13 Al

22 Ti | 24 Cr | 26 Fe | 27 Co | 28 Ni | 29 Cu

M2 Series 5 Nickel 718

Parameters for GE Additive's Concept Laser M2 Series 5

Data in this material datasheet represents material built with 25 and 50 µm layer thicknesses and in a nitrogen atmosphere on a Concept Laser M2 Series 5 single-laser or dual-laser machine. Values listed are typical.

Nickel 718

Nickel chromium superalloys like 718 are often used in high-stress, high-temperature aeronautical, petrochemical and auto racing environments. The excellent high temperature strength and creep resistance derive from precipitation hardening of finely dispersed precipitates. Next to that Alloy 718 is a metal that is also highly resistant to the corrosive effects of hydrochloric acid and sulfuric acid. The favorable weldability of Alloy 718 makes this alloy suitable for additive manufacturing as well. Typical applications are high-quality components designed for thermally challenging environments such as rocket engines, gas-turbine hot sections, and heat exchangers.

M2 Series 5 Nickel 718

The Alloy 718 parameters for the Concept Laser M2 Series 5 are developed leveraging the performance of the previous M2 generations. The base parameters deliver good surface quality while maintaining a very good density and productivity. For highest all-around surface quality the surface parameter has been developed. The hybrid parameter can significantly increase the productivity of parts having a high volume/surface ratio and still meeting highest surface quality requirements. Parameter 316 is optimized for steel recoater and highest productivity. All parameters succeed the minimum tensile properties specified in ASTM F3055 for additive manufactured parts in the heat treated state.

M2 Series 5 Nickel 718

With corresponding approval* Nickel 718 can be used for manufacturing components for high-temperature applications.

Data in this material datasheet represents material built with 25 and 50 µm layer thicknesses and in a nitrogen atmosphere on a Concept Laser M2 Series 5 single-laser or dual-laser machine. Values listed are typical.

POWDER CHEMISTRY

Nickel 718 powder chemical composition according to ASTM B 637 UNS N07718
For additional information on Nickel 718 powder, visit www.advancedpowders.com/powders/nickel/718.

MACHINE CONFIGURATION

- Concept Laser M2 Series 5 (single-laser or dual-laser)
- Nitrogen gas
- Rubber/ Steel recoater blade

AVAILABLE PARAMETERS

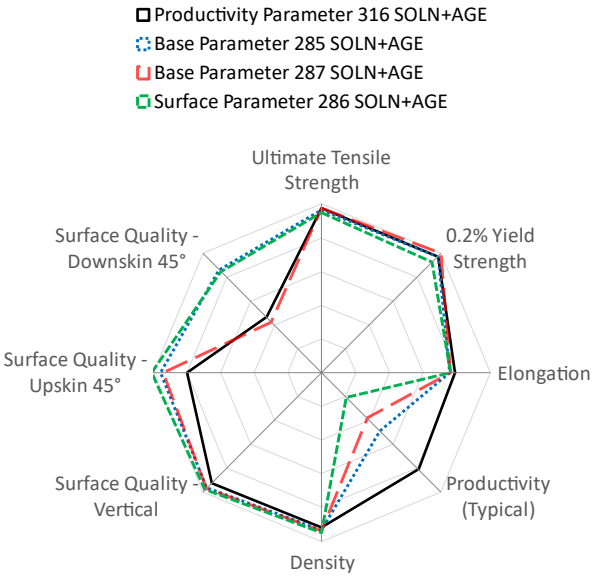
- **Base Parameter 131 / 285****	50 µm layer thickness, rubber recoater
- **Base Parameter 296 / 287****	50 µm layer thickness, steel recoater
- **Surface Parameter 158 / 286****	25 µm layer thickness, rubber recoater
- **Hybrid Parameter 159**	25 / 50 µm layer thickness, rubber recoater
- **Premium Productivity Parameter 316 ****	100 µm layer thickness, steel recoater

**Productivity optimized version (productivity bundle required)

THERMAL STATES

1. As-Built
2. Solution Anneal + Age (SOLN+AGE)
   SOLN: 980°C, 1 hour in argon; AGE: 720°C, 8 hours, furnace cooling down to 620°C; 620°C, 8 hours, cooling in air
3. Vacuum Stress Relieve + HIP + Solution + Age (VSR+HIP+SOLN+AGE)
   VSR: 950 °C, 2 hours in argon; HIP: 1160°C, 4 hours, 100 MPa; SOLN: 980°C, 1 hour in argon; AGE: 720°C, 8 hours, furnace cooling down to 620°C; 620°C, 8 hours, cooling in air

PARAMETER COMPARISON



Spider Plot is generated by normalizing typical material data (containing both horizontal and vertical data) against a range defined for each material family. For nickel-based superalloys, the ranges are as follows: UTS: 0-1600 MPa, 0.2%YS: 0-1400 MPa, Elongation: 0-40 %, Density: 0-100 %, Productivity: 5-50 cm³/h, Surface Quality (all): 70-5 µm

TYPICAL BUILD RATE

Base Parameter 131 / 285

	Standard (cm³/h)	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	18.6	24.5
Theoretical melting rate[2] bulk per Laser	21.6	21.6

[1]Using standard Factory Acceptance Test layout and 2 lasers

[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	8	6	5
Downskin	15	9	6

	Surface Roughness Ra** (µm)
H	18
V	8

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	282	--	--	--
SOLN+AGE	99.9	99.9	480	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	190	150	740	620	1060	970	29.0	33.0	--	--
SOLN+AGE	195	175	1305	1220	1495	1400	15.0	17.5	--	--

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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** Roughness measurements have been performed according to DIN EN ISO 4287 and DIN EN ISO 4288. In general analysis of the surface quality is strongly dependent on the methodology used and therefore deviations might be observed depending on methodology used. Vertical and horizontal sidewalls have been characterized using a tactile system, overhangs using an optical system.

TYPICAL BUILD RATE

Base Parameter 296 / 287

	Standard (cm³/h)	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	14.7	19.0
Theoretical melting rate[2] bulk per Laser	15.1	15.1

[1]Using standard Factory Acceptance Test layout and 2 lasers
[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	9	7	5
Downskin	43	12	7

	Surface Roughness Ra** (µm)
H	7
V	7

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	289	--	--	--
SOLN+AGE	99.9	99.9	475	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	185	180	755	705	1065	1040	29.5	30.5	--	--
SOLN+AGE	195	195	1315	1285	1480	1450	16.5	16.5	--	--
VSR+HIP+SOLN+AGE	205	200	1100	1105	1355	1350	24.5	24	36.5	35.5

Test Temperature: 650°C	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	--	--	--	--	--	--	--	--	--	--
SOLN+AGE	--	--	--	--	--	--	--	--	--	--
VSR+HIP+SOLN+AGE	170	175	905	905	1085	1085	17	17	20.5	21.2

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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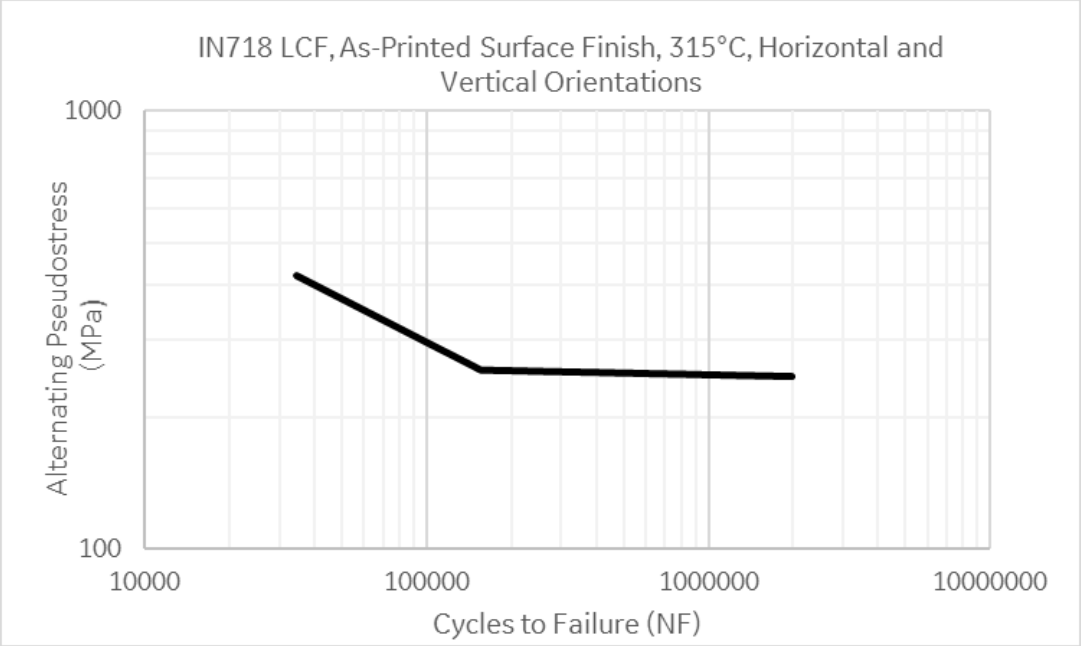
LOW CYCLE FATIGUE DATA (STRAIN-CONTROLLED)

LCF testing done in accordance with ASTM E606

R-Ratio: 0
Temperature: 315°C

Test Frequency: 0.5 Hz for 24 hrs; 9 Hz in load-control >24 hrs per ASTM E606

	AS-PRINTED SURFACE				MACHINED SURFACE			
	Alt Stress at 1E5 cycles (MPa)		Alt Stress at 1E6 cycles (MPa)		Alt Stress at 1E5 cycles (MPa)		Alt Stress at 1E6 cycles (MPa)	
Thermal State	H	V	H	V	H	V	H	V
As-Built	--	--	--	--	--	--	--	--
SOLN+AGE	--	--	--	--	--	--	--	--
VSR+HIP+SOLN+AGE	295	295	250	250	--	--	--	--



H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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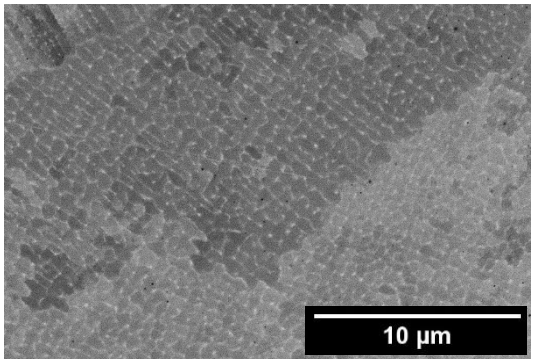
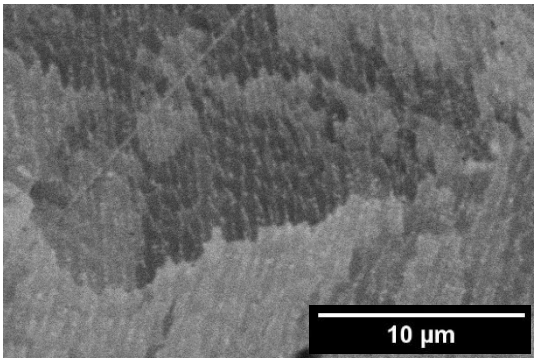
** Roughness measurements have been performed according to DIN EN ISO 4287 and DIN EN ISO 4288. In general analysis of the surface quality is strongly dependent on the methodology used and therefore deviations might be observed depending on methodology used. Vertical and horizontal sidewalls have been characterized using a tactile system, overhangs using an optical system.

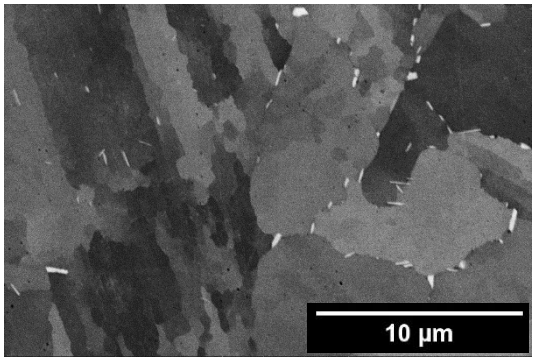
Horizontal Vertical

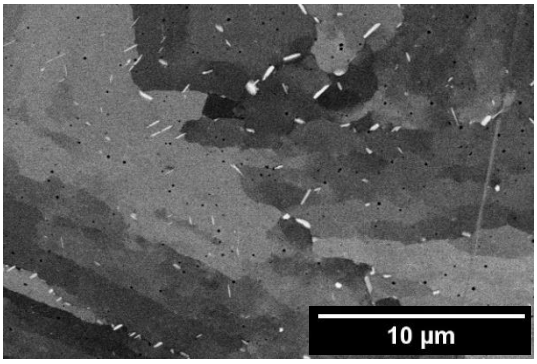
As-Built





SOLN+AGE



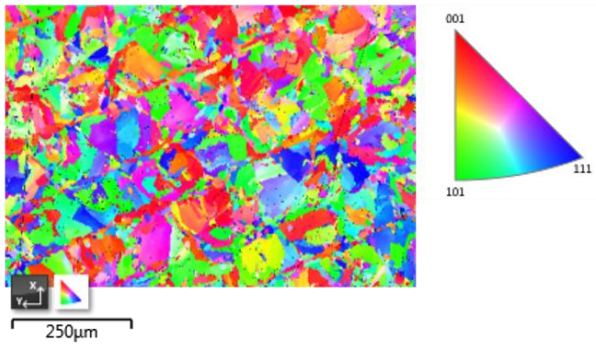


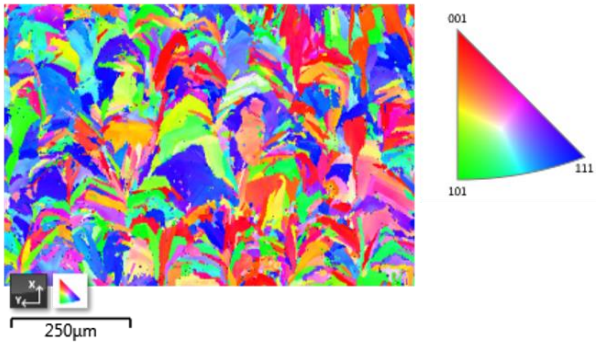
EBSD Images – Crystallographic grain orientation

Horizontal Vertical

As-Built

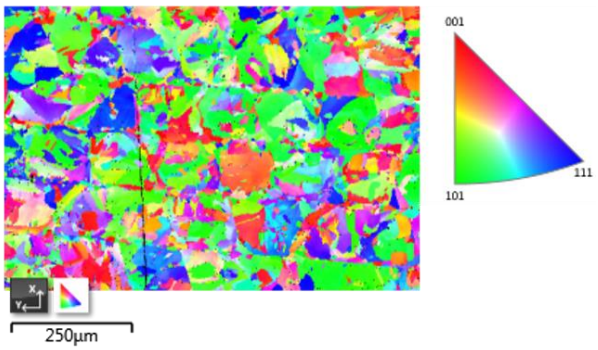
150x

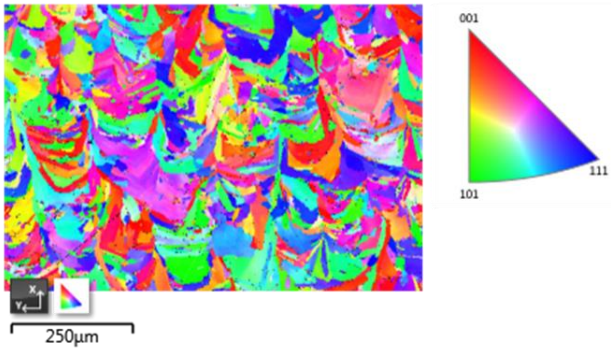




SOLN+AGE

150x





H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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TYPICAL BUILD RATE

Surface Parameter 158 / 286

	Standard (cm³/h)	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	8.2	10.2
Theoretical melting rate[2] bulk per Laser	8.1	8.1

[1]Using standard Factory Acceptance Test layout and 2 lasers
[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	5	4	4
Downskin	15	7	5

	Surface Roughness Ra** (µm)
H	8
V	7

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	302	--	--	--
SOLN+AGE	99.9	99.9	--	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	170	135	810	675	1080	980	25.5	30.0	--	--
SOLN+AGE	183	173	1245	1165	1475	1365	15.0	18.0	--	--

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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** Roughness measurements have been performed according to DIN EN ISO 4287 and DIN EN ISO 4288. In general analysis of the surface quality is strongly dependent on the methodology used and therefore deviations might be observed depending on methodology used. Vertical and horizontal sidewalls have been characterized using a tactile system, overhangs using an optical system.

TYPICAL BUILD RATE

Hybrid Parameter 159

	(cm³/h)
Typical build rate[1] w/coating	8.4 *(8-20)*[3]
Theoretical melting rate[2] bulk per Laser	20.7

[1]Using standard Factory Acceptance Test layout and 2 lasers

[2]Calculated (layer thickness x scan velocity x hatch distance)

[3]The hybrid parameter build rate is strongly dependent on application design, in particular wall thickness. For this parameter, a larger increase in productivity (faster build rate) can be expected for parts having high volume/surface ratios.

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	5	4	4
Downskin	15	6	5

	Surface Roughness Ra** (µm)
H	8
V	6

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	282	--	--	--
SOLN+AGE	--	--	465	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	176	163	750	645	1065	965	27.0	32.5	--	--
SOLN+AGE	205	195	1230	1170	1450	1355	15.5	17.0	--	--

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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TYPICAL BUILD RATE

Premium Productivity Parameter 316

	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	40.6
Theoretical melting rate[2] bulk per Laser	32.4

[1]Using standard Factory Acceptance Test layout and 2 lasers

[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	18	15	10
Downskin	40	18	12

	Surface Roughness Ra** (µm)
H	9
V	10

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	268	--	--	--
SOLN+AGE	99.9	99.9	465	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	200	165	690	645	1035	1020	33.5	32.5	52.5	51.5
SOLN+AGE	201	195	1270	1265	1475	1455	18.5	18.5	31.5	34.5

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

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