Stainless Steel GP1

MATERIAL DATA SHEET

Stainless Steel GP1 is a pre-alloyed stainless steel in fine powder form, and 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 in:

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

This material is ideal for many part-building applications (DirectPart) such as functional metal prototypes, small series products, individualized 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 Stainless Steel GP1 can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required.

General process 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 %
Minimum wall thickness [3]	0.3 - 0.4 mm 0.012 - 0.016 in
Surface roughness *- after shot-peening*	Ra 2.5 - 4.5 µm, Ry 15 - 40 µm Ra 0.1 - 0.2 , Ry 0.6 - 1.6 mil
- after polishing	Rz up to < 0.5 µm (can be very finely polished)
Volume rate [4]	
- standard parameters *(20 µm layers, full density)*	2 mm^3/s 0.44 in^3/h
- Inner core parameters *(Skin & Core style, full density)*	4 mm^3/s 0.88 - 1.1 in^3/h

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Physical & chemical properties of parts

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

Mechanical properties of parts [5] - as manufactured

	Horizontal axis (XY)	*Vertical axis (Y)*
Ultimate tensile strength [5]	min 850 MPa (123 ksi	min 850 MPa (123 ksi)
	typical 930 ± 50 MPa (135 ± 7 ksi)	typical 960 ± 50 MPa (139 ± 7 ksi)
Yield strength *(ReL, Lower yield strength)*	min 530 MPa (77 ksi)	min 530 MPa (77 ksi)
	typical 586 ± 50 MPa (85 ± 7 ksi)	typical 570 ± 50 MPa (83 ± 7 ksi)
Yield strength *(ReH, Upper yield strength))*	min 595 MPa (86 ksi)	min 580 MPa (84 ksi)
	typical 645 ± 50 MPa (94 ± 7 ksi)	typical 630 ± 50 MPa (91 ± 7 ksi)
Young's modulus	170 ± 30 GPa	
	(25 ± 4 msi)	
Elongation at break	min 25 %	min 25 %
	typical 31 ± 5 %	typical 35 ± 5 %
Hardness [6] - *as built*	approx. 230 ± 20 HV1	
Hardness [6] - *ground & polished* [7]	approx. 250 - 400 HV1	

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Mechanical properties of parts [5] - stress relieved (1 hour at 650 °C)

	Horizontal axis (XY)	*Vertical axis (Y)*
Ultimate tensile strength [5]	typical 1100 MPa (160 ksi)	typical 980 MPa (142 ksi)
Yield strength *(ReL, Lower yield strength)*	typical 590 Mpa (86 ksi)	typical 550 MPa (80 ksi)
Yield strength *(ReH, Upper yield strength)*	typical 634 MPa (92 ksi)	typical 595 MPa (86 ksi)
Young's modulus	typical 180 GPa (26 msi)	
Elongation at break	typical 29 %	typical 31 %

Thermal properties of parts

Coefficient of thermal expansion *- over 20 - 600 °C (68 - 1080 °F)*	14 x 10^{-6} m/m °C 7.8 x 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*

[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 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 re-coating time (related to the number of layers) and other factors such as DMLS-Start settings.

[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