Material data sheet

EOS CobaltChrome MP1 for EOSINT M 270

A number of different materials are available for use with EOSINT M systems, offering a broad range of e-Manufacturing applications. EOS CobaltChrome MP1 is a multi-purpose cobalt-chrome-molybdenum-based superalloy powder which has been optimized especially for processing on EOSINT M 270 systems. Other materials are also available for EOSINT M systems, including a special-purpose cobalt-chrome-molybdenum-based superalloy for dental veneering application, and further materials are continuously being developed - please refer to the relevant material data sheets for details.

This document provides a brief description of the principle applications, and a table of technical data. For details of the system requirements please refer to the relevant information quote.

Description, application

EOS CobaltChrome MP1 is a fine powder mixture for processing on EOSINT M 270 systems, which produces parts in a cobalt-chrome-molybdenum-based superalloy. This class of superalloy is characterized by having excellent mechanical properties (strength, hardness etc.), corrosion resistance and temperature resistance. Such alloys are commonly used in biomedical applications such as dental and medical implants (note: widely used in Europe but much less so in North America), and also for high-temperature engineering applications such as in aero engines.

The chemistry of EOS CobaltChrome MP1 conforms to the composition UNS R31538 of high carbon CoCrMo alloy. Parts built from this material are nickel-free (< 0.1 % nickel content), sterilisable and suitable for biomedical applications, and are characterized by a fine, uniform crystal grain structure. They fully meet the requirements of ISO 5832-4 and ASTM F75 for cast CoCrMo implant alloys, as well as the requirements of ISO 5832-12 and ASTM F1537 for wrought CoCrMo implants alloys except remaining elongation. The remaining elongation can be increased to fulfil even this standard by hot isostatic pressing (HIP).

This material is ideal for many part-building applications (DirectPart) such as functional metal prototypes, small series products, individualised products or spare parts. Standard processing parameters use full melting of the entire geometry with 20 µm layer thickness, but it is also possible to use the Skin & Core building style to increase the build speed. Using standard parameters the mechanical properties are fairly uniform in all directions. Parts made from EOS CobaltChrome MP1 can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required. Unexposed powder can be reused.

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Typical applications:

- prototype, one-off or small-series biomedical implants, e.g. spinal, knee, hip bone, toe and dental.
- parts requiring high mechanical properties in elevated temperatures (500 - 1000 °C) and with good corrosion resistance, e.g. turbines and other parts for engines, cutting parts, etc.
- parts having very small features such as thin walls, pins, etc., which require particularly high strength and/or stiffness.

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Technical data

General process data

Minimum recommended layer thickness	20 µm 0.8 mil
Typical achievable part accuracy	
- small parts [1]	± 20 – 50 µm 0.8 – 2 mil
- large parts [2]	± 50 – 200 µm 2 – 8 mil
Min. wall thickness [3]	0.3 mm 0.012 inch
Surface roughness (µm)	
- as built	approx. R_a 10 µm, R_z 40 - 50 µm R_a 0.39, R_z 1.6 - 2.0 mil
- after polishing	R_z up to < 1µm R_z up to < 0.04 mil
Volume rate [3]	
- standard parameters (no Skin & Core, full melting, full density, maximum strength)	1.6 mm³/s 0.35 in³/h
- faster Skin & Core parameters (full melting, full density)	3.0 mm³/s 0.66 in³/h

[1] Based on users' experience of dimensional accuracy for typical geometries, e.g. ± 20 µm when parameters can be optimized for a certain class of parts or ± 50 µm when building a new kind of geometry for the first time.

[2] For larger parts the accuracy can be improved by post-process stress-relieving at 1050 °C for 2 hours.

[3] Mechanical stability is dependent on geometry (wall height etc.) and application

[4] Volume rate is a measure of build speed during laser exposure. The total build speed depends on the average volume rate, the recoating time (related to number of layers) and other factors such as DMLS-Start settings.

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Physical and chemical properties of parts

Material composition	Co: 60 - 65 wt-% Cr: 26 - 30 wt-% Mo: 5 - 7 wt-% Si: max. 1.0 wt-% Mn: max. 1.0 wt-% Fe: max. 0.75 wt-% C: max. 0.16 wt-% Ni: max. 0.10 wt-%
Relative density with standard parameters	approx. 100 %
Density with standard parameters	8.29 g/cm³ 0.300 lb/in³

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Mechanical properties of parts at 20 °C

Ultimate tensile strength (MPIF 10)	
- in horizontal direction (XY)	1300 MPa ± 50 MPa 189 ksi ± 7 ksi
- in vertical direction (Z)	1150 MPa ± 50 MPa 167 ksi ± 7 ksi
Yield strength (Rp 0.2 %) (MPIF 10)	
- in horizontal direction (XY)	960 MPa ± 50 MPa 139 ksi ± 7 ksi
- in vertical direction (Z)	880 MPa ± 50 MPa 128 ksi ± 7 ksi
Elongation at break (MPIF 10)	
- in horizontal direction (XY)	11 % ± 2 %
- in vertical direction (Z)	9 % ± 1 %
- after hot isostatic pressing (HIP)	21 - 24 %
Young's Modulus (MPIF 10)	
- in horizontal direction (XY)	220 GPa ± 20 GPa 29 msi ± 3 msi
- in vertical direction (Z)	220 GPa ± 20 GPa 29 msi ± 3 msi
Fatigue life [5]	
- in vertical direction (Z) at 0-400 MPa load range and 20 Hz	approx. 7.2 million cycles
Hardness (DIN EN ISO 6508-1)	35 - 45 HRC

[5] Tested using round fatigue bar of approx. 4 mm smallest diameter in neck region, 6 mm diameter at the ends and 50 mm total length. Neck regions smoothed by sand paper prior to testing.

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Thermal properties of parts

Coefficient of thermal expansion	
- over 20 - 500 °C (36 - 900 °F)	13.6 x 10^{-6} m/m °C 7.6 x 10^{-6} in/in °F
- over 500 - 1000 °C (900 - 1800 °F)	15.1 x 10^{-6} m/m °C 8.4 x 10^{-6} in/in °F
Thermal conductivity	
- at 20 °C (36 °F)	13 W/m °C 90 Btu/(h ft² °F/in)
- at 300 °C (540 °F)	18 W/m °C 125 Btu/(h ft² °F/in)
- at 500 °C (900 °F)	22 W/m °C 153 Btu/(h ft² °F/in)
- at 1000 °C (1800 °F)	33 W/m °C 229 Btu/(h ft² °F/in)
Maximum operating temperature	1150 °C 2100 °F
Melting range	1350 - 1430 °C 2460 – 2600 °F

The quoted values refer to the use of these materials with EOSINT M 270 systems according to current specifications (including the latest released process software PSW and any hardware specified for the relevant material) and operating instructions. All values are approximate. Unless otherwise stated, the quoted mechanical and physical properties refer to standard building parameters and test samples built in horizontal orientation. They depend on the building parameters and strategies used, which can be varied by the user according to the application. Measurements of the same properties using different test methods (e.g. specimen geometries) can give different results. The data are based on our latest knowledge and are subject to changes without notice. They are provided as an indication and not as a guarantee of suitability for any specific application.
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