A2024-RAM2C

MATERIAL DATA SHEET

Nikon SLM SOLUTIONS

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MATERIAL

A2024-RAM2C is a high-strength aluminum material that also combines good ductility and wear resistance. Due to the added ceramic, A2024-RAM2C is highly suited for structural parts at elevated temperatures, such as engine components. The material is heat treatable to achieve best properties.

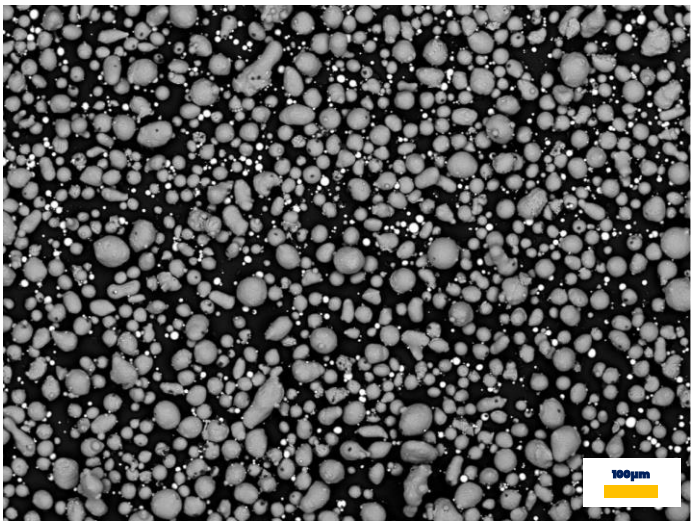
CHEMICAL COMPOSITION

Customized[1]

	Al	Cr	Cu	Fe	Mg	Mn	Si	Zn	RAM	Total each	Total others
Min.	Bal.	max.	3.80	max.	1.20	0.25	max.	max.	4.0	max.	max.
Max.		0.10	4.80	0.30	1.80	0.90	0.15	0.25		0.05	0.15

POWDER PROPERTIES

Particle Size[1]	20-63 µm
Mass Density[2]	≈ 2.85 g/cm³
Particle Shape[3,4]	Spherical, typical batch morphology displayed below



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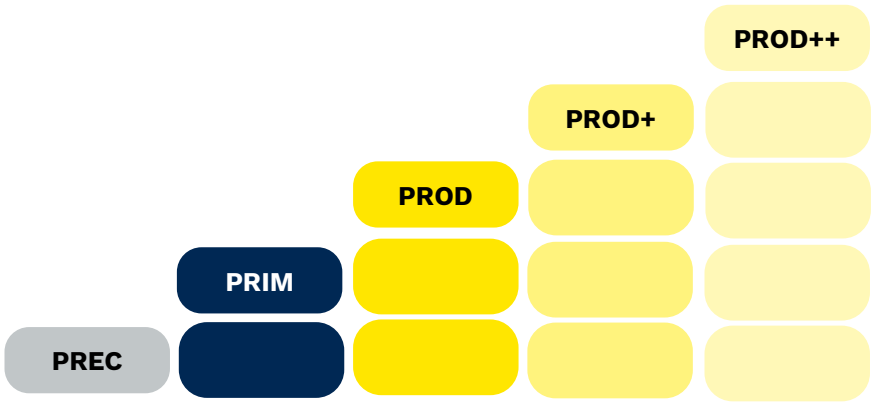
NIKON SLM® PARAMETERS

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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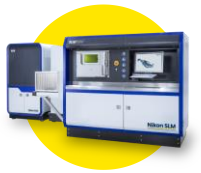

SLM® 500 PRECISION

Parameter Set	A2024-RAM2C_SLM500_PREC_MBP3_V1 (30 µm)
Machine Compatibility	SLM® 500 1.3 (400 W)
Validated Data Preparation	Materialise SLM Build Processor
Theoretical System Build Rate[5]	90.4 cm^3/h (Quad)
Minimum Relative Density[6,7]	99.5 %

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	355	325	305	265	12	9
Vertical	375	330	295	260	11	8

Heat-treated (T6)[9]

	Tensile strength R_m [MPa]		Yield strength $R_{p0.2}$ [MPa]		Elongation at break A [%]	
Machined	**M**	**MIN**	**M**	**MIN**	**M**	**MIN**
Horizontal	495	475	350	305	9	5
Vertical	480	460	355	325	5	2

HARDNESS[10]

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

	Vickers hardness HV5	
	M	**MIN**
NHT	110	99
Heat treated[9]	148	144

SURFACE ROUGHNESS[11]

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	19	32	121	184

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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. Special handling of the powder during the process chain is recommended to limit or prevent segregation of the RAM ceramic components. 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 3252:2001.

[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] 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). 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] T6 heat treatment, consisting of a Solution Treatment at 500°C ± 5°C with approximately 15°C per min ramp rate, hold at 500°C for 1.5 hours, then quench in cold water, followed by Artificial Aging, place parts in furnace at 165°C ± 5°C, hold at this temperature for 24 hours, then air cool.

[10] 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.

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[11] Roughness measurement on vertical walls according to DIN EN ISO 21920-3:2022; λc = 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.