COLIBRIUM ADDITIVE
a GE Aerospace company

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

L-PBF remanium® star CL

Parameters for Colibrium Additive's M2 Series 5

remanium® star CL

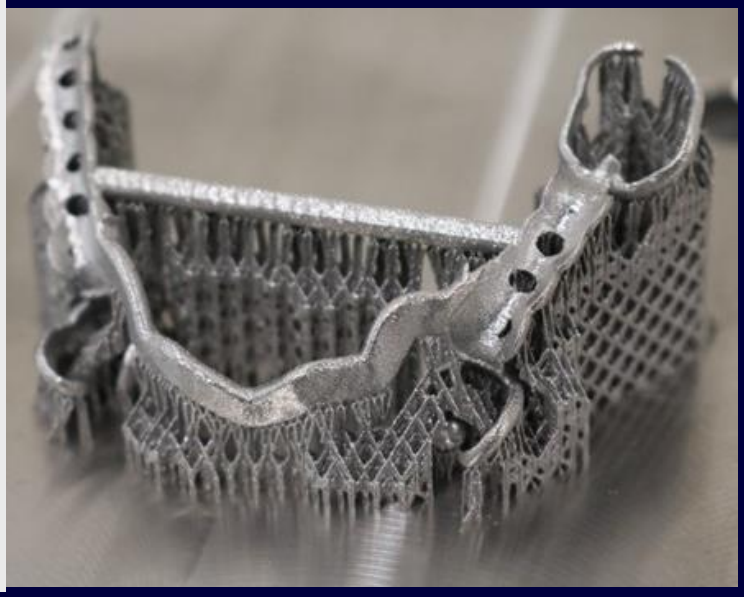
CoCrW alloy according to DIN EN ISO 22674 type 5/ DIN EN ISO 9693.

Due to its proven biocompatibility and long history in the medical industry, it is an established material used for medical/ dental applications.

remanium® star CL is particularly suitable for the manufacture of fixed and removable prosthetic restoration, appliances and metal-ceramic frameworks.

M2 Series 5 remanium® star CL

Parameter sets in two different layer thicknesses were developed for the Colibrium Additive M2 Series 5. The productivity parameter is a 50 µm layer thickness parameter that results in fast printing while still maintaining good surface finish. The surface parameter is a 25 µm layer thickness parameter that results in excellent surface finish while still maintaining good productivity. Both parameters have outstanding tensile properties in heat treated state and meet the DIN EN ISO 22674 type 5/ DIN EN ISO 9693 requirements.



M2 Series 5 remanium® star CL

Machine Configuration

M2 Series 5

Single- or dual-laser architecture

Nitrogen gas

Powder Chemistry

CoCrW alloy powder chemical composition according to remanium ® star CL.

Produced by Dentaurum distributed by Colibrium Additive

Particle size: 10-30 µm

Thermal States

As-Built (AB)

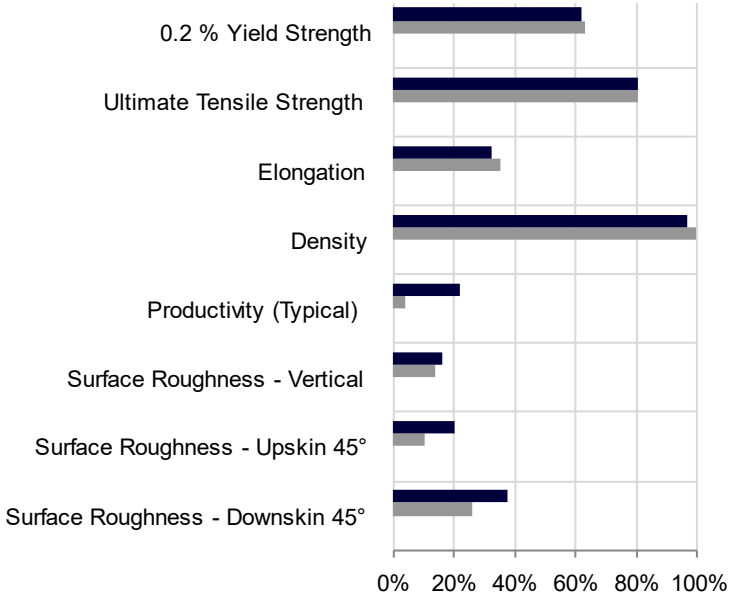
Stress Relief (SR1) – classic, following the IFU
1150°C for 1 hour in argon; furnace cooling

Stress Relief (SR2) – speed, following the IFU
preheat furnace to 1050°C, place samples directly in heated furnace, continue heating until samples reach 1050°C then hold for 1 h in argon, air cooling

Stress Relief + Simulated Firing (SR1+SIM-FIR)
1150°C for 1 hour in argon; furnace cooling; SIM-FIR: 950°C for 0.25 hours in argon, air cooling

Parameter Availability and Thermal State Comparison

- Productivity Parameter 172 SR1
  400 W, 50 µm layer thickness, rubber recoater
- Surface Parameter 173 SR1
  400 W, 25 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 cobalt-based alloys, the ranges are as follows: 0.2%YS: 0-1150 MPa UTS: 0-1450 MPa, Elongation: 0-60%, Density (as built): 99-100%, Productivity: 5-60 cm^3/h, Surface Quality (all): 0-40 µm. 0% in the bar plot indicates the lower range value, 100% indicates the upper range value

Productivity Parameter 172 - 400 W / 50 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	17.1
Theoretical melting rate bulk per laser[2]	16.2

[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	214	186	915	775	1235	1150
SR1	228	225	720	695	1175	1150
SR2	223	220	865	825	1280	1235
SR1+SIM-FIR	248	241	635	625	1055	1050

Thermal State	Elongation (%)	
	H	V
As-Built	15.0	24.0
SR1	18.5	20.0
SR2	12.0	19.5
SR1+SIM-FIR	9.5	12.5

Physical Properties at Room Temperature

Parameter 172

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	9	6	5
Downskin	15	8	6

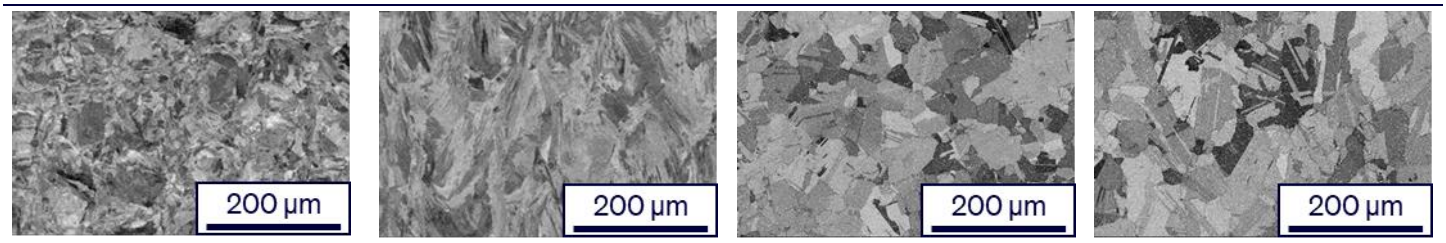
	Surface Roughness, Ra (µm)
H	7
V	7

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.9	99.9	368
SR1	---	---	355
SR2	---	---	419
SR1+SIM-FIR	---	---	349

Thermal State	Melting range (°C)	Coefficient of Thermal Expansion CTE 25-500°C (10^{-6}/K)
As-Built	1320-1420	14.4
SR1	---	14.5
SR2	---	14.1
SR1+SIM-FIR	---	14.5

Microstructure

As-Built		SR1	
H	V	H	V



Scanning electron microscope images in As-Built and Stress Relief (SR1) condition as defined previously.

Surface Parameter 173 - 400 W / 25 µm

Typical Build Rate

	(cm^3/h)
Typical build rate with coating[1]	7.2
Theoretical melting rate bulk per laser[2]	6.3

[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	236	181	980	800	1310	1070
SR1	233	215	745	695	1210	1115
SR2	248	225	900	820	1330	1130
SR1+SIM-FIR	245	241	655	630	1070	1015

Thermal State	Elongation (%)	
	H	V
As-Built	13.5	29.5
SR1	19.0	22.5
SR2	9.0	21.5
SR1+SIM-FIR	9.5	9.0

	Overhang Surface Roughness, Ra (µm)		
	45°	60°	75°
Upskin	5	4	3
Downskin	11	7	4

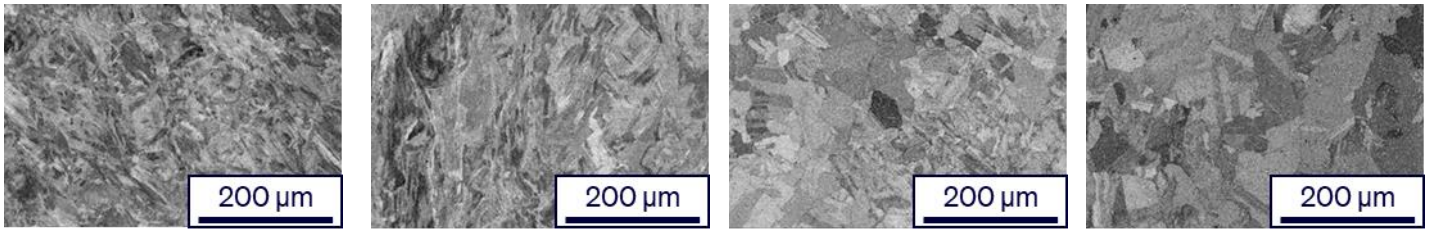
Surface Roughness, Ra (µm)	
H	5
V	6

Thermal State	Relative Density (%)		Hardness (HV10)
	H	V	H
As-Built	99.9	99.9	384
SR1	---	---	363
SR2	---	---	423
SR1+SIM-FIR	---	---	355

Thermal State	Melting range (°C)	Coefficient of Thermal Expansion CTE 25-500°C (10^{-6}/K)
As-Built	1320-1420	14.5
SR1	---	14.3
SR2	---	14.6
SR1+SIM-FIR	---	14.5

Microstructure

As-Built		SR1	
H	V	H	V



Scanning electron microscope images in As-Built and Stress Relief (SR1) condition as defined previously.

Data Sheet Nomenclature and Notation

IFU: Instruction For Use – provided with powder.

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.