SLM SOLUTIONS

316L

ASTM A276 / DIN EN 10088 / 1.4404

MATERIAL DATA SHEET

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MATERIAL

316L is one of the most commonly used stainless steels and already around for a good century. Due to its outstanding corrosion resistance, versatility, and a well-balanced mix of both mechanical and welding properties, it already made its way into multiple industries: automotive, chemical industries, energy, general transportation, and many more. Whenever an application requires a premium resistance against corrosion, especially when in contact with acids, chlorine or hydrogen, 316L stainless steel is a suitable, long-lasting solution.

CHEMICAL COMPOSITION

ASTM A276[1]	Fe	Cr	Ni	Mo	Mn	Si	P	C	S	N
Min.	Bal.	16.00	10.00	2.00						
Max.		18.00	14.00	3.00	2.00	1.00	0.045	0.030	0.030	-

DIN EN 10088[1]	Fe	Cr	Ni	Mo	Mn	Si	P	C	S	N
Min.	Bal.	16.5	10.0	2.00						
Max.		18.5	13.0	2.50	2.00	1.00	0.045	0.030	0.030	0.10

POWDER PROPERTIES

Particle Size[1]	10 - 45 µm
Mass Density[2]	≈ 7.9 g/cm³
Particle Shape[3]	Spherical

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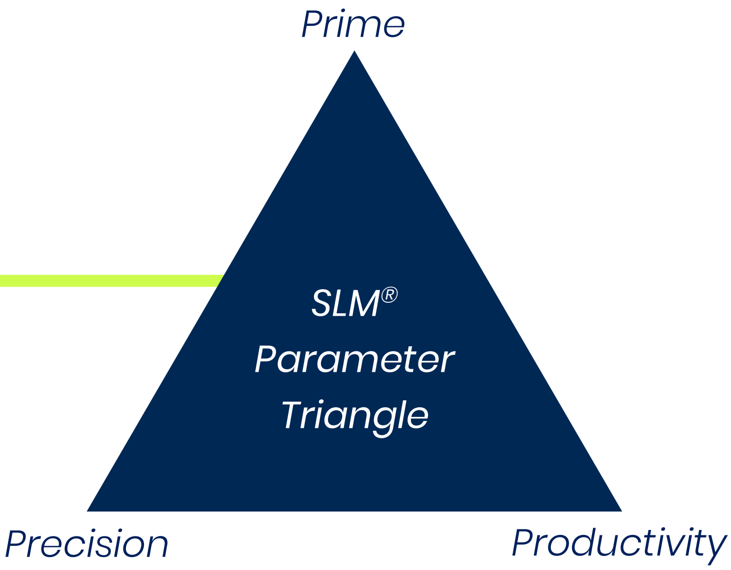
SLM® PARAMETERS

It only takes 3 tools to make you successful with metal additive manufacturing:

1. The **SLM® machine** fitting your needs,
2. The **metal powder** that defines the later purpose and functionality of a part,
3. Precisely engineered **SLM® parameters** as the missing link.

Our open parameters are the result of our vast experience in multi-laser technology and a diligent development and qualification procedure. They are key to produce fully functional parts with properties you can expect and rely on – whether you are new to AM or a large-scale production operator. We offer them in three categories to you: from high-resolution complex details (**Precision**) up to the highest build rates (**Productivity**) or right in between (**Prime**).



MATERIAL QUALIFICATION

As one of the inventors of the selective laser melting process, we impose the most comprehensive test procedures on ourselves: hundreds of samples, multiple systems, various powder batches, numerous heat-treatments, machined vs. near-net-shape tensile specimens, several surface roughness conditions and angles, fatigue behavior, corrosion investigation, creep testing... Did we miss anything? Get in touch with us!

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PRECISION

Parameter Set	316L_PREC_MBP3_V1.0 (30 µm, 400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[4]	10.4 cm³/h
Minimum Relative Density[5]	99.8 %

Mechanical Properties[6]

M: Mean | SD: Standard deviation

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	SD	M	SD	M	SD
Horizontal	695	5	590	20	39	3
Vertical	615	5	540	5	45	3

Hardness[7]

M: Mean | SD: Standard Deviation

	Vickers hardness HV10	
	M	SD
NHT	221	4

Surface Roughness[8]

M: Mean | SD: Standard Deviation

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	SD	M	SD
As built	8	2	68	10
Corundum	6	2	40	6
Corundum + Glass bead	5	1	30	5

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PRIME

Parameter Set	316L_PRIM_MBP3_V1.0 (50 µm, 400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[4]	15.3 cm³/h
Minimum Relative Density[5]	99.6 %

Mechanical Properties[6]

M: Mean | SD: Standard deviation

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	SD	M	SD	M	SD
Horizontal	650	5	545	10	41	2
Vertical	640	10	525	15	43	2

Hardness[7]

M: Mean | SD: Standard Deviation

	Vickers hardness HV10	
	M	SD
NHT	211	4

Surface Roughness[8]

M: Mean | SD: Standard Deviation

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	SD	M	SD
As built	9	3	71	13
Corundum	7	2	54	11
Corundum + Glass bead	6	2	44	7

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PRODUCTIVITY

Parameter Set	316L_PROD_MBP3_V1.0 (60 µm, 400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[4]	24.6 cm³/h
Minimum Relative Density[5]	99.3 %

Mechanical Properties[6]

M: Mean | SD: Standard deviation

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	SD	M	SD	M	SD
Horizontal	670	20	555	15	40	5
Vertical	615	20	495	15	44	5

Hardness[7]

M: Mean | SD: Standard Deviation

	Vickers hardness HV10	
	M	SD
NHT	215	5

Surface Roughness[8]

M: Mean | SD: Standard Deviation

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	SD	M	SD
As built	12	5	83	18
Corundum	10	3	63	7
Corundum + Glass bead	9	2	57	6

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DISCLAIMER

The properties and mechanical characteristics apply to powder that is tested and sold by SLM Solutions, and that has been processed on SLM Solutions machines using the original SLM Solutions parameters in compliance with the applicable operating instructions (including installation conditions and maintenance). The part properties are determined based on specified procedures. More details about the procedures used by SLM Solutions are available upon request.

The specifications correspond to the most recent knowledge and experience available to us at the time of publication and do not form a sufficient basis for component design on their own. Certain properties of products or parts or the suitability of products or parts for specific applications are not guaranteed. The manufacturer of the products or parts is responsible for the qualified verification of the properties and their suitability for specific applications. The manufacturer of the products or parts is responsible for protecting any third-party proprietary rights as well as existing laws and regulations.

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CONTACT

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NOTES

[1] With respect to powder material. Compositions stated as mass or weight percent.

[2] Material density varies within the range of possible chemical composition variations.

[3] According to DIN EN ISO 3252:2001.

[4] Theoretical system build rate = layer thickness x scan speed x hatch distance x number of lasers. The value represents a comparable indicator but remains a theoretical value after all. It does expressively not reflect true build rates, which are influenced by part geometry, ratio between hatch and contour areas, area of exposure, recoating times, and more.

[5] Optical density determination at test specimens by light microscopy according to internal specification. Relative density may vary depending on part geometry, orientation, volume, and other process factors.

[6] Tensile testing was performed in accordance to DIN EN ISO 6892-1:2017 B and conducted at room temperature. Samples are either machined before testing or tested in near-net-shape without any surface finishing (geometry according to DIN 50125:2016-D6x30). Values include overlap samples, i.e. multiple lasers work simultaneously on one specimen. All data is derived from standardized SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.

[7] Hardness testing according to DIN EN ISO 6507-1:2018. Measurement direction “2” according to VDI 3405 2.1. Values include overlap samples, i.e. multiple lasers work simultaneously on one specimen. All data is derived from standardized SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.

[8] Roughness measurement on vertical walls according to DIN EN ISO 4288:1998; $\lambda c = 2.5$ mm. Glass bead blasting is an additional post-processing step after corundum blasting. Values include overlap samples, i.e. multiple lasers work simultaneously on one specimen. All data is derived from standardized SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.