Material data sheet

EOS MaragingSteel MS1

EOS MaragingSteel MS1 is a steel powder which has been optimized especially for processing on EOSINT M systems.

This document provides information and data for parts built using EOS MaragingSteel MS1 powder (EOS art.-no. 9011-0016) on the following system specifications:

- EOSINT M 270 Installation Mode *Standard*
  with PSW 3.3 or 3.4 and default job MS1_020_default.job or MS1_040_default.job
- EOSINT M 270 Dual Mode
  with PSW 3.5 and EOS Original Parameter Set MS1_Surface 1.0 or
  MS1_Performance 2.0

Description

Parts built in EOS 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 heat-treatable using a simple thermal age-hardening process to obtain excellent hardness and strength.

Parts built from EOS MaragingSteel MS1 are easily machinable after the building process and can be easily post-hardened to more then 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.

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Technical data

General process data

Typical achievable part accuracy [1]	
- small parts	approx. ± 40 – 60 µm approx. ± 1.6 – 2.4 x 10^{-3} inch
- large parts	approx. ± 0.2 %
Age hardening shrinkage [2]	approx. 0.08 %
Min. wall thickness [3]	approx. 0.3 - 0.4 mm approx. 0.012 - 0.016 inch
Surface roughness (approx.) [4]	
- after shot-peening	R_a 4 - 6.5 µm; R_z 20 - 50 µm R_a 0.16 – 0.26 x 10^{-3} inch R_z 0.78 – 1.97 x 10^{-3} inch
- after polishing	R_z up to < 0.5 µm R_z up to < 0.02 x 10^{-3} inch (can be very finely polished)
Volume rate [5]	
- Parameter set MS1_Performance 2.0 / default job MS1_040_default.job (40µm layer thickness)	3 mm^3/s (10.8 cm^3/h) 0.66 in^3/h
- Parameter set MS1_Surface 1.0 / default job MS1_020_default.job (20µm layer thickness)	1.6 mm^3/s (5.8 cm^3/h) 0.35 in^3/h

[1] Based on users' experience of dimensional accuracy for typical geometries, e.g. ± 40 µm (0.0016 inch) when parameters can be optimized for a certain class of parts or ± 60 µm (0.0024 inch) when building a new kind of geometry for the first time. Part accuracy is subject to appropriate data preparation and post-processing, in accordance with EOS training.

[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.

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Physical and chemical properties of 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/cm³ 0.289 - 0.293 lb/in³

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Mechanical properties of parts at 20 °C (68°F)

	As built	After age hardening [2]
Tensile strength [6]		min. 1930 MPa min. 280 ksi
- in horizontal direction (XY)	typ. 1040 ± 100 MPa typ. 151 ± 15 ksi	typ. 2050 ± 100 MPa typ. 297 ± 15 ksi
- in vertical direction (Z)	typ. 1130 ± 100 MPa typ. 164 ± 15 ksi	
Yield strength (Rp 0.2 %) [6]		min. 1862 MPa typ. 270 ksi
- in horizontal direction (XY)	typ. 1080 ± 100 MPa typ. 157 ± 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. (9 ± 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 (Notched Charpy impact test)	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.

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Thermal properties of parts

	As built	After age hardening [2]
Thermal conductivity	typ. 15 ± 0.8 W/m °C typ. 104 ± 6 Btu in/(h ft² °F)	typ. 20 ± 1 W/m °C typ. 139 ± 7 Btu in/(h ft² °F)
Specific heat capacity	typ. 450 ± 20 J/kg °C typ. 0.108 ± 0.005 Btu/(lb °F)	typ. 450 ± 20 J/kg °C typ. 0.108 ± 0.005 Btu/(lb °F)
Maximum operating temperature		approx. 400 °C approx. 750 °F

Abbreviations

typ.	typical
min.	minimum
approx.	approximately
wt	weight

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 as part of EOS' continuous development and improvement processes.

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