Material data sheet

EOS StainlessSteel GP1 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 StainlessSteel GP1 is a stainless steel powder which has been optimized especially for EOSINT M 270 systems. Other materials are also available for EOSINT M systems, 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 StainlessSteel GP1 is a pre-alloyed stainless steel in fine powder form. Its composition corresponds to US classification 17-4 and European 1.4542. This kind of steel is characterized by having good corrosion resistance and mechanical properties, especially excellent ductility in laser processed state, and is widely used in a variety of engineering applications.

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 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 StainlessSteel GP1 can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required. Unexposed powder can be reused.

Typical applications:

- engineering applications including functional prototypes, small series products, individualised products or spare parts.
- parts requiring high corrosion resistance, sterilisability, etc.
- parts requiring particularly high toughness and ductility.

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Technical data

General process and geometric data

Minimum recommended layer thickness	20 µm 0.8 mil
Typical achievable part accuracy [1]	
- small parts	± 20 – 50 µm 0.8 – 2.0 mil
- large parts [2]	± 0.2 %
Min. wall thickness [3]	0.3 - 0.4 mm 0.012 - 0.016 in
Surface roughness	
- after shot-peening	R_a 2.5 - 4.5 µm, R_y 15 - 40 µm R_a 0.1 - 0.2 , R_y 0.6 - 1.6 mil
- after polishing	R_z up to < 0.5 µm (can be very finely polished)
Volume rate [4]	
- standard parameters (20 µm layers, full density)	2 mm³/s 0.44 in³/h
- Inner core parameters (Skin & Core style, full density)	4 mm³/s 0.88 - 1.1 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 650 °C for 1 hour.

[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 the number of layers) and other factors such as DMLS-Start settings.

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Physical and chemical properties of parts

Material composition	steel including alloying elements Cr (15 – 17.5 wt-%) Ni (3 - 5 wt-%) Cu (3 - 5 wt-%) Mn (max. 1 wt-%) Si (max. 1 wt-%) Mo (max. 0.5 wt-%) Nb (0.15 - 0.45 wt-%) C (max. 0.07 wt-%)
Relative density with standard parameters	approx. 100 %
Density with standard parameters	7.8 g/cm³ 0.28 lb/in³

Mechanical properties of parts [5]

	As manufactured	Stress relieved (1 hour at 650 °C)
Ultimate tensile strength		
- in horizontal direction (XY)	min 850 MPa (123 ksi) typical 930 ± 50 MPa (135 ± 7 ksi)	typical 1100 MPa (160 ksi)
- in vertical direction (Z)	min 850 MPa (123 ksi) typical 960 ± 50 MPa (139 ± 7 ksi)	typical 980 MPa (142 ksi)
Yield strength		
(R_{eL}, Lower yield strength)		
- in horizontal direction (XY)	min 530 MPa (77 ksi) typical 586 ± 50 MPa (85 ± 7 ksi)	typical 590 Mpa (86 ksi)
- in vertical direction (Z)	min 530 MPa (77 ksi) typical 570 ± 50 MPa (83 ± 7 ksi)	typical 550 MPa (80 ksi)
(R_{eH}, Upper yield strength)		
- in horizontal direction (XY)	min 595 MPa (86 ksi) typical 645 ± 50 MPa (94 ± 7 ksi)	typical 634 MPa (92 ksi)
- in vertical direction (Z)	min 580 MPa (84 ksi) typical 630 ± 50 MPa (91 ± 7 ksi)	typical 595 MPa (86 ksi)

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Young's modulus	170 ± 30 GPa (25 ± 4 msi)	typical 180 GPa (26 msi)
Elongation at break		
- in horizontal direction (XY)	min 25 % typical 31 ± 5 %	typical 29 %
- in vertical direction (Z)	min 25 % typical 35 ± 5 %	typical 31 %
Hardness [6]		
- as built	approx. 230 ± 20 HV1	
- ground & polished [7]	approx. 250 - 400 HV1	

[5] Mechanical testing according to ISO 6892:1998(E) Annex C, proportional test pieces, Diameter of the neck area 5 mm, original gauge length 25 mm

[6] Vickers hardness measurement (HV) according to DIN EN ISO 6507-1. Note that depending on the measurement method used, the measured hardness value can be dependent on the surface roughness and can be lower than the real hardness. To avoid inaccurate results, hardness should be measured on a polished surface.

[7] Due to work-hardening effect

Thermal properties of parts

Coefficient of thermal expansion	
- over 20 - 600 °C (68 - 1080 °F)	14×10^{-6} m/m °C 7.8×10^{-6} in/in °F
Thermal conductivity	
- at 20 °C (68 °F)	13 W/m °C 90 Btu/(h ft² °F/in)
- at 100 °C (212 °F)	14 W/m °C 97 Btu/(h ft² °F/in)
- at 200 °C (392 °F)	15 W/m °C 104 Btu/(h ft² °F/in)
- at 300 °C (572 °F)	16 W/m °C 111 Btu/(h ft² °F/in)
Maximum operating temperature	550 °C 1022 °F

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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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