

MaragingSteel MS1

This document provides information and data for parts built using MaragingSteel MS1 Powder.

Description

Parts built in MaragingSteel MS1 have a chemical composition corresponding to US classification 18% Ni Maraging 300, European 1.2709 and German X3NiCoMoTi 18-9-5. This kind of steel is characterized by having very good mechanical properties, and being easily heattreatable using a simple thermal age-hardening process to obtain excellent hardness and strength.

Parts built from MaragingSteel MS1 are easily machinable after the building process and can be easily post-hardened to more than 50 HRC by age-hardening at 490 °C (914 °F) for 6 hours. In both as-built and age-hardened states the parts can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required. Due to the layerwise building method, the parts have a certain anisotropy, which can be reduced or removed by appropriate heat treatment - see Technical Data for examples.

Technical data	
General process and geometrical data	
Typical achievable part accuracy [1]	
- Small parts (< 80 x 80 mm)	approx. $\pm 20 \mu\text{m}$ approx. $\pm 0.8 \times 10^{-3}$ inch
- Large parts	approx. $\pm 50 \mu\text{m}$ approx. ± 0.002 inch
Age hardening shrinkage [2]	approx. 0.08 %
Smallest wall thickness [3]	approx. 0.3 - 0.4 mm approx. 0.012 - 0.016 inch
Surface roughness (approx.) [4]	
- as manufactured MS1 Surface (20 μm)	Ra 4 μm , Rz 20 μm Ra 0.16×10^{-3} inch, Rz 0.78×10^{-3} inch
MS1 Performance (40 μm)	Ra 5 μm , Rz 28 μm Ra 0.19×10^{-3} inch, Rz 1.10×10^{-3} inch
MS1 Speed (50 μm)	Ra 9 μm , Rz 50 μm Ra 0.47×10^{-3} inch, Rz 2.36×10^{-3} inch
- after shot-peening	Ra 4 - 6.5 μm ; Rz 20 - 50 μm Ra $0.16 - 0.26 \times 10^{-3}$ inch Rz $0.78 - 1.97 \times 10^{-3}$ inch
- after polishing	Rz up to < 0.5 μm Rz up to < 0.02×10^{-3} inch (can be very finely polished)
Volume rate [4]	
- Parameter set MS1_Surface 1.0 / default job MS1_020_default.job (20 μm layer thickness)	1.6 mm ³ /s (5.8 cm ³ /h) 0.35 in ³ /h
- Parameter set MS1_Performance 2.0 / default job MS1_040_default.job (40 μm layer thickness)	3 mm ³ /s (10.8 cm ³ /h) 0.66 in ³ /h
- Parameter set MS1_Performance 1.0 / for M 280 / 400 W (40 μm layer thickness)	4.2 mm ³ /s (15.1 cm ³ /h) 0.92 in ³ /h
- Parameter set MS1_Speed 1.0 / for M 280 / 400 W (50 μm layer thickness)	5.5 mm ³ /s (19.8 cm ³ /h) 1.21 in ³ /h

[1] Based on users' experience of dimensional accuracy for typical geometries, as built. Part accuracy is subject to appropriate data preparation and post-processing.

[2] Ageing temperature 490 °C (914 °F), 6 hours, air cooling

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

[4] Due to the layerwise building, the surface structure depends strongly on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect. The values also depend on the measurement method used. The values quoted here given an indication of what can be expected for horizontal (up-facing) or vertical surfaces. [5] Volume rate is a measure of build speed during laser exposure of hatched areas. The total build speed depends on the average volume rate, the recoating time (related to the number of layers) and other geometry- and machine setting-related factors.

Physical and chemical properties of the parts	
Material composition	Fe (balance) Ni (17 - 19 wt-%) Co (8.5 - 9.5 wt-%) Mo (4.5 - 5.2 wt-%) Ti (0.6 - 0.8 wt-%) Al (0.05 - 0.15 wt-%) Cr, Cu (each ≤ 0.5 wt-%) C (≤ 0.03 wt-%) Mn, Si (each ≤ 0.1 wt-%) P, S (each ≤ 0.01 wt-%)
Relative density	approx. 100 %
Density	8.0 - 8.1 g/cm ³ 0.289 - 0.293 lb/in ³

Mechanical properties of the parts		
	As built	After age hardening [2]
Tensile strength [6]		min. 1930 MPa min. 280 ksi
- in horizontal direction (XY)	typ. 1100 ± 100 MPa typ. 160 ± 15 ksi	typ. 2050 ± 100 MPa typ. 297 ± 15 ksi
- in vertical direction (Z)	typ. 1100 ± 100 MPa typ. 160 ± 15 ksi	
Yield strength (Rp 0.2 %) [6]		min. 1862 MPa min. 270 ksi
- in horizontal direction (XY)	typ. 1050 ± 100 MPa typ. 152 ± 15 ksi	typ. 1990 ± 100 MPa typ. 289 ± 15 ksi
- in vertical direction (Z)	typ. 1000 ± 100 MPa typ. 145 ± 15 ksi	
Elongation at break [6]		min. 2 %
- in horizontal direction (XY)	typ. (10 ± 4) %	typ. (4 ± 2) %
- in vertical direction (Z)	typ. (10 ± 4) %	
Modulus of elasticity [6]		
- in horizontal direction (XY)	typ. 160 ± 25 GPa typ. 23 ± 4 Msi	typ. 180 ± 20 GPa typ. 26 ± 3 Msi
- in vertical direction (Z)	typ. 150 ± 20 GPa typ. 22 ± 3 Msi	
Hardness [7]	typ. 33 - 37 HRC	typ. 50 - 56 HRC
Ductility	typ. 45 ± 10 J	typ. 11 ± 4 J

[6] Tensile testing according to ISO 6892-1:2009 (B) Annex D, proportional test pieces, diameter of the neck area 5mm (0.2 inch), original gauge length 25mm (1 inch).

[7] Rockwell C (HRC) hardness measurement according to EN ISO 6508-1 on polished surface. Note that measured hardness can vary significantly depending on how the specimen has been prepared.

Thermal properties of parts		
	As built	After age hardening [2]
Thermal conductivity	typ. $15 \pm 0.8 \text{ W/m}^\circ\text{C}$ typ. $104 \pm 6 \text{ Btu in/(h ft}^2 \text{ }^\circ\text{F)}$	typ. $20 \pm 1 \text{ W/m}^\circ\text{C}$ typ. $139 \pm 7 \text{ Btu in/(h ft}^2 \text{ }^\circ\text{F)}$
Specific heat capacity	typ. $450 \pm 20 \text{ J/kg}^\circ\text{C}$ typ. $0.108 \pm 0.005 \text{ Btu/(lb }^\circ\text{F)}$	typ. $450 \pm 20 \text{ J/kg}^\circ\text{C}$ typ. $0.108 \pm 0.005 \text{ Btu/(lb }^\circ\text{F)}$
Maximum operating temperature		approx. $400 \text{ }^\circ\text{C}$ approx. $750 \text{ }^\circ\text{F}$

Notes

The data are valid for the combinations of powder material, machine and parameter sets referred to on page 1, when used in accordance with the relevant Operating Instructions (including Installation Requirements and Maintenance) and Parameter Sheet. Part properties are measured using defined test procedures. Further details of the test procedures used by EOS are available on request. Unless otherwise specified, the data refer to the default job MS1_040_default.job or the equivalent parameter set MS1_Performance 2.0. The corresponding data for the default job MS1_020_default.job or the equivalent parameter set MS1_Surface 1.0 are approximately the same except where otherwise specified.

The data correspond to our knowledge and experience at the time of publication. They do not on their own provide a sufficient basis for designing parts. Neither do they provide any agreement or guarantee about the specific properties of a part or the suitability of a part for a specific application. The producer or the purchaser of a part is responsible for checking the properties and the suitability of a part for a particular application. This also applies regarding any rights of protection as well as laws and regulations. The data are subject to change without notice.