13 Al

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

M2 Series 5 Maraging Steel M300

Parameters for GE Additive's Concept Laser M2 Series 5

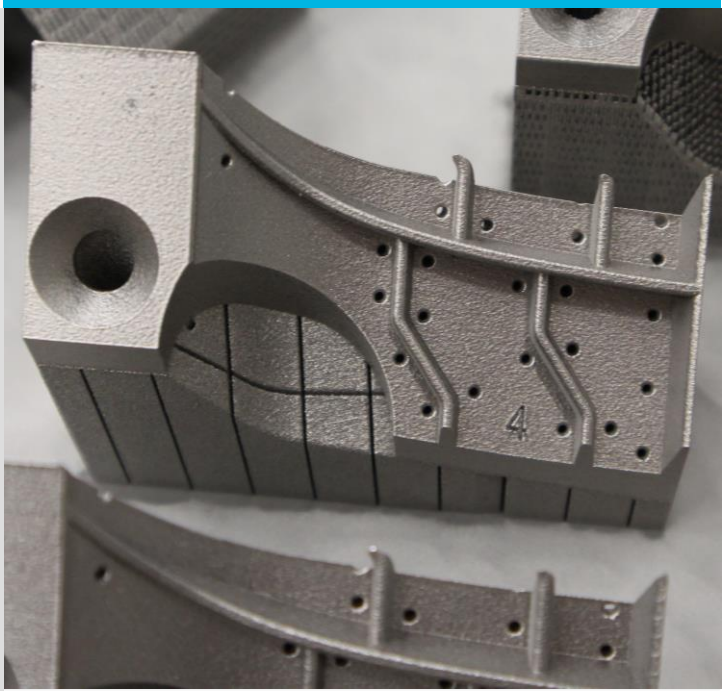
Data in this material datasheet represents material built with 25, 40 and 50 µm layer thicknesses and in a nitrogen atmosphere on a Concept Laser M2 Series 5 single-laser or dual-laser machine. Values listed are typical.

Maraging Steel

Maraging steel M300 has a chemical composition according to 1.2709 and similar to ASTM A646/A646M with exception of Mn, Ni, Co, Ti content. Maraging steels are a class of low-carbon high strength alloys that achieve high strength from intermetallic precipitates while maintaining good ductility. Because of their high strength and hardenability, maraging steels lend themselves to a variety of applications, including manufacturing tool components, structural components, and die casting and injection molding tools.

M2 Series 5 M300

The M300 parameters for the Concept Laser M2 Series 5 are developed leveraging the performance of the previous M2 generations. The base parameter deliver good surface quality, while maintaining a very good density, mechanical strength and productivity. To gain highest all-around surface quality and best part resolution the surface parameter has been developed. To maximize the build rate, the productivity parameter can be used, which is processable using rubber or steel recoater. The hybrid parameter combines surface & productivity parameter and can significantly increase the productivity of parts having a high volume/surface ratio and still meeting highest surface quality requirements.



M2 Series 5 Maraging Steel M300

With corresponding approval* Maraging Steel M300 can be used for manufacturing tool components with conformal cooling for series injection-molding as well as die casting and functional components.

Data in this material datasheet represents material built with 25, 40 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

Maraging Steel M300 powder chemical composition et al. according to 1.2709 and similar to ASTM A646/A646M with exception of Mn, Ni, Co, Ti content.

MACHINE CONFIGURATION

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

AVAILABLE PARAMETERS

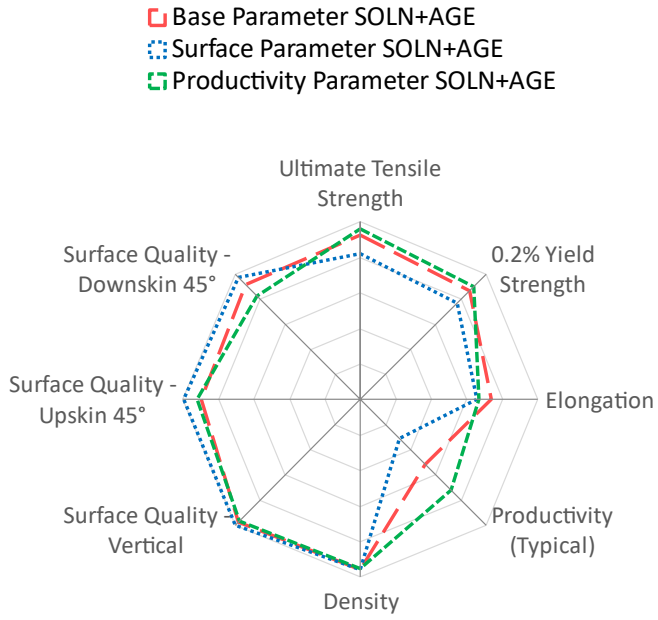
- **Base Parameter 194† / 298†**** 40 µm layer thickness, rubber recoater
- **Surface Parameter 170 / 299**** 25 µm layer thickness, rubber recoater
- **Hybrid Parameter 171** 25/50 µm layer thickness, rubber recoater
- **Productivity Parameter 205 / 300**; 221 / 301**** 50 µm layer thickness, steel ; rubber recoater

†For larger components, a modified parameter is recommended. Please contact GE Additive for additional information.
**Productivity optimized version (productivity bundle required)

THERMAL STATES

1. As-Built
2. Solution Anneal + Age (SOLN+AGE)
   SOLN: 940°C, 2 hours with air cooling + AGE: 490°C, 6 hours

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 **Maraging Steel** alloys, the ranges are as follows: UTS: 1650-2300 MPa, 0.2%YS: 1550-2275 MPa, Elongation: 0-5 %, Density: 99-100 %, Productivity: 5-30 cm³/h, Surface Quality (all): 40-5 µm

TYPICAL BUILD RATE

Base Parameter

	Standard (cm³/h)	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	11.4	15.4
Theoretical melting rate[2] bulk per Laser	15.0	15.0

[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	8	5
Downskin	8	6	5

	Surface Roughness Ra** (µm)
H	14
V	6

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	370	--	--	--
SOLN+AGE	99.9	99.9	675	--	--	--

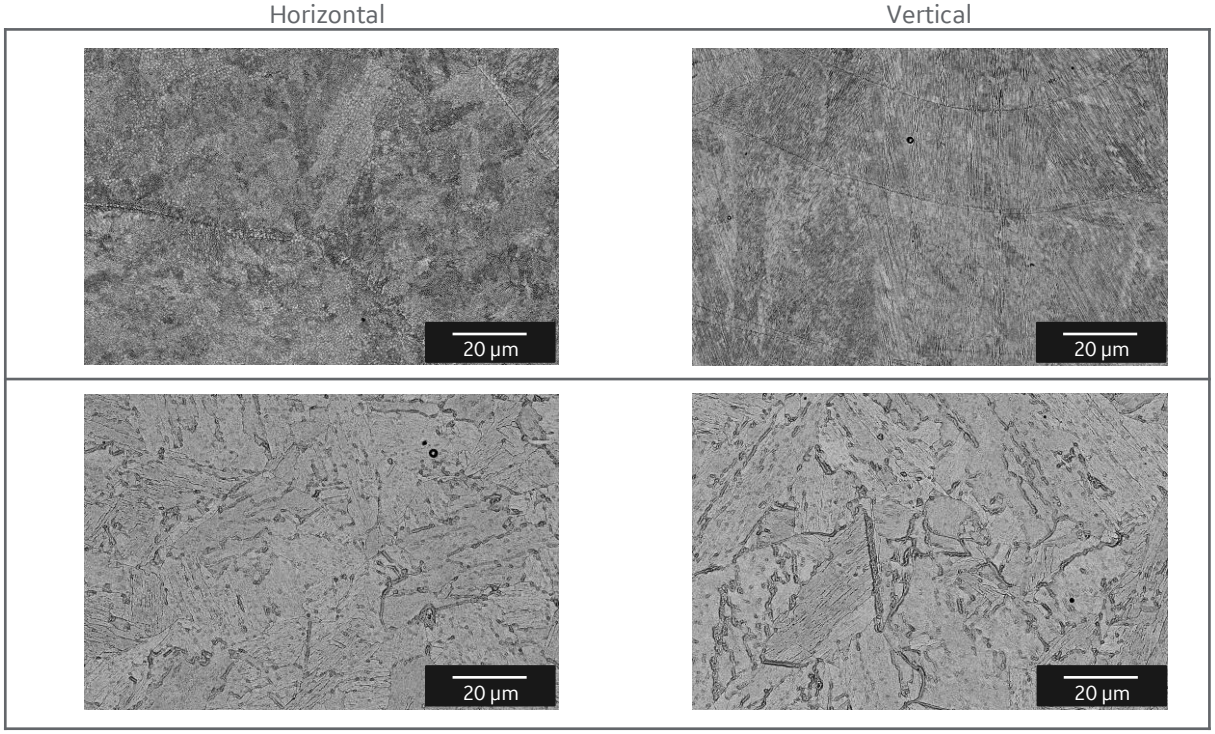
TENSILE DATA

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	152	153	820	1095	1115	1180	15.0	13.5	--	--
SOLN+AGE	183	184	2175	2175	2255	2255	3.0	3.0	--	--

SEM IMAGES



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

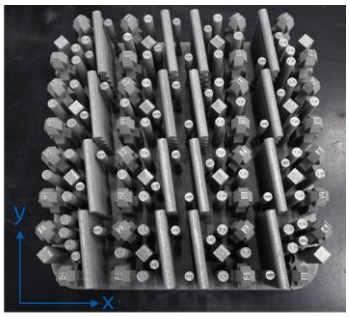
* All of the figures contained herein are approximate only. The figures provided are dependent on a number of factors, including but not limited to, process and machine parameters, and the approval is brand specific and/or application specific. The information provided on this material data sheet is illustrative only and cannot be relied on as binding.
** 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.

PLATFORM STABILITY

Base Parameter

The platform stability build evaluates porosity, roughness and tensile properties across different positions and orientations. To illustrate the position dependency of the M2 Series 5, the samples were homogenously distributed across the platform on 16 different positions. Regarding surface quality all sides of the specimen, so all orientations with respect to gas flow and optical system, are included in the analysis. Data shown below are dependent on part & print layout as well as batch chemistry variations and thus might deviate from “typical values” given on previous pages.

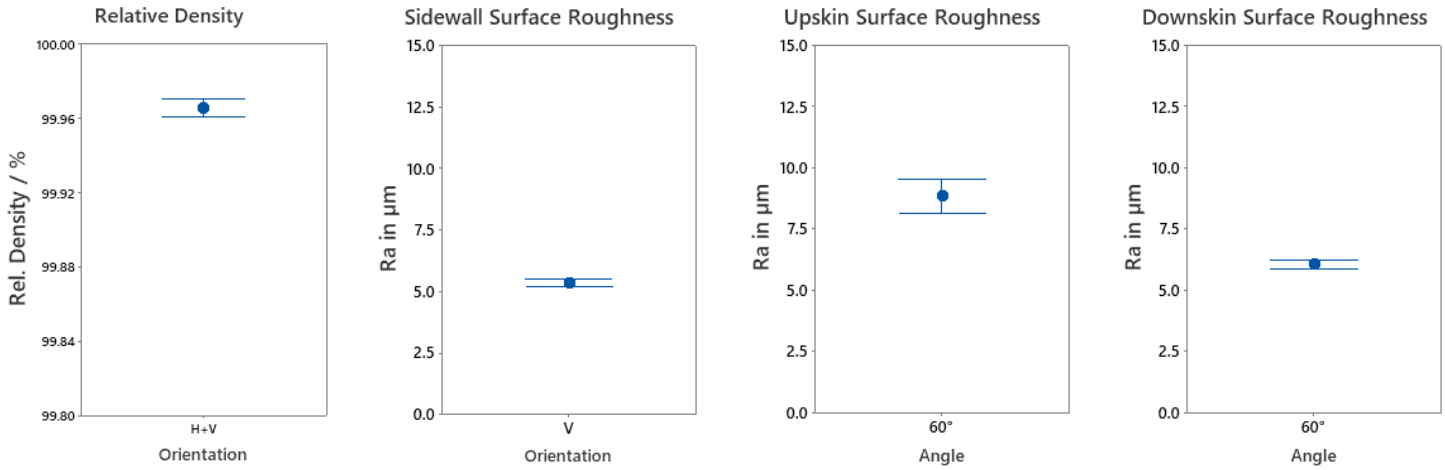
BUILD JOB DESIGN AND SUMMARIZED DATA (AS-BUILT)



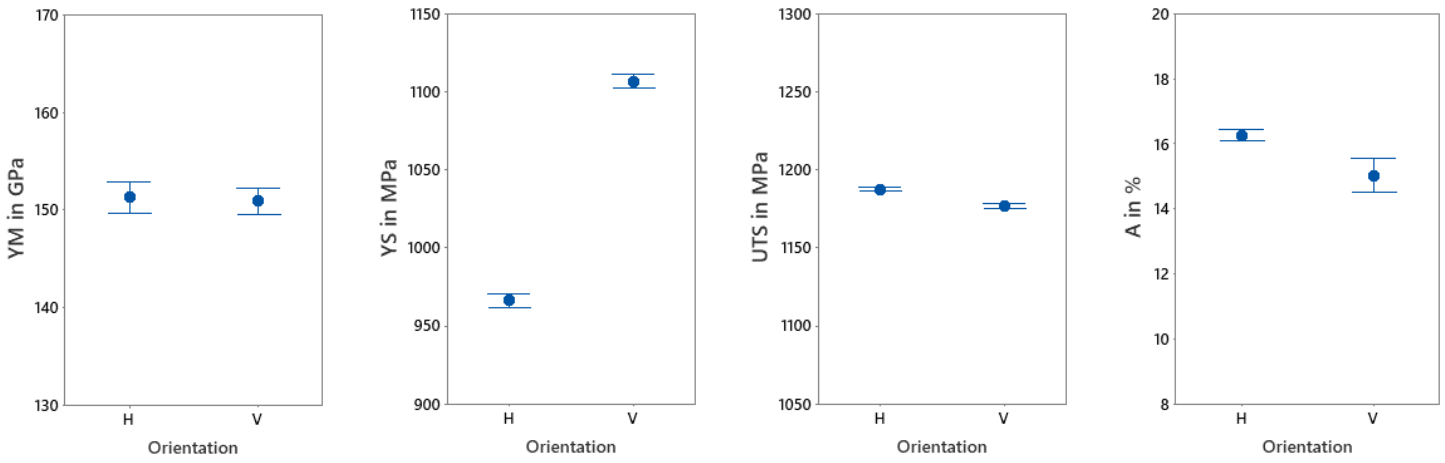
	Sample Size	Mean	St.Dev.
Rel. Density in %	32	99.97	0.01
Sidewall Roughness Ra in µm	64	5	1
Upside Roughness Ra in µm (60°)	64	9	3
Downside Roughness Ra in µm (60°)	64	6	1

	Sample Size	Mean	St.Dev.
YM in GPa (H/V)	16/16	151/151	3/3
YS in MPa (H/V)	16/16	966/1107	9/9
UTS in MPa (H/V)	16/16	1187/1177	2/3
Elongation in % (H/V)	16/16	16.3/15.0	0.4/1.0

RESULTS – RELATIVE DENSITY AND SURFACE QUALITY



RESULTS - MECHANICAL PROPERTIES IN AS-BUILT CONDITION



Data points represent the mean value, intervals the 95% confidence level.

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

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TYPICAL BUILD RATE

	Standard (cm³/h)	Productivity optimized (cm³/h)
Typical build rate[1] w/coating	7.8	9.,3
Theoretical melting rate[2] bulk per Laser	7.2	7.2

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

Surface Parameter

PHYSICAL DATA AT ROOM TEMPERATURE

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

	Surface Roughness Ra** (µm)
H	9
V	5

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	356	--	--	--
SOLN+AGE	99.9	99.9	636	--	--	--

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	150	165	950	1135	1140	1195	13.5	13.0	--	--
SOLN+AGE	190	192	2100	2115	2175	2190	3.0	2.0	--	--

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

Productivity Parameter

	Standard	Productivity optimized
	(cm³/h)	(cm³/h)
Typical build rate[1] w/coating	18.0	21.6
Theoretical melting rate[2] bulk per Laser	18.7	18.7

[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	11	7	5

	Surface Roughness Ra** (µm)
H	9
V	6

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	351	--	--	--
SOLN+AGE	99.9	99.9	675	--	--	--

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	156	162	840	1035	1105	1155	14.5	12.5***	--	--
SOLN+AGE	187	187	2200	2220	2270	2290	3.0	2.5	--	--

*** Data used from different build layout. Elongation in Z-direction depends on exposure area due to aging effect of M300.

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V: VERTICAL (Z) orientation

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TYPICAL BUILD RATE

Hybrid Parameter

	(cm³/h)
Typical build rate[1] w/coating	8.6 *(8-20)*[3]
Theoretical melting rate[2] bulk per Laser	18.7

[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	6	5	4
Downskin	7	5	5

	Surface Roughness Ra** (µm)
H	10
V	5

	Relative Density (%)		Hardness (HV10)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.9	99.9	363	--	--	--
SOLN+AGE	99.9	99.9	641	--	--	--

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	149	162	970	1145	1160	1200	14.0	13.0	--	--
SOLN+AGE	188	189	2090	2100	2165	2175	3.5	3.5	--	--

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

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