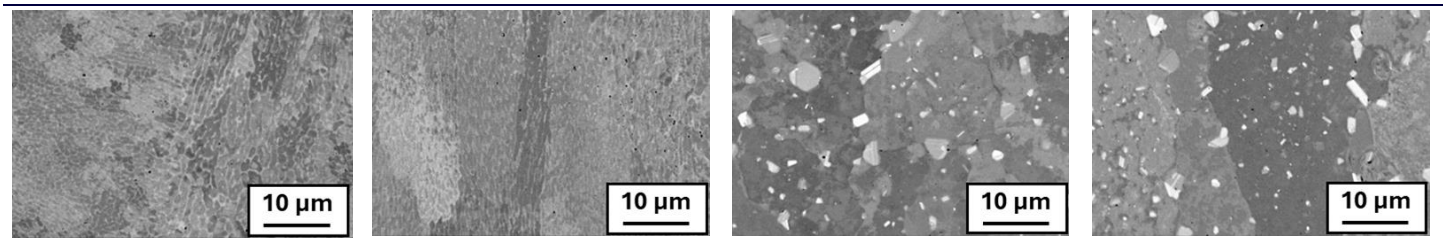
	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	21	17	13
Downskin	25	16	11

Surface Roughness, Ra (µm)	
H	--
V	15

Thermal State	Relative Density (%)		Hardness (HV5)
	H	V	H
As-Built	99.4	99.4	109
T6 SOLN + AGE	--	--	93

Microstructure

As-Built		T6 SOLN + AGE	
H	V	H	V



Scanning electron microscope images in As-Built and T6 SOLN + AGE 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.

SL: Single Laser, parts build by one optical system.
ST: Stitched, parts build by multiple optical systems.

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.