# 1.2709

ASTM A276 / M300

# MATERIAL DATA SHEET

Nikon SLM SOLUTIONS

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## MATERIAL

Tool steels are, by definition, used for tooling applications and require a high wear resistance, high hardness, and sufficient ductility. Depending on the media being processed, the martensitic maraging steel adds additional corrosion resistance. Regarding postprocessing, a variety of heat-treatments can be performed before machining and polishing. Besides tools and inserts, actual components with excellent strength for aerospace and automotive are a focus of this tool steel.

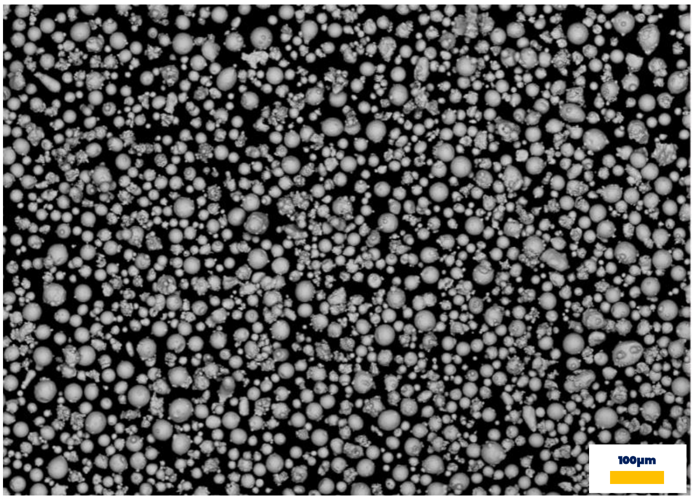
## CHEMICAL COMPOSITION

ASTM A646 / M300[1]

| | Fe | Ni | Co | Mo | Ti | Al | Mn | Si | C | P | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Min.** | Bal. | 18.00 | 8.50 | 4.70 | 0.50 | 0.05 | | | | | |
| **Max.** | | 19.00 | 9.50 | 5.20 | 0.80 | 0.15 | 0.10 | 0.10 | 0.03 | 0.01 | 0.01 |

## 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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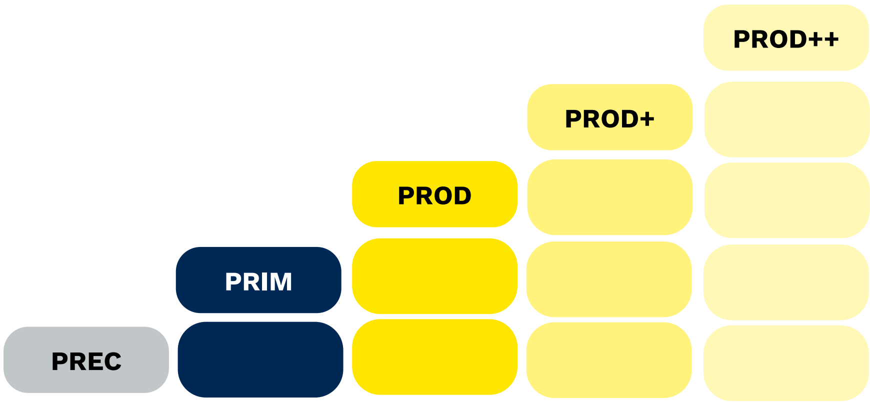
## NIKON SLM® PARAMETERS

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 | 1.2709_PREC_MBP3_V1.0 (30 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] | 20.8 cm³/h (Twin) |
| Minimum Relative Density[6,7] | 99.8 % |

## MECHANICAL PROPERTIES[8]

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** | 1250 | 1240 | 1000 | 945 | 16 | 14 |
| **Vertical** | 1240 | 1215 | 1055 | 990 | 13 | 9 |

## HARDNESS[9]

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

| | Vickers hardness HV10 | |
|---|---|---|
| | M | MIN |
| **As built** | 355 | 340 |

## 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** | 5 | 9 | 35 | 61 |

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## SLM® 280 PRIME

| | |
|---|---|
| Parameter Set | 1.2709_SLM280_PRIM_MBP3_V1 (50 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] | 30.6 cm$^3$/h (Twin) |
| Minimum Relative Density[6,7] | 99.9 % |

## MECHANICAL PROPERTIES[8]

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** | 1190 | 1160 | 960 | 890 | 15 | 13 |
| **Vertical** | 1135 | 1060 | 915 | 795 | 12 | 9 |
| Near-Net-Shape | **M** | **MIN** | **M** | **MIN** | **M** | **MIN** |
| **Vertical** | 1170 | 1155 | 1000 | 940 | 14 | 10 |

### Heat-treated (AGE)[11]

| | Tensile strength $R_m$ [MPa] | | Yield strength $R_{p0.2}$ [MPa] | | Elongation at break A [%] | |
|---|---|---|---|---|---|---|
| Machined | **M** | **MIN** | **M** | **MIN** | **M** | **MIN** |
| **Horizontal** | 1920 | 1875 | 1840 | 1775 | 6 | 3 |
| **Vertical** | 1955 | 1840 | 1870 | 1750 | 5 | 1 |

## HARDNESS[9]

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

| | Vickers hardness HV10 | |
|---|---|---|
| | **M** | **MIN** |
| **NHT** | 339 | 304 |
| **AGE[11]** | 572 | 562 |

## 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 | 19 | 63 | 127 |

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## SLM® 280 PRODUCTIVITY

| | |
|---|---|
| Parameter Set | 1.2709_PROD_MBP3_V1.0 (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] | 49.2 cm³/h (Twin) |
| Minimum Relative Density[6,7] | 99.3 % |

## MECHANICAL PROPERTIES[8]

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** | 1170 | | 935 | | 13 | |
| **Vertical** | 1095 | | 945 | | 11 | |

### Heat-treated (AGE)[11]

| | Tensile strength $R_m$ [MPa] | | Yield strength $R_{p0.2}$ [MPa] | | Elongation at break A [%] | |
|---|---|---|---|---|---|---|
| Machined | **M** | **MIN** | **M** | **MIN** | **M** | **MIN** |
| **Horizontal** | 1975 | | 1890 | | 6 | |
| **Vertical** | 1980 | | 1920 | | 4 | |

## HARDNESS[9]

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

| | Vickers hardness HV10 | |
|---|---|---|
| | **M** | **MIN** |
| **NHT** | 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** | 10 | | 61 | |
| **Corundum** | 5 | | 35 | |

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## NXG PRIME

| | |
|---|---|
| Parameter Set | 1.2709_NXG600_PRIM_MBP3_V0.8[12] (50 µm) |
| Machine Compatibility | NXG XII 600, NXG 600E (1000 W) |
| Validated Data Preparation | Materialise SLM Build Processor |
| Theoretical System Build Rate[5] | 186.3 cm³/h (12 Lasers) |
| Minimum Relative Density[6,7] | 99.8 % |

## MECHANICAL PROPERTIES[8]

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** | 1175 | 1130 | 985 | 905 | 15 | 11 |
| **Vertical** | 1160 | 1110 | 977 | 840 | 12 | 6 |
| Near-Net-Shape | **M** | **MIN** | **M** | **MIN** | **M** | **MIN** |
| **Vertical** | 1215 | 1200 | 1060 | 990 | 14 | 10 |

### Heat-treated (AGE)[11]

| | Tensile strength $R_m$ [MPa] | | Yield strength $R_{p0.2}$ [MPa] | | Elongation at break A [%] | |
|---|---|---|---|---|---|---|
| Machined | **M** | **MIN** | **M** | **MIN** | **M** | **MIN** |
| **Horizontal** | 1975 | 1910 | 1890 | 1795 | 7 | 3 |
| **Vertical** | 1935 | 1870 | 1865 | 1800 | 5 | 1 |

## HARDNESS[9]

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

| | Vickers hardness HV10 | |
|---|---|---|
| | **M** | **MIN** |
| **NHT** | 358 | 347 |
| **AGE[11]** | 562 | 551 |

## 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 | 12 | 43 | 63 |

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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 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 50125:2016-D6x30 and DIN 50125:2016-C6x30). 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.

[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 SLM Solutions qualification jobs. Samples are built out of both virgin powder as well as used powder.

[11] Heat treatment: age at 500°C +/-10°C for 6 h +0-0.5, followed by slow furnace cooling at 2 °C/min until 300°C, then cooling non-controlled in air. For scale-free or discoloration-free parts, air atmospheres, and air-cooling should be avoided. Acceptable protective atmospheres in accordance with AMS2759 are limited to helium, argon, hydrogen, nitrogen, or vacuum.

[12] Version 0.8 was qualified with a lower theoretical system build up rate of 62.1 $cm^3$/h, which can impact the thermal history of the parts.