COLIBRIUM ADDITIVE
a GE Aerospace company

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

Binder Jet Line Cobalt Chromium

Parameters and Processes for Colibrium Additive Binder Jet Line

Cobalt Chromium (2.4778)

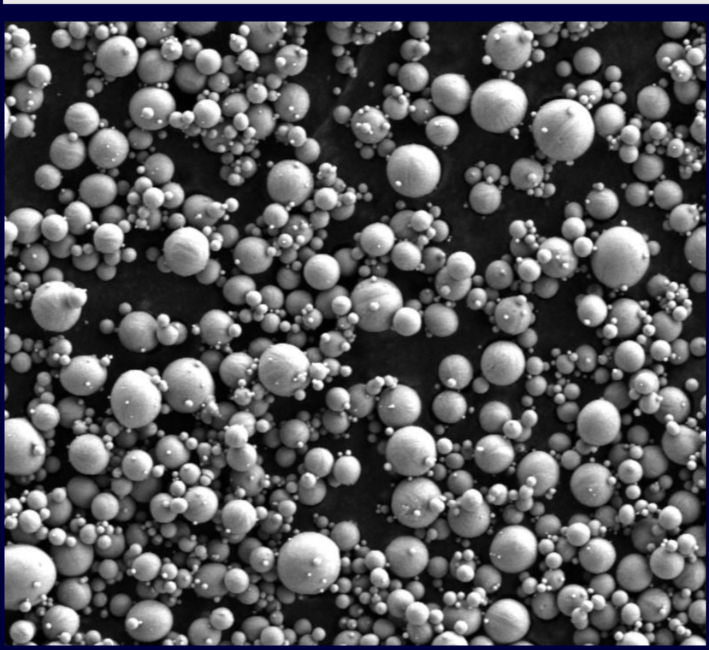
Parts are fabricated from cobalt chromium alloys when excellent resistance to high temperatures, corrosion, and wear are critical. It is an appropriate selection where nickel-free components are required, such as in orthopedic and dental applications due to the hardness and bio-compatibility necessary for long-term performance.

In aerospace and automotive, their ability to endure high temperatures and mechanical stress for long durations make them particularly suitable for turbine and wear-resistant machinery. The combination of toughness, durability, and chemical stability make cobalt chromium alloys attractive to a variety of industries.

Cobalt Chromium (2.4778) Binder Jet

Through mechanical testing and bulk material characterization, this parameter and the applied post-processing cycle demonstrated properties that conform to ASTM F75.

Compared to other powder bed additive manufacturing processes, binder jet offers economy of scale for customers requiring both part quantity and part variation with favorable cost: a build box 0.5 meters per side can be fully printed in approximately 18 hours.



Binder Jet Line CoCrMo (2.4778)

Machine Configuration

Colibrium Additive Binder Jet Line

Air Atmosphere

Aqueous Binder

Powder Chemistry

Binder Jet CoCrMo powder conforms to ASTM F75

Parameter Information

This build parameter utilizes a 100 µm layer thickness and green parts are sintered for 180 minutes at 1320°C after a curing step. The sinter cycle includes a hold at 1220°C for 240 minutes to ensure a homogenous microstructure post-sinter.

Thermal States

There are two separate post-processing cycles that have been investigated to date:

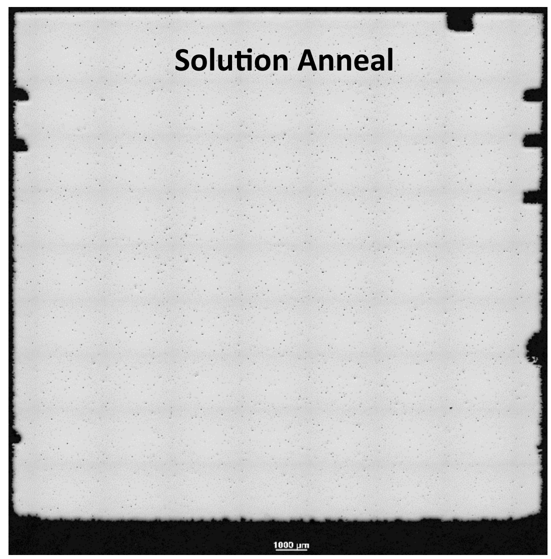
1. Solution Anneal (SOLN)

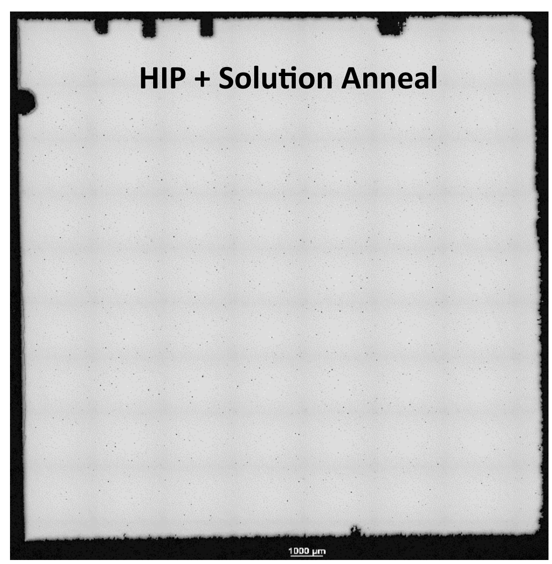
SOLN: 1220°C for 2 hours in argon or nitrogen, then rapid quench to 800°C at 50°C/min and furnace cool to 65°C.

2. HIP and Solution Anneal (HIP + SOLN)

HIP: 1200°C for 2 hours at 100 MPa in argon, then furnace cool at 10°C/min

SOLN: 1220°C for 2 hours in argon or nitrogen, then rapid quench to 800°C at 50°C/min and furnace cool to 65°C.





Figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.

Residual Carbon & Nominal Chemistry

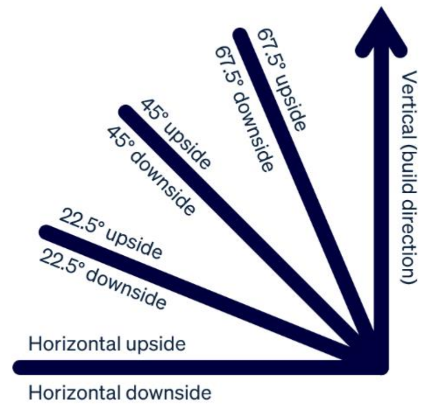
The carbon concentration after sintering cycle conforms to ASTM F75 specification requirements.

Additionally, all other constituents were measured post-sinter and observed within the ASTM F75 limits.

Physical Properties at Room Temperature

As-Sintered Surface Roughness (µm Ra)

	H	22.5°	45°	67.5°	V
Upside	7.9	17.6	16.5	18.3	16.8
Downside	11.4	17.4	16.7	15.7	16.8



HIP + SOLN Surface Roughness (µm Ra)

	H	22.5°	45°	67.5°	V
Upside	7.7	16.2	15.7	18.9	16.9
Downside	10.6	17.5	16.5	16.1	16.9

	Porosity (%)		**Hardness (HRC)**		**Archimedes Density (%)**
	H	V	H	V	Orientation-independent
As-Sintered	--	0.56	--	--	98.6
SOLN	--	0.23	27	--	98.6
HIP+SOLN	--	0.03	29	--	99.2

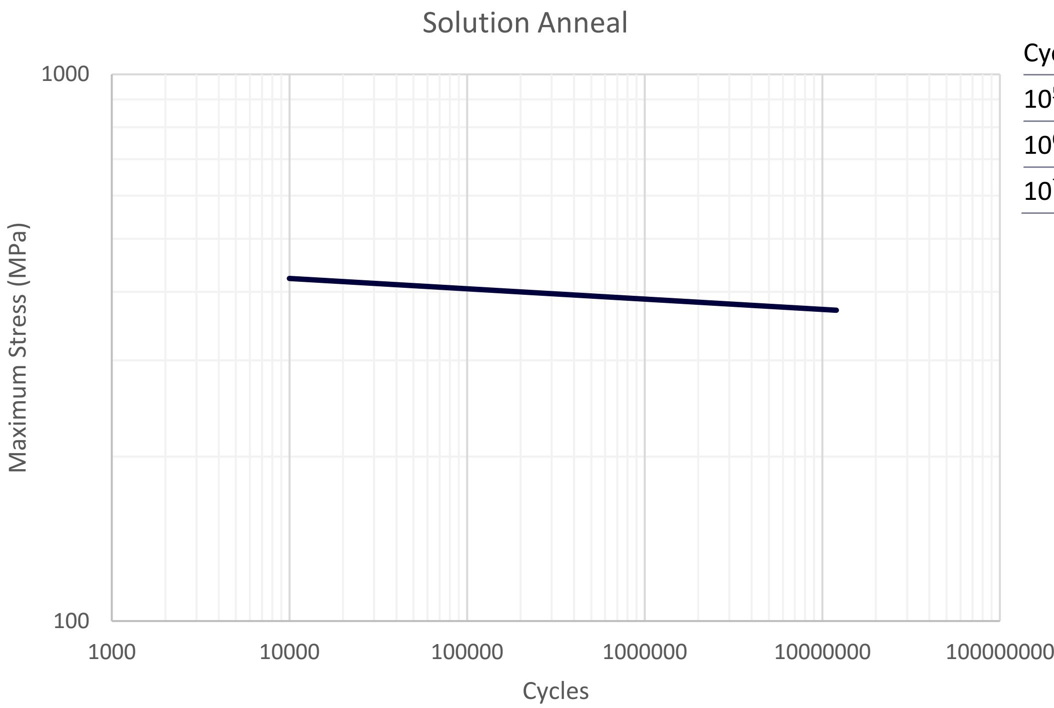
Tensile Performance at Room Temperature

	Modulus of Elasticity (GPa)		**0.2% Yield Strength (MPa)**		**Ultimate Tensile Strength (MPa)**	
	H	V	H	V	H	V
SOLN	233	238	600	600	977	977
HIP+SOLN	239	242	611	607	1094	1082

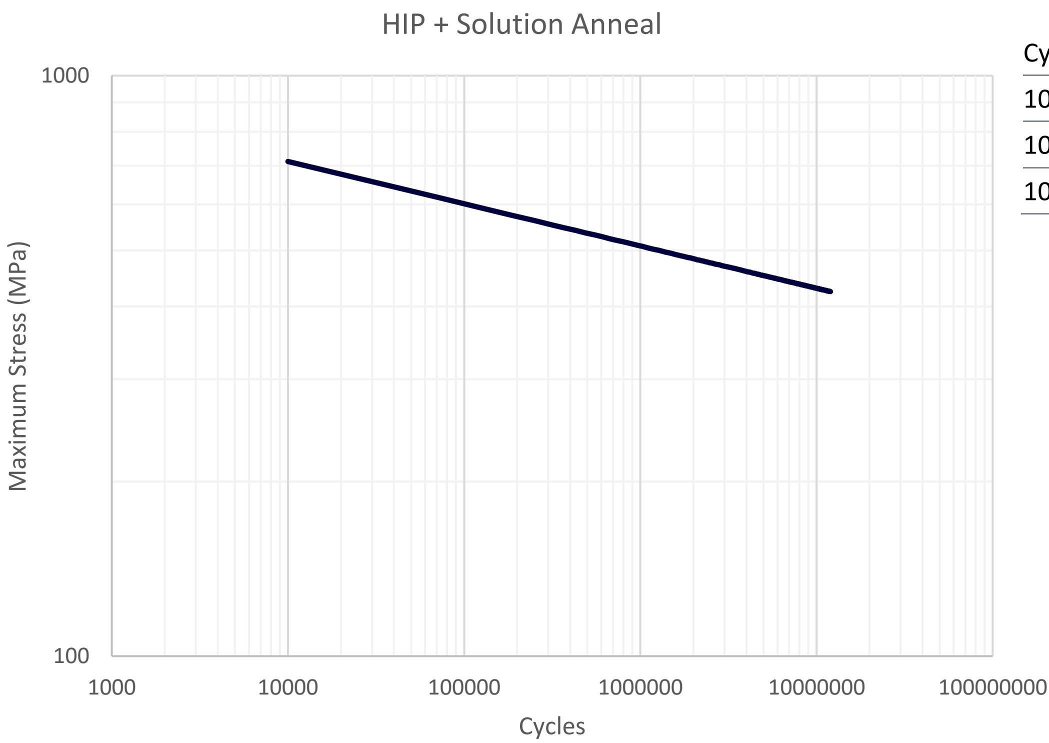
	Elongation (%)		**Area Reduction (%)**	
	H	V	H	V
SOLN	13	14	10	11
HIP+SOLN	20	20	16	16

Figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.

Rotating Beam Fatigue Performance (H and V) at Room Temperature



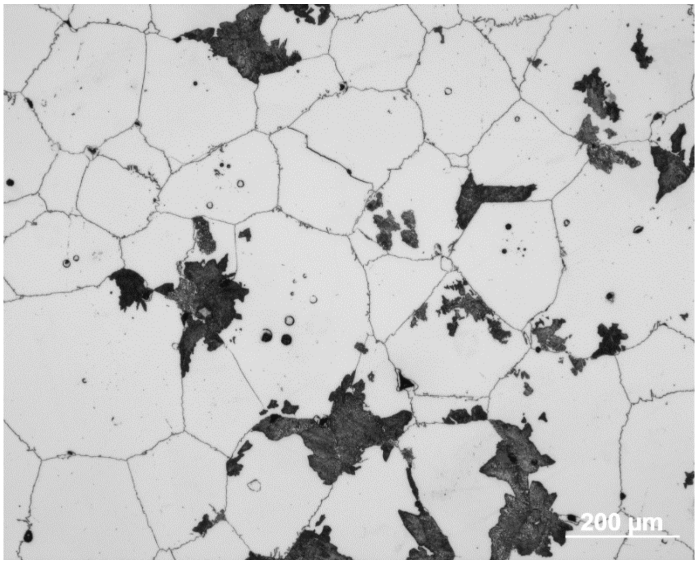
Cycles	Max. Stress (MPa)
10^5	405
10^6	388
10^7	371



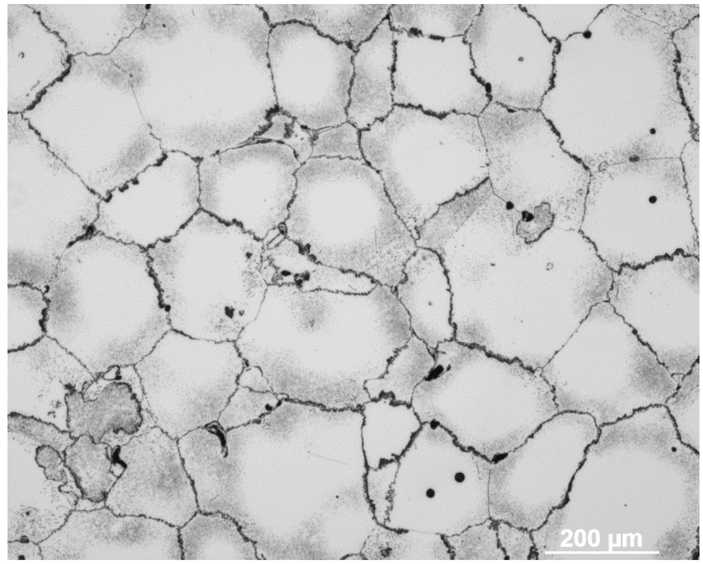
Cycles	Max. Stress (MPa)
10^5	601
10^6	508
10^7	430

Figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.

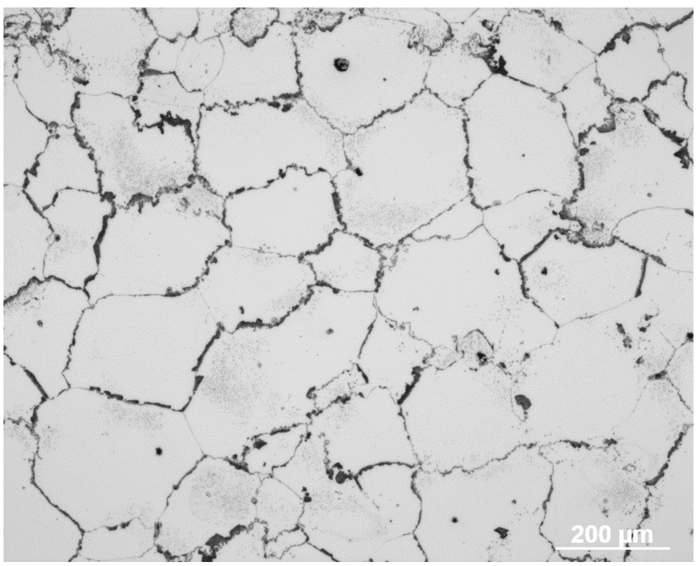
Microstructures (Etched)



Vertical, As-Sintered



Vertical, SOLN



Vertical, HIP+SOLN

Figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.

Data Sheet Nomenclature and Notation

H: Horizontal, X or Y.
V: Vertical, Z.
Other angles are measured from horizontal.

Compositional testing was performed according to ASTM E1447 and E1097.

Roughness measurements were performed according to DIN EN ISO 4287 and DIN EN ISO 4288. Analysis of surface quality varies as a function of methodology and specific settings, therefore some deviations might be observed depending on the chosen technology.

Hardness was tested according to ASTM E18.

Tensile evaluations were performed per ASTM E8. All surfaces were machined prior to testing.

Rotating beam fatigue characterization was performed per ISO 1143. All surfaces were machined prior to testing.