COLIBRIUM ADDITIVE
a GE Aerospace company

13 Al

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

Coarse Cut L-PBF Ti6Al4V Grade 23

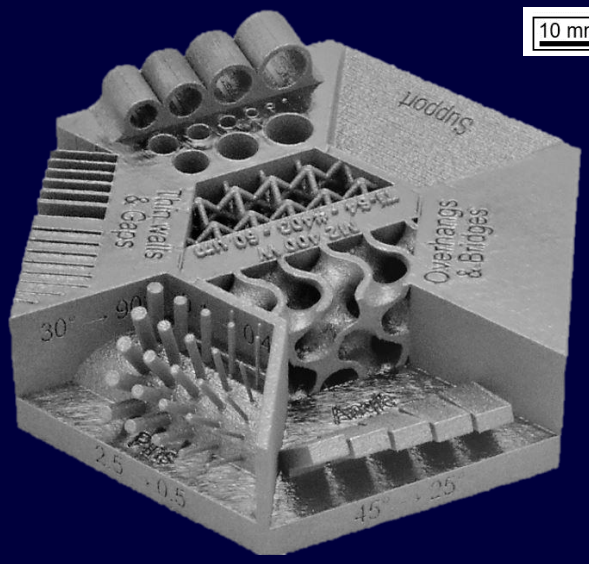
Parameters for Colibrium Additive's M2 Series 5

Titanium Ti6Al4V Grade 23 (ELI)

Ti6Al4V Grade 23, renowned for its exceptional strength-to-weight ratio, is ideal for additive manufacturing. It offers outstanding biocompatibility, making it perfect for medical implants. Its superior corrosion resistance ensures longevity and reliability in demanding environments. This alloy is widely used in the aerospace industry for critical components, in the medical field for durable implants, and in high-performance motorsports for lightweight, robust parts. Its versatile properties make Ti6Al4V Grade 23 a preferred choice across these advanced industries.

M2 Series 5 Coarse Cut Ti6Al4V

Introducing the first Coarse Cut Ti6Al4V parameter for the Colibrium Additive M2 Series 5, enabling the utilization of lower cost raw material (powder) as well as simplified powder handling and storage. The balanced 400 W parameter has a layer thickness of 60 µm and is characterized by highest process stability. Given the usage of coarser powder particles, it is expected that surface roughness will be impacted. The parameter was thus optimized to minimize the impact and maintain the printability of fine features. The result is a slightly lower surface quality compared to existing Fine Cut Ti6Al4V parameters and also a lower productivity but with good feature resolution. The end-part mechanical properties have outstanding tensile properties in stress relieved state and meet the ASTM F3001 standard.



M2 Series 5 Coarse Cut Ti6Al4V

Machine Configuration

M2 Series 5

Single- or dual-laser architecture

Argon gas

Platform heating: 200°C

Powder Chemistry

Ti6Al4V Grade 23 powder chemical composition according to ASTM F3001

Particle size: 45-106 µm

For more information, visit: AP&C

Thermal States

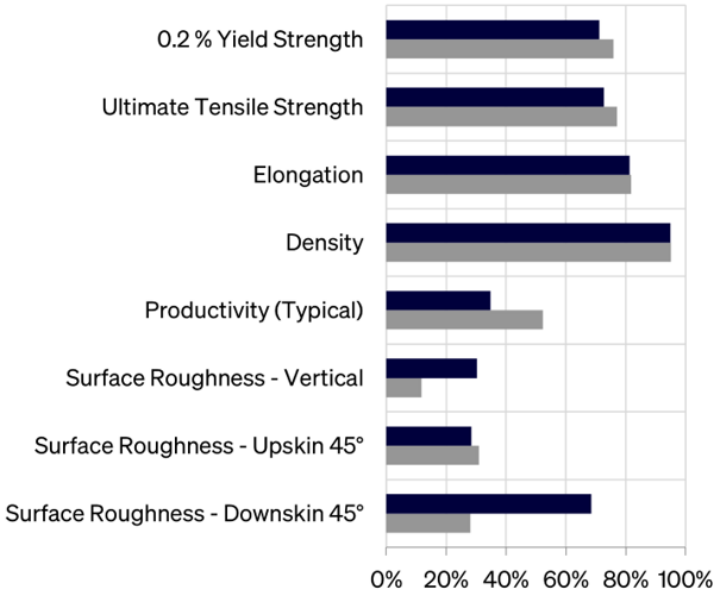
As-Built (AB)

Stress Relief (SR)

900°C for 1 hour in argon; furnace cooling

Parameter Availability and Thermal State Comparison

- Balanced Parameter 402/403 SR
  Coarse powder, 400 W, 60 µm layer thickness, steel (402) or rubber (403) recoater
- Balanced Parameter 277 SR
  Fine powder, 400 W, 60 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 titanium-based alloys, the ranges are as follows: 0.2%YS: 0-1250 MPa, UTS: 0-1350 MPa, Elongation: 0-20 %, Density: 99-100 %, Productivity: 5-70 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 402/403 - 400 W / 60 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	27.6
Theoretical melting rate bulk per laser[2]	25.3

[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	114	115	1045	1115	1145	1205
SR	115	119	880	895	980	980

Thermal State	Elongation (%)		Area Reduction (%)	
	H	V	H	V
As-Built	10.0	8.5	30	37
SR	16.0	16.0	43	46

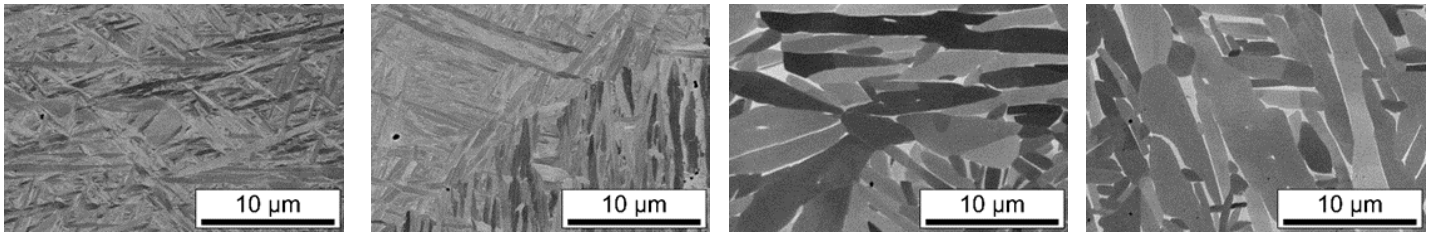
	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	15	16	14
Downskin	29	20	14

Surface Roughness, Ra (µm)	
H	5
V	16

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.9	99.9	341
SR	99.9	99.9	323

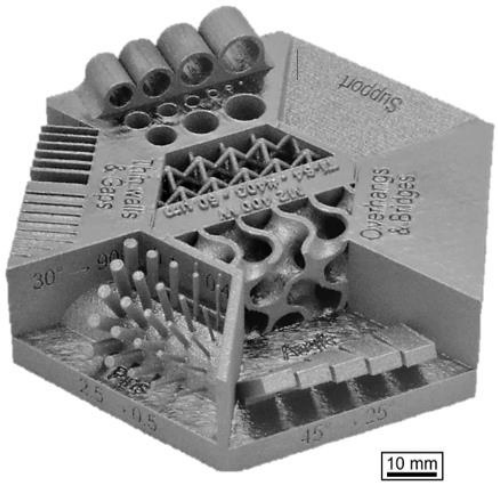
Microstructure

As-Built		SR	
H	V	H	V



Scanning electron microscope images in As-Built and Stress Relief condition as defined previously.

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)	0.32
Minimum Gap Width (mm)	0.39
Minimum Pin Diameter (mm)	0.34
Minimum Drill Hole Diameter, V (mm)	0.38
Minimum Drill Hole Diameter, H (mm)	0.38
Minimum Printable Angle (°)	25
Maximum Bridge Length (mm)	5

Data Sheet Nomenclature and Notation

ELI: Extra Low Interstitials.

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.