

MATERIAL DATA SHEET



Stainless Steel PH1 is a pre-alloyed stainless steel in fine powder form, and is characterized by having good corrosion resistance and excellent mechanical properties, especially in the precipitation hardened state. This type of steel is widely used in variety of medical, aerospace and other engineering applications requiring high hardness, strength and corrosion resistance.

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 hardness and strength.

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. Using standard parameters the mechanical properties are fairly uniform in all directions. Parts made from Stainless Steel PH1 can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required. micro shot-peened, polished and coated if required.

GENERAL PROCESS DATA

Min. recommended layer thickness	20 µm 0.8 mil
Typical achievable part accuracy ^[1] - <i>small parts</i>	± 20 – 50 µm 0.8 – 2.0 mil
- <i>large parts</i>	± 0.2 %
Minimum wall thickness ^[2]	~ 0.4 mm ~ 0.016 in
Surface roughness - <i>after shot-peening</i>	Ra ~ 5.0 µm, Rz ~ 25.0 µm Ra ~ 0.2 mil, Rz ~ 1.0 mil
- <i>after polishing</i>	Rz up to < 0.5 µm <i>[can be very finely polished]</i>
Volume rate ^[3] - <i>standard parameters (20 µm layers, bulk part)</i>	~ 2.0 mm ³ /s ~ 0.40 in ³ /h



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PHYSICAL & CHEMICAL PROPERTIES OF PARTS

Material composition	steel including alloying elements		
	Fe (balance)	Cu (2.5 – 4.5%)	C (max. 0.07%)
	Cr (14 – 15.5%)	Mn (max. 1.00%)	Mo (max. 0.5%)
	Ni (3.5 – 5.5%)	Si (max. 1.00%)	Nb (0.15 - 0.45%)
Relative density	approx. 100 %		
Density	~ 7.7 g/cm ³		
	~ 0.27 lb/in ³		

MECHANICAL PROPERTIES OF PARTS^[4] - AS MANUFACTURED

	Horizontal axis (XY)	Vertical axis (Z)
Ultimate tensile strength	1200 ± 50 MPa	1200 ± 50 MPa
Yield strength (Rp 0.2 %)	1025 ± 75 MPa	940 ± 75 MPa
Elongation at break	17% ± 4%	14% ± 4%

MECHANICAL PROPERTIES OF PARTS^[4] - HARDENED^[6] (MOD H900 HEAT TREATMENT)

	Horizontal axis (XY)	Vertical axis (Z)
Ultimate tensile strength ^[4]	min. 1350 MPa [typical 1450 ± 100 MPa]	min. 1340 MPa [typical 1440 ± 100 MPa]
Yield strength (Rp 0.2 %)	min. 1250 MPa [typical 1350 ± 100 MPa]	min. 1200 MPa [typical 1300 ± 100 MPa]
Elongation at break	min 10% [typical 15% ± 3%]	min 10% [typical 13% ± 3%]
Hardness ^[5] -as built	min 40 HRC [typical 43 HRC]	



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- [1] Based on users' experience of dimensional accuracy for typical geometries, e.g. $\pm 20 \mu\text{m}$ when parameters can be optimized for a certain class of parts or $\pm 50 \mu\text{m}$ when building a new kind of geometry for the first time.
- [2] Mechanical stability is dependent on geometry (wall height etc.) and application.
- [3] 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.
- [4] Mechanical test gth 25mm, test pieces built in $20 \mu\text{m}$ layer-thickness.
- [5] Rockwell C (HRC) hardness measurement according to DIN EN ISO 6508-1. 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.
- [6] Mechanical properties are expressed as minimum values to indicate that mechanical properties exceed the min requirements of material specification standards such as ASTM A564-04 [XM12], ASTM A693-06 [XM12]. Hardening of Stainless Steel PH1 done using modified H900 heat treatment (soaking time at precipitation hardening temperature $525 \text{ }^\circ\text{C}$ elongated for 4 hours)

