COLIBRIUM ADDITIVE
a GE Aerospace company

L-PBF Aluminum Al-Si10-Mg

Parameters for Colibrium Additive's X Line 2000R

Aluminum Al-Si10-Mg

Al-Si10-Mg has a chemical composition according to ASTM F3318 and is an essential Aluminum alloy in the world of additive manufacturing. As good casting alloy for complex geometries, it combines light weight and excellent thermal conductivity. The alloy is ideally suited for part designs with thin walls such as ductwork or heat exchangers. Once post-processed, parts offer good strength and hardness superior to conventionally cast material, as well as good dynamic properties for industries in the aerospace, automotive, automation and tooling sectors. In summary this aluminum alloy holds great promises to bring additive manufacturing to high volume consumer applications.

X Line 2000R Al-Si10-Mg

The Al-Si10-Mg parameters for the Colibrium Additive X Line 2000R are developed leveraging the performance of the previous X Line generations.

The 40 µm parameter produces good surface roughness without bead blast or shot peening. Additionally, this parameter set is improved enabling thin feature printability for applications like heat exchangers. Moreover, the mechanical properties succeed the limits specified in ASTM F3318 for additive manufactured parts in the stress relieved (SR1) state. Higher productivity for e.g. prototyping applications can be gained by using the 60 µm parameter.

X Line 2000R Al-Si10-Mg

Machine Configuration

X Line 2000R

Dual-laser architecture

Argon/Nitrogen gas

Platform heating: 100°C/-

Powder Chemistry

Aluminum Al-Si10-Mg chemical composition according to ASTM F3318

Particle size: 15-63 µm

Thermal States

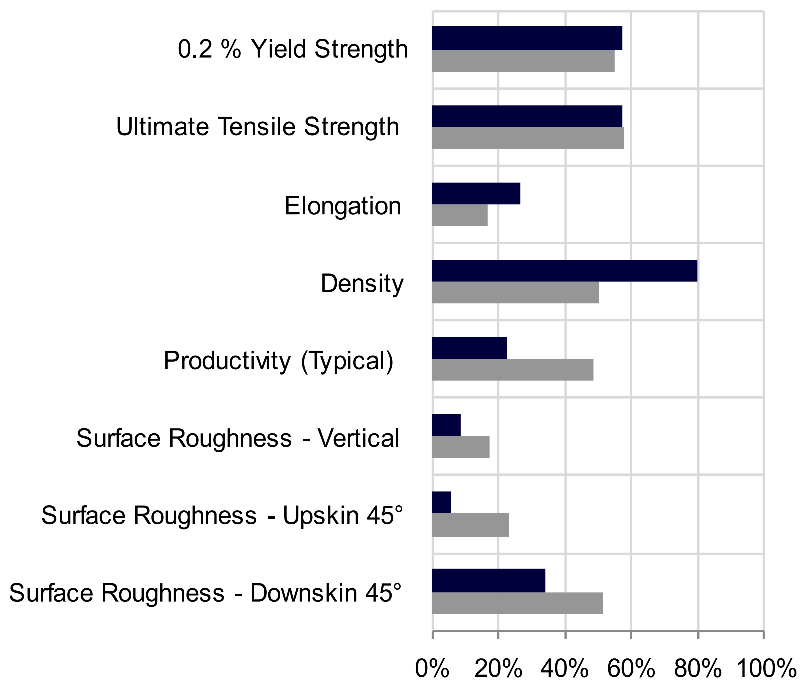
As-Built (AB)

Stress Relief (SR1)

295°C for 2 hours in argon; cooling in air

Parameter Availability and Thermal State Comparison

- Surface 396 SR1
  1 kW, 40 µm layer thickness, rubber recoater, argon gas, 100°C platform heating
- Productivity 395 SR1
  1 kW, 60 µm layer thickness, rubber recoater, nitrogen gas



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% (As-Built state), Productivity: 5-100 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 396 – 1 kW / 40 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	26.5
Theoretical melting rate bulk per laser[2]	27.2

[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	71	69	265	230	455	460
SR1	74	71	175	170	285	290

Thermal State	Elongation (%)		Area Reduction (%)	
	H	V	H	V
As-Built	9.5	6.5	8	6
SR1	15.5	15.0	38	33

Physical Properties at Room Temperature

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	7	6	6
Downskin	17	13	9

Surface Roughness, Ra (µm)	
H	---
V	8

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.8	99.8	120
SR1	---	---	88

Productivity Parameter 395 - 1 kW / 60 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	50.9
Theoretical melting rate bulk per laser[2]	86.4

[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	69	68	235	205	415	390
SR1	66	69	165	165	280	300

Thermal State	Elongation (%)		Area Reduction (%)	
	H	V	H	V
As-Built	6.5	3.5	6	4
SR1	13.5	7.0	19	12

Physical Properties at Room Temperature

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	13	11	10
Downskin	23	15	12

Surface Roughness, Ra (µm)	
H	---
V	11

Thermal State	Relative Density (%)		Hardness (HV5)
	H	V	H
As-Built	99.5	99.5	110
SR1	---	---	89

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.