316L

ASTM A276 / DIN EN 10088 / 1.4404

MATERIAL DATA SHEET

Nikon SLM SOLUTIONS

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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.

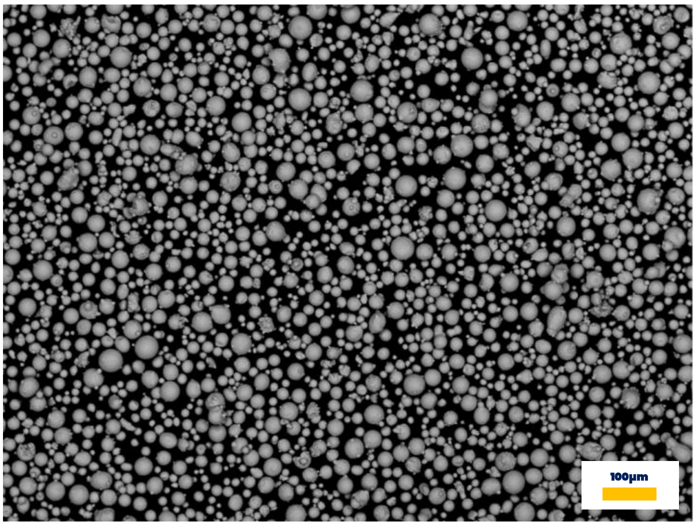
CHEMICAL COMPOSITION

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[3,4]	Spherical, typical batch morphology displayed below



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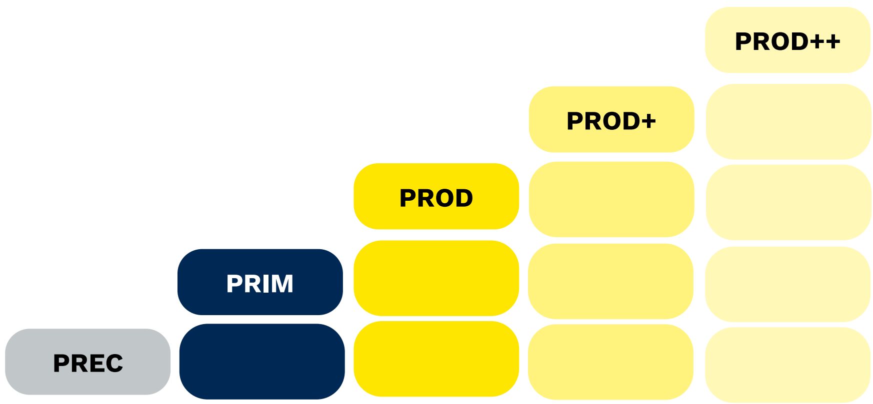
NIKON SLM® PARAMETERS

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

1. The **NIKON SLM® machine** fitting your needs,
2. The **metal powder** that defines the later purpose and functionality of a part,
3. Precisely engineered **NIKON 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 to you in the following categories: **Precision (PREC)** for high-resolution complex details, **Prime (PRIM)** for balanced properties with improved productivity and **Productivity (PROD)** for the highest build rates. Pushing boundaries is in our work culture, we can also offer a new dimension of productivity on selected materials with **Productivity+ (PROD+)** and **Productivity++ (PROD++)** parameters.



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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SLM® 280 PRECISION

Parameter Set	316L_PREC_MBP3_V1.0 (30 µm)
Machine Compatibility	SLM® 280 2.0, SLM® 280 Production System (400W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	20.8 cm³/h (Twin)
Minimum Relative Density[6,8]	99.8 %

MECHANICAL PROPERTIES[7]

PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95% population coverage / 95% confidence level)[8]

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	**M**	**MIN**	**M**	**MIN**	**M**	**MIN**
Horizontal	670	640	570	545	41	31
Vertical	605	580	520	490	45	41

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[8]

	Vickers hardness HV10	
	M	**MIN**
NHT	220	205

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[8]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	**MAX**	**M**	**MAX**
As built	6	10	36	65

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SLM® 280 PRECISION

Parameter Set	316L_PREC_MBP3_V1.0 (30 µm)
Machine Compatibility	SLM® 280 2.0, SLM® 280 Production System (400W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	20.8 cm³/h (Twin)
Minimum Relative Density[6,8]	99.8 %

MECHANICAL PROPERTIES[7]

PROCESS GAS: NITROGEN

M: Mean | MIN: Minimum (95% population coverage / 95% confidence level)[8]

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Horizontal	690	640	575	545	34	32
Vertical	620	580	520	490	42	39

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[8]

	Vickers hardness HV10	
	M	MIN
NHT	227	205

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[8]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	7	10	40	65

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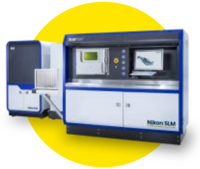

SLM® 500 PRIME

Parameter Set	316L_SLM500_PRIM_MBP3_V1 (60 µm)
Machine Compatibility	SLM® 500 (400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	98.9 cm³/h (Quad)
Minimum Relative Density[6,8]	99.8 %

MECHANICAL PROPERTIES[7] — PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95% population coverage / 95% confidence level)[8]

Non-heat-treated (NHT)

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Horizontal	690	640	550	520	37	35
Vertical	645	570	490	460	43	36

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[8]

	Vickers hardness HV10	
	M	MIN
NHT	222	205

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[8]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	9	16	59	94

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NXG PRIME

Parameter Set	316L_NXG600_PRIM_MBP3_V1 (60 µm)
Machine Compatibility	NXG XII 600, NXG 600E (1000 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	310 cm³/h (12 Lasers)
Minimum Relative Density[6, 8]	99.9 %

MECHANICAL PROPERTIES[7] — PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95 % population coverage / 95 % confidence level)[8]

Non-heat-treated

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Vertical	615	605	495	485	40	33
Near-Net-Shape	M	MIN	M	MIN	M	MIN
Vertical	590	580	460	440	43	39

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[8]

	Vickers hardness HV5	
	M	MIN
NHT	219	213

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[8]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	7	11	50	72

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DISCLAIMER

The properties and mechanical characteristics apply to powder that is tested and sold by Nikon SLM Solutions, and that has been processed on Nikon SLM Solutions machines using the original Nikon 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 Nikon 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 3252:2023.

[4] Secondary Electron Image of a typical powder batch

[5] 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.

[6] 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. Population coverage: 99 %, confidence level: 99 %.

[7] Tensile testing was performed in accordance to DIN EN ISO 6892-1:2020 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 50125:2022-08 D6x30 and DIN 50125:2022-08 C6x30). Values include overlap samples, i.e. multiple lasers work simultaneously on one specimen. All data is derived from standardized Nikon SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.

[8] Minimum and maximum values are set by using tolerance interval method, which is a statistical approach based on the input of population coverage (PC) and confidence level (CL). Tolerance intervals ensure that a certain percentage of samples within a batch will be above the minimum or maximum value with a certain probability, e.g. the probability that 95 % of all samples will be above or below the stated minimum or maximum value (within a defined batch and tested according to mentioned specifications) is 95 %.

[9] Hardness testing according to DIN EN ISO 6507-1:2024. 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 Nikon SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.

[10] Roughness measurement on vertical walls according to DIN EN ISO 21920-3:2022; $\lambda c = 2.5$ 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 Nikon SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.