

Cobalt chrome

Parameter set options

Layer thickness	Optimised for	Laser mode	Page
40 µm	Single laser per part	Continuous wave	4
60 µm	Single laser per part	Continuous wave	5

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Material description

Cobalt chrome (Co28Cr6Mo) alloy comprises cobalt alloyed with chromium of mass fraction up to 30% and molybdenum up to 7%, along with other minor elements.

The alloy has a high melting point and corrosion resistance, making it very stable at high temperatures. Excellent biocompatibility, strength and wear resistance have led to the alloy being widely used in the orthopaedic and dental industries.

Material properties

- High strength and hardness
- High corrosion resistance
- Excellent biocompatibility
- High temperature resistance

Applications

- Medical and dental
- Gas turbines
- Engine components

Disclaimer

The mechanical property data featured in this document were obtained from tests performed in Renishaw's laboratories and they indicate the mechanical properties that can be achieved. The data is not intended as a guaranteed minimum specification.

Glossary of terms

Term	Definition
Scan strategy	Determines the path the laser will take to melt the cross-sectional area of the parts featured in each layer of the build process.
Meander	A scan strategy that takes the form of a straight-line vector path that bounces back and forth from each side of the part border. Meander strategy is quick and ideal for parts with a small XY cross section.
Stripe	A scan strategy where the area within the part border is split into strips and a meander technique is used within each strip. Stripe is ideal for parts with a large XY cross section.

Typical wrought material properties

Material property	Wrought material value
Density	8.4 g/cm ³
Thermal conductivity	13 W/mK
Melting temperature	1 260 °C to 1 360 °C
Coefficient of thermal expansion ¹	13×10 ⁻⁶ K ⁻¹

¹ In the range of 20 °C to 100 °C.

Recommended composition of powder

Element	Mass (%)
Cobalt	Balance
Chromium	27.00 to 30.00
Molybdenum	5.00 to 7.00
Manganese	≤ 1.00
Silicon	≤ 1.00
Iron	≤ 0.75
Nickel	≤ 0.50
Nitrogen	≤ 0.25
Tungsten	≤ 0.20
Aluminium	≤ 0.10
Oxygen	≤ 0.10
Titanium	≤ 0.10
Carbon	≤ 0.05
Phosphorus	≤ 0.02
Boron	≤ 0.01
Sulphur	≤ 0.01

Recommended powder size distribution: 15 µm to 45 µm.

The values shown in this table are for ASTM standard composition powder. Renishaw powders are supplied to a tighter specification to minimise batch-to-batch variations. Results quoted in this data sheet are from samples produced using Renishaw's tighter-specification powder. To purchase powder from Renishaw, visit the online store at www.renishaw.com/shop.

Please contact Renishaw for further information about specifications or if you require support in qualifying non-Renishaw powders.

Parameter set summary

Layer thickness	Optimised for	Laser mode	Gas flow rate	Build rate	
40 µm	Single laser per part	Continuous wave	190 m ³ /h	One laser: 13.7 cm ³ /h	Four lasers: 54.7 cm ³ /h

Material files: CoCr_500QS_B40_M_02_A (meander scan strategy)
CoCr_500QS_B40_S_02_A (stripe scan strategy)

Properties of additively manufactured components

NOTE: This parameter set is optimised for bulk density. The material properties in this table are indicative only. Further modification of the material file may be required to suit your application.

		Solution treated ¹
Bulk density ²		≥ 99.8%
Ultimate tensile strength ³	Horizontal (XY)	1 092 MPa ±15 MPa
	Vertical (Z)	1 068 MPa ±20 MPa
Yield strength ³	Horizontal (XY)	573 MPa ±5 MPa
	Vertical (Z)	566 MPa ±12 MPa
Elongation after fracture ³	Horizontal (XY)	34% ±2%
	Vertical (Z)	37% ±3%
Modulus of elasticity ³	Horizontal (XY)	238 GPa ±12 GPa
	Vertical (Z)	236 GPa ±8 GPa
Hardness (Vickers) ⁴	Horizontal (XY)	323 HV0.5 ±9 HV0.5
	Vertical (Z)	322 HV0.5 ±9 HV0.5
Surface roughness ⁵	Vertical (Z) (Median Ra)	8 µm ±1 µm

Mechanical test samples were created using four lasers, one laser per sample and with no downstream processing. Meander scan strategy was used for vertical samples. Stripe scan strategy was used for horizontal samples.

- ¹ Solution treatment method used for testing: Under vacuum, heat at 8 °C/min to 640 °C ±10 °C, then hold temperature for 15 min. Heat at 8 °C/min to 1 000 °C ±10 °C, then hold temperature for 5 min. Heat at 8 °C/min to 1 050 °C ±10 °C, then hold temperature for 2 hours. Gas quench with argon at 1 bar to room temperature.
- ² Measured optically on 10 mm × 10 mm × 10 mm samples at 75× magnification.
- ³ Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 32 samples.
- ⁴ Tested to ASTM E384-11 after polishing.
- ⁵ Tested on as-built vertical surfaces using laser interferometry. Tested to JIS B 0601 2001 (ISO 4287:1997).

Parameter set summary

Layer thickness	Optimised for	Laser mode	Gas flow rate	Build rate	
60 µm	Single laser per part	Continuous wave	190 m ³ /h	One laser: 26.1 cm ³ /h	Four lasers: 104.6 cm ³ /h

Material files: CoCr_500QS_B60_M_01_A (meander scan strategy)
CoCr_500QS_B60_S_01_A (stripe scan strategy)

Properties of additively manufactured components

NOTE: This parameter set is optimised for bulk density. The material properties in this table are indicative only. Further modification of the material file may be required to suit your application.

		As built	Annealed ¹
Bulk density ²		≥ 99.8%	–
Ultimate tensile strength ³	Vertical (Z)	1 193 MPa ±9 MPa	1 104 MPa ±28 MPa
Yield strength ³	Vertical (Z)	689 MPa ±5 MPa	560 MPa ±11 MPa
Elongation after fracture ³	Vertical (Z)	25% ±1%	39% ±5%
Modulus of elasticity ³	Vertical (Z)	224 GPa ±14 GPa	237 GPa ±13 GPa
Hardness (Vickers) ⁴	Vertical (Z)	365 HV0.5 ±17 HV0.5	–
Surface roughness ⁵	Vertical (Z) (Median Ra)	8 µm ±1 µm	8 µm ±1 µm

Mechanical test samples were created using four lasers, one laser per sample and with no downstream processing. Meander scan strategy was used for vertical samples.


- ¹ Annealing method used for testing: Under vacuum, heat at 8 °C/min to 1150 °C ±10 °C, then hold temperature for 6 hours. Furnace cool to room temperature.
- ² Measured optically on 10 mm × 10 mm × 10 mm samples at 75× magnification.
- ³ Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 32 samples.
- ⁴ Tested to ASTM E384-11 after polishing.
- ⁵ Tested on as-built vertical surfaces using laser interferometry. Tested to JIS B 0601 2001 (ISO 4287:1997).

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