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Cobalt chrome

Parameter set options

Layer thickness	Optimised for	Page
40 µm	Single laser per part	3
60 µm	Single laser per part	4

To download the latest material files, visit **www.renishaw.com/softwarelicensing**.

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 the alloy to 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

Generic material data

Typical wrought material properties

Material property	Wrought material value
Density	8.3 g/cm^3
Thermal conductivity	13 W/mK
Melting temperature	1 260 °C to 1 482 °C
Coefficient of thermal expansion [1]	12×10^{-6} K^{-1}

[1] In the range of 0 °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_##_# (meander scan strategy)
CoCr_500QS_B40_S_##_# (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]	
	Mean	Standard deviation
Bulk density [2]	≥ 99.8%	-
Ultimate tensile strength [3]		
Horizontal direction (XY)	1 092 MPa	15 MPa
Vertical direction (Z)	1 068 MPa	20 MPa
Yield strength [3]		
Horizontal direction (XY)	573 MPa	5 MPa
Vertical direction (Z)	566 MPa	12 MPa
Elongation after fracture [3]		
Horizontal direction (XY)	34%	2%
Vertical direction (Z)	37%	3%
Modulus of elasticity [3]		
Horizontal direction (XY)	238 GPa	12 GPa
Vertical direction (Z)	236 GPa	8 GPa
Hardness (Vickers) [4]		
Horizontal direction (XY)	323 HV0.5	9 HV0.5
Vertical direction (Z)	322 HV0.5	9 HV0.5
Surface roughness (Ra) [5]		
Vertical direction (Z)	8 Ra	1 Ra

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 and stripe scan strategy for horizontal samples. The mechanical property data 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.

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 a 10 mm × 10 mm × 10 mm sample 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 97).

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_##_# (meander scan strategy)
CoCr_500QS_B60_S_##_# (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]	
	Mean	Standard deviation
Bulk density [2]	≥ 99.8%	-
Ultimate tensile strength [3]		
Horizontal direction (XY)	1 109 MPa	62 MPa
Vertical direction (Z)	1 042 MPa	10 MPa
Yield strength [3]		
Horizontal direction (XY)	710 MPa	57 MPa
Vertical direction (Z)	631 MPa	10 MPa
Elongation after fracture [3]		
Horizontal direction (XY)	14%	4%
Vertical direction (Z)	13%	4%
Modulus of elasticity [3]		
Horizontal direction (XY)	223 GPa	21 GPa
Vertical direction (Z)	221 GPa	21 GPa
Hardness (Vickers) [4]		
Vertical direction (Z)	365 HV0.5	17 HV0.5
Surface roughness (Ra) [5]		
Vertical direction (Z)	8 Ra	1 Ra

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 and stripe scan strategy for horizontal samples. The mechanical property data 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.

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