H13

ASTM A681 / AMS 6408 / 1.2344

MATERIAL DATA SHEET

Nikon SLM SOLUTIONS

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MATERIAL

Hard, harder, H13. This hot working tool steel is the right choice for applications requiring very high wear resistance, especially against abrasive wear, such as die casting molds or shear knives. A heat treatment is not mandatory, as the SLM® process transforms H13 powder into fully functional, crack-free parts already. If additional ductility or hardness is required, a simple heat treatment can be performed. Looking for the ultimate hardness? After nitriding, a surface hardness of up to 72 HRC can be achieved. Text about material

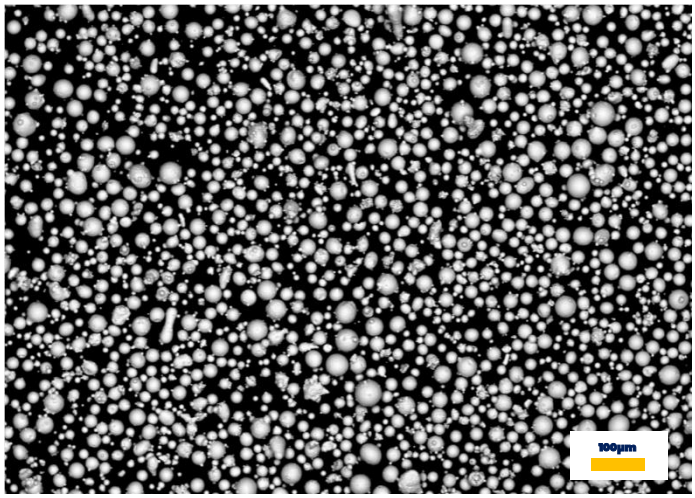
CHEMICAL COMPOSITION

ASTM A681[1]

	Fe	Cr	Mo	Si	V	Mn	C	P	S
Min.	Bal.	4.75	1.10	0.80	0.80	0.20	0.32		
Max.		5.50	1.75	1.20	1.20	0.60	0.45	0.03	0.03

POWDER PROPERTIES

Particle Size[1]	10-45 µm
Mass Density[2]	≈ 8.0 g/cm³
Particle Shape[3,4]	Spherical, typical batch morphology displayed below



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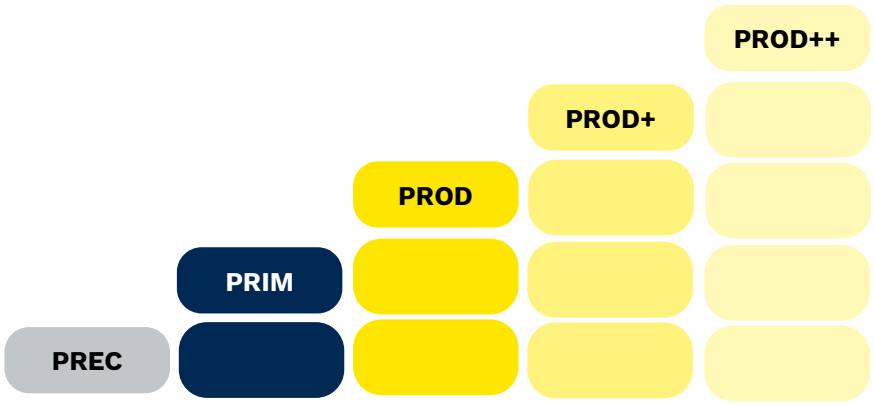
NIKON SLM® PARAMETERS

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	H13_SLM280_PREC_MBP3_V1 (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]	20.6 cm^3/h (Twin)
Minimum Relative Density[6,7]	99.8 %

MECHANICAL PROPERTIES[8]

PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95 % population coverage / 95 % confidence level)[7]

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	1910	1720	1080	920	6	0
Vertical	1920	1670	990	780	6	1

Heat-treated (HARD)[11]

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	**M**	**MIN**	**M**	**MIN**	**M**	**MIN**
Horizontal	1885	1785	1530	1400	9	4
Vertical	1890	1805	1540	1445	6	1

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[7]

	Vickers hardness HV5	
	M	**MIN**
As built	570	540
HARD[11]	560	540

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[7]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	**MAX**	**M**	**MAX**
As built	6	12	40	85
Glass Blasting	4	9	30	65

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SLM® 280 PRIME

Parameter Set	H13_SLM280_PRIM_MBP3_V2 (60 µm)
Machine Compatibility	SLM® 280 2.0, SLM® 280 Production System (400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	36.7 cm^3/h (Twin)
Minimum Relative Density[6,7]	99.9 %

MECHANICAL PROPERTIES[8]

PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95 % population coverage / 95 % confidence level)[7]

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	1990	1930	1030	900	9	3
Vertical	1940	1740	955	775	8	1

Heat-treated (HARD2)[12]

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Horizontal	1840	1820	1445	1340	10	7
Vertical	1850	1745	1485	1380	8	4

Heat-treated (DA1)[13]

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Horizontal	2175	1980	1595	1420	7	2
Vertical	2180	2125	1680	1590	6	1

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[7]

	Vickers hardness HV5	
	M	MIN
NHT	549	530
HARD2[12]	555	545
DA1[13]	643	620

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[7]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	9	16	53	95

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SLM® 280 PRIME

Parameter Set	H13_SLM280_PRIM_MBP3_V2 (60 µm)
Machine Compatibility	SLM® 280 2.0, SLM® 280 Production System (400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	36.7 cm^3/h (Twin)
Minimum Relative Density[6,7]	99.9 %

MECHANICAL PROPERTIES[8]

PROCESS GAS: NITROGEN

M: Mean | MIN: Minimum (95 % population coverage / 95 % confidence level)[7]

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	1955	1815	1040	910	7	1
Vertical	1910	1650	1035	790	7	0

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[7]

	Vickers hardness HV5	
	M	MIN
NHT	555	540

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[7]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	9	16	53	95

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SLM® 280 PRODUCTIVITY

Parameter Set	H13_SLM280_PROD_MBP3_V1 (90 µm)
Machine Compatibility	SLM® 280 2.0, SLM® 280 Production Series (400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	65.6 cm^3/h (Twin)
Minimum Relative Density[6,7]	99.7 %

MECHANICAL PROPERTIES[8]

PROCESS GAS: ARGON

M: Mean | MIN: Minimum (95 % population coverage / 95 % confidence level)[7]

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	1695	1355	925	725	3	0
Vertical	1610	1125	1085	785	2	0

Heat-treated (HARD)[11]

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	M	MIN	M	MIN	M	MIN
Horizontal	1840	1750	1500	1415	9	5
Vertical	1815	1725	1495	1430	6	0

HARDNESS[9]

M: Mean | MIN: Minimum (95% Population Coverage / 95% Confidence Level)[7]

	Vickers hardness HV5	
	M	MIN
NHT	550	535
HARD[11]	570	550

SURFACE ROUGHNESS[10]

M: Mean | MAX: Maximum (95% Population Coverage / 95% Confidence Level)[7]

	Roughness average Ra [µm]		Mean roughness depth Rz [µm]	
	M	MAX	M	MAX
As built	7	11	47	70
Glass Blasting	6	10	40	60

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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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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 com-parable 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] Minimum or 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 value or below the maximum value with a certain probability, e.g. the probability that 95% of all samples will be above the minimum value or below the maximum value (within a defined batch and tested according to mentioned specifications) is 95%.

[8] 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.

[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 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.

[11] Heat treatment: Hardening for 45 min at 1040 °C, followed by gas quenching in nitrogen, hold for 4 h at 550 °C and air-cooling.

[12] Heat treatment: Hardening for 45 min at 1020 °C, followed by gas quenching in nitrogen, hold for 4 h at 550 °C and air-cooling.

[13] Heat treatment: Direct aging for 120 min at 575 °C, in air, followed by air cooling.