



## Material data sheet

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### EOS MaragingSteel MS1

EOS MaragingSteel MS1 is a tool steel powder intended for processing on EOS DMLS™ 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:

- EOS DMLS™ EOS M290 system
  - Ceramic blade (2200-3013)
  - Grid nozzle (2200-5501)
  - Nitrogen atmosphere
  - IPCM extra sieving module with 63 µm mesh recommended
- EOSYSTEM:
  - EOSPRINT v 1.5 (Build9) or higher
  - HCS v 2.5.22 or higher
- EOS Parameter set: MS1\_040\_FlexM290\_200

### Description

Parts built in EOS MaragingSteel MS1 have a chemical composition following 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 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 – e.g. solution treatment at 940 °C (1724 °F) for 2 hours – see Technical Data for examples.



## Material data sheet

### Technical Data

#### Powder properties

The chemical composition of the powder (wt-%):

#### Material composition

Element	Min	Max
Fe	Balance	
Ni	17.00	19.00
Co	8.50	9.50
Mo	4.50	5.20
Ti	0.60	0.80
Al	0.05	0.15
Cr	-	0.50
Cu	-	0.50
C		0.03
Mn		0.10
Si		0.10
P		0.01
S		0.01

#### Max. particle size

> 63 $\mu$ m [1]

max 0.5 wt.-%

[1] Sieve analysis according to ASTM B214.



## Material data sheet

### General process data

Layer thickness	40 $\mu\text{m}$
Volume rate [2]	4.2mm <sup>3</sup> /s (15.2cm <sup>3</sup> /h)

- [2] The volume rate is a measure of build speed during laser exposure of the skin area. The total build speed depends on this volume rate and many other factors such as exposure parameters of contours, supports, up and downskin, recoating time, Home-In or LPM settings.

### Physical and chemical properties of parts\*

Part density [3]	8.0-8.1 g/cm <sup>3</sup>
Part accuracy [4]	
Small parts	Approx. $\pm 50 \mu\text{m}$
Large parts	Approx $\pm 0.1 \%$
Min. wall thickness [5]	Approx. 0.3 - 0.4 mm
Surface roughness after shot peening [6]	Ra 4-6.5 $\mu\text{m}$ ; Rz 20-50 $\mu\text{m}$

- [3] Weighing in air and water according to ISO 3369.
- [4] Based on users' experience of dimensional accuracy for typical geometries, e.g.  $\pm 50 \mu\text{m}$  when parameters can be optimized for a certain class of parts or  $\pm 0.1\%$  when building a new kind of geometry for the first time or building larger parts. Part accuracy is subject to appropriate data preparation and postprocessing.
- [5] Mechanical stability is dependent on geometry (wall height etc.) and application.
- [6] Measurement according to ISO 4287. Due to the layerwise building the roughness strongly depends on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect.

### Hardness in heat treated status\* [7]

Hardness Rockwell C [8]	50-57 HRC
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- [7] Heat treatment procedure: solution treatment at 940 °C (1724 °F) for 2 hours, air cooling + ageing at 490 °C for 6 hours, air cooling.
- [8] Rockwell C (HRC) hardness measurement according to EN ISO 6508-1 on polished surface.



## Material data sheet

### Tensile properties at room temperature\* [9, 10, 11]

	Heat treated [7]	
	Horizontal	Vertical
Ultimate tensile strength, Rm	2080 MPa	2080 MPa
Yield strength, Rp0.2	2010 MPa	2000 MPa
Elongation at break, A	4 %	4 %

[9] Tensile testing according to. ISO 6892-1 B10, proportional test pieces, diameter of the neck area 5 mm (0.2 inch) , original gauge length 25 mm (1 inch). Results are derived from the validation data made with EOS M290 system and two powder LOTs.

[10] Solution and ageing treatments are needed in order to achieve corresponding mechanical properties. The numbers are average values determined from samples with horizontal and vertical orientation respectively.

[11] Mechanical properties depend on the thermal load of particular job layout as well as the positioning on the platform.



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### Abbreviations

Min.	Minimum
Max.	Maximum
Approx.	Approximately
Wt.	Weight

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This powder has not been developed, tested or certified as a medical device according to Directive 93/42/EEC (MDD) or Regulation (EU) 2017/745 (MDR) and is not intended to be used as a medical device, in particular for the purposes specified in Art. 2 No. 1 MDR. Insofar as you intend to use the powder as raw material for the manufacture of pharmaceutical products or medical devices (e.g. as raw material which as a material must meet the requirements of Annex 1, Chapter II MDR), the responsibility and liability for all analyses, tests, evaluations, procedures, risk assessments, conformity assessments, approval and certification procedures as well as for all other official and regulatory measures required for this purpose shall lie solely with you both with regard to the pharmaceutical product and/or medical device manufactured by you and with regard to the properties, suitability, testing, evaluation, risk assessment, other requirements for use of the powder as raw material. This also applies to applications with food contact. In this respect, the limitations of liability pursuant to our General Terms and Conditions and the system sales or material contracts shall apply.

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## Material data sheet

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### 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 280 400W  
with PSW 3.6 and EOS Original Parameter Set MS1\_Performance 1.0 or MS1\_Speed 1.0
- EOS M290 400W  
with EOSPRINT 1.0 and Parameter Set MS1\_Performance 1.0 or MS1\_Speed 1.0

### 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 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.

## Material data sheet

### Technical data

#### General process data

Typical achievable part accuracy [1], [8]	
- 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. $\pm 0.002$ inch
Age hardening shrinkage [2], [8]	approx. 0.08 %
Min. wall thickness [3], [8]	approx. 0.3 – 0.4 mm approx. 0.012 – 0.016 inch
Surface roughness (approx.) [4]	
- as manufactured	
MS1 Performance (40 $\mu\text{m}$ )	$R_a$ 5 $\mu\text{m}$ ; $R_z$ 28 $\mu\text{m}$ $R_a$ 0.19 $\times 10^{-3}$ inch, $R_z$ 1.10 $\times 10^{-3}$ inch
MS1 Speed (50 $\mu\text{m}$ )	$R_a$ 9 $\mu\text{m}$ ; $R_z$ 50 $\mu\text{m}$ $R_a$ 0.47 $\times 10^{-3}$ inch, $R_z$ 2.36 $\times 10^{-3}$ inch
- after shot-peening	$R_a$ 4 – 6.5 $\mu\text{m}$ ; $R_z$ 20 – 50 $\mu\text{m}$ $R_a$ 0.16 – 0.26 $\times 10^{-3}$ inch $R_z$ 0.78 – 1.97 $\times 10^{-3}$ inch
- after polishing	$R_z$ up to < 0.5 $\mu\text{m}$ $R_z$ up to < 0.02 $\times 10^{-3}$ inch (can be very finely polished)
Volume rate [5]	
- Parameter set MS1_Performance (40 $\mu\text{m}$ )	4.2 $\text{mm}^3/\text{s}$ (15.1 $\text{cm}^3/\text{h}$ ) 0.92 $\text{in}^3/\text{h}$
- Parameter set MS1_Speed 1.0 (50 $\mu\text{m}$ )	5.5 $\text{mm}^3/\text{s}$ (19.8 $\text{cm}^3/\text{h}$ ) 1.21 $\text{in}^3/\text{h}$

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

## Material data sheet

- [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 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 $\leq$ 0.5 wt-%) C ( $\leq$ 0.03 wt-%) Mn, Si (each $\leq$ 0.1 wt-%) P, S (each $\leq$ 0.01 wt-%)
Relative density	approx. 100 %
Density	8.0 - 8.1 g/cm <sup>3</sup> 0.289 - 0.293 lb/in <sup>3</sup>



## Material data sheet

### Mechanical properties of parts at 20 °C ( 68°F )\* [8]

	As built
<b>Tensile strength [6]</b>	
- in horizontal direction (XY)	typ. 1200 ± 100 MPa typ. 160 ± 15 ksi
- in vertical direction (Z)	typ. 1100 ± 150 MPa typ. 160 ± 22 ksi
<b>Yield strength (Rp 0.2 %) [6]</b>	
- in horizontal direction (XY)	typ. 1100 ± 100 MPa typ. 1xx ± 22 ksi
- in vertical direction (Z)	typ. 930 ± 150 MPa typ. 145 ± 22 ksi
<b>Elongation at break [6]</b>	
- in horizontal direction (XY)	typ. (12 ± 4 ) %
- in vertical direction (Z)	x
<b>Modulus of elasticity [6]</b>	
- in horizontal direction (XY)	typ. 150 ± 25 GPa typ. 22 ± 4 Msi
- in vertical direction (Z)	typ. 140 ± 25 GPa typ. 20 ± 4 Msi
<b>Hardness [7]</b>	typ. 33 - 37 HRC

[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.

[8] Hint: these properties were determined on an EOSINT M 280-400W. Test parts from machine type EOS M 290-400W correspond with these data.

## Material data sheet

### 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. $750 \text{ }^\circ\text{F}$

### Abbreviations

typ.	typical
min.	minimum
approx.	approximately
wt	weight

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This also applies to applications with food contact. In this respect, the limitations of liability pursuant to our General Terms and Conditions and the system sales or material contracts shall apply.

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## EOS MaragingSteel MS1 for EOS M 300-4

# EOS MaragingSteel MS1

## EOS M 300-4 | 50 µm

Parts built with EOS MaragingSteel MS1 are 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.



### Main Characteristics

- The parts are easily post-hardened to more than 50 HRC
- The parts can be machined, spark-eroded, welded, micro shot-peened, polished and coated
- Chemical composition corresponding to 18Ni300 and M300

### Typical Applications

- Injection molding tools & inserts
- Mechanical engineering parts

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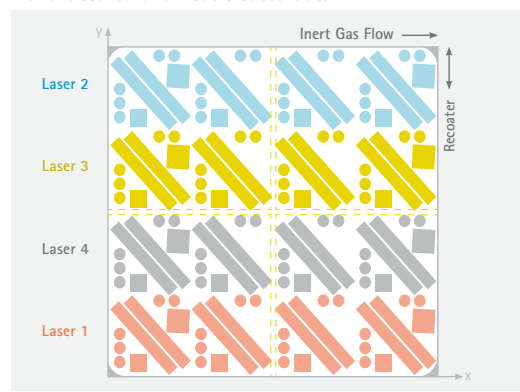
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### Product Information

DMLS System	EOS M 300-4
Material	EOS MaragingSteel MS1
Process	50 µm layer thickness
Inert Gas	Nitrogen
Recoater blade	ceramic, two-sided recoating
Volume rate	up to 4 x 5.5 mm <sup>3</sup> /s

### Layout of test job

Part properties based on one test job each for the as manufactured and heat treated data.



Typical part properties	Yield strength Rp <sub>0.2</sub> [MPa]	Tensile strength Rm [MPa]	Elongation at break A [%]	Number of samples
As manufactured vertical	860	1,100	12	80
As manufactured horizontal	980	1,200	13	32
Heat treated vertical	1,990	2,110	3	70
Heat treated horizontal	2,040	2,120	4	18
Max. pore size		90 µm		32
Porosity		0.05 %		32

Mechanical properties tested according to EN ISO 6892-1 B10. The values in the table are average values and dependent on the thermal load of the job layout as well as the position on the build plate. Heat treatment procedure by solution treatment at 940 °C (1,724 °F) for 2 hours, air cooling to room temperature, age-hardening at 490 °C (914 °F) for 6 hours, air cooling.

Status 11/2020

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The quoted values refer to the use of this material with above specified type of EOS DMLS system, EOSYSTEM and EOSPRINT software version, parameter set and operation in compliance with parameter sheet and operating instructions. Part properties are measured with specified measurement methods using defined test geometries and procedures. Further details of the test procedures used by EOS are available on request. Any deviation from these standard settings may affect the measured properties. The data correspond to EOS knowledge and experience at the time of publication and they are subject to change without notice as part of EOS' continuous development and improvement processes. EOS does not warrant any properties or fitness for a specific purpose, unless explicitly agreed upon. This also applies regarding any rights of protection as well as laws and regulations.





## Material data sheet – FlexLine

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### EOS MaragingSteel MS1

EOS MaragingSteel MS1 is a tool steel powder intended for processing on EOS DMLS 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:

- EOS M400 system
- EOSYSTEM: EOSPRINT v.1.2
- EOS Parameter set MS1\_050\_FlexM400\_1.0

### 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 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.



## Material data sheet – FlexLine

### Technical Data

#### Powder properties

The chemical composition of the powder (wt-%):

#### Material composition

Element	Min	Max
Fe	Balance	
Ni	17.00	19.00
Co	8.50	9.50
Mo	4.50	5.20
Ti	0.60	0.80
Al	0.05	0.15
Cr	-	0.50
Cu	-	0.50
C	-	0.03
Mn	-	0.10
Si	-	0.10
P	-	0.01
S	-	0.01

#### Max. particle size

> 63µm [1]

max 0.5 wt.-%

[1] Sieve analysis according to ASTM B214.



## Material data sheet – FlexLine

### General process data

Layer thickness	50 µm
Volume rate [2]	5.5 mm <sup>3</sup> /s (19.8 cm <sup>3</sup> /h)
[2] The volume rate is a measure of build speed during laser exposure of the skin area. The total build speed depends on this volume rate and many other factors such as exposure parameters of contours, supports, up and downskin, recoating time and Home-In settings.	

### Physical properties of parts\*

Part density [3]	8.0–8.1 g/cm <sup>3</sup>
Surface roughness as-manufactured [4]	
horizontal upskin surface	R <sub>a</sub> 9 µm; R <sub>z</sub> 60 µm
vertical surface	R <sub>a</sub> 9 µm; R <sub>z</sub> 45 µm
[3] Weighing in air and water according to ISO 3369.	
[4] Measurement according to ISO 4287. Due to the layerwise building the roughness strongly depends on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect.	

### Hardness in heat treated status\* [5]

Hardness Rockwell C [6]	50–56 HRC
[5] Heat treatment procedure: Ageing temperature 490 °C (914 °F), 6 hours, air cooling	
[6] Rockwell C (HRC) hardness measurement according to EN ISO 6508-1 on polished surface	



## Material data sheet – FlexLine

### Tensile data at room temperature\* [7, 8]

	As built	Heat treated [5]
Ultimate tensile strength, Rm	1200 MPa	2080±100 MPa
Yield strength, Rp0.2	1070 MPa	2030±100 MPa
Elongation at break A [9]	11 %	2 ± 1 %

[7] The numbers are average values and are determined from samples with horizontal and vertical orientation.

[8] Tensile testing according to. ISO 6892-1:2009 B10, proportional test pieces, diameter of the neck area 5 mm (0.2 inch) , original gauge length 25 mm (1 inch).

[9] Elongation values depends on the thermal load of particular job layout





## Material data sheet – FlexLine

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### Abbreviations

min. minimum

max. maximum

wt. weight

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## Material data sheet

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### EOS MaragingSteel MS1

EOS MaragingSteel MS1 is a tool steel powder intended for processing on EOS DMLS™ systems.

This document provides information and data for parts built using

- EOS Powder: EOS MaragingSteel MS1 (EOS art.-no. 9011-0016)
- EOS Laser Sintering Machine: EOS M400-4
  - Ceramic Blade (EOS art.-no. 300007622)
  - DirectBase S40 Building Platform (EOS art.-no. 300000729)
  - Nitrogen atmosphere
  - 63 µm mesh for powder sieving recommended (EOS art.-no. 9044-0032 for IPCM M Extra Sieving Module or EOS art.-no. 200001059 for IPM M Powder Station L)
  - EOSYSTEM v. 2.5\* or higher
- EOS Software:
  - EOSPRINT v. 1.6 (EOS art.-no. 7501-4031) or higher
- EOS Process:
  - MS1 ParameterEditor (EOS art.-no. 7500-3068)
  - Name of the Default Job: MS1\_040\_FlexM404\_100.eosjob

\* EOSYSTEM v. 2.6 or higher enables EOSPRINT v. 2.0 (EOS art.-no. 7012-0119) or higher usage

### Description

EOS MaragingSteel MS1 has a chemical composition following 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 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.

## Material data sheet

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

#### Powder properties

The chemical composition of the powder (wt-%):

#### Material composition

Element	Min	Max
Fe	Balance	
Ni	17.00	19.00
Co	8.50	9.50
Mo	4.50	5.20
Ti	0.60	0.80
Al	0.05	0.15
Cr	-	0.50
Cu	-	0.50
C		0.03
Mn		0.10
Si		0.10
P		0.01
S		0.01

#### Max. particle size

> 63µm [1]

max 0.5 wt.-%

[1] Sieve analysis according to ASTM B214.

## Material data sheet

### General process data

Layer thickness	40 $\mu\text{m}$
Volume rate [2]	Up to 4 x 4.2 mm <sup>3</sup> /s (4 x 15.1 cm <sup>3</sup> /h)

- [2] The volume rate is a measure of build speed during laser exposure of the skin area. The total build speed depends on this volume rate and other factors such as exposure parameters of contours, supports, up- and downskin, recoating time, Home-In or LPM settings, job design (load, part geometry or overlap settings).

### Physical and chemical properties of parts\*

Part density [3]	8.0-8.1 g/cm <sup>3</sup>
Part accuracy [4]	
Small parts	Approx. $\pm 50 \mu\text{m}$
Large parts	Approx $\pm 0.1 \%$
Min. wall thickness [5]	Approx. 0.3 - 0.4 mm
Surface roughness after shot peening [6]	Ra 4-6.5 $\mu\text{m}$ ; Rz 20-50 $\mu\text{m}$

- [3] Weighing in air and water according to ISO 3369.

- [4] Based on users' experience of dimensional accuracy for typical geometries, e.g.  $\pm 50 \mu\text{m}$  when parameters can be optimized for a certain class of parts or  $\pm 0.1\%$  when building a new kind of geometry for the first time or building larger parts. Part accuracy is subject to appropriate data preparation and postprocessing.

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

- [6] Measurement according to ISO 4287. Due to the layerwise building the roughness strongly depends on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect.

### Hardness in heat treated status\* [7]

Hardness Rockwell C [8]	50-57 HRC
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- [7] Heat treatment procedure: Ageing temperature 490 °C 6 hours, air cooling

- [8] Rockwell C (HRC) hardness measurement according to EN ISO 6508-1 on polished surface



## Material data sheet

### Tensile data at room temperature\* [9,10]

<b>As built</b>		
	<b>Horizontal</b>	<b>Vertical</b>
Ultimate tensile strength, Rm	1200 MPa	1200 MPa
Yield strength, Rp0.2	1020 MPa	1050 MPa
Elongation at break, A [11]	13 %	11 %

<b>Heat treated [7]</b>		
	<b>Horizontal</b>	<b>Vertical</b>
Ultimate tensile strength, Rm	2060 MPa	2080 MPa
Yield strength, Rp0.2	1990 MPa	2010 MPa
Elongation at break, A [11]	4 %	3 %

[9] Tensile testing according to ISO 6892-1 B10, proportional test pieces, diameter of the neck area 5 mm, original gauge length 25 mm.

[10] The numbers are average values determined from samples with horizontal and vertical orientation respectively

[11] Elongation values depend on the thermal load of particular job layout as well as the positioning on the platform.



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### Abbreviations

Min.	Minimum
Max.	Maximum
Approx.	Approximately
Wt.	Weight

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