

POWDERRANGE M300

Associated specifications: AMS6514, AMS6521, AMS6463, AMS-S-46850, SAE J1099 (A538C), MIL-S-46850, UNS K93120, K93130, K93160

Type analysis

Single figures are nominal except where noted.

Iron	Balance	Nickel	17.0–19.0 %	Cobalt	8.50–10.0 %
Molybdenum	4.50–5.20 %	Titanium	0.80–1.20 %	Chromium	0.25 %
Manganese	0.15 %	Oxygen	0.10 %	Silicon	0.10 %
Carbon	0.030 %	Phosphorous	0.010 %	Sulfur	0.010 %

Description

PowderRange M300 is an age hardenable martensitic tool steel with exceptional mechanical properties, specifically a high tensile strength and hardness. It is easily heat treated with superior mechanical properties being achieved after age hardening.

The high carbon tool steels such as H13 or M2, which are typically used in tooling and molding applications, are very difficult to process by conventional Laser Powder Bed Fusion. PowderRange M300 offers a comparable alternative in terms of mechanical properties, but with proven additive manufacturing suitability. PowderRange M300 maintains strict control over residual alloying elements to optimize for additive manufacturing.

Key Properties:

- Exceptional strength
- Heat resistant to 900°F
- High hardness and wear resistance

Markets:

- Automotive
- Industrial

Applications:

- Tool inserts for molding and casting
- Hard-wearing functional components
- Tire sipes and molds

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Powder properties

PART NUMBER	PowderRange M300 F	PowderRange M300 E
APPLICATION	L-PBF ⁽¹⁾	EB-PBF or DED ⁽¹⁾
MAXIMUM PARTICLE SIZE	Max 1 wt% > 53 μm ⁽²⁾	Max 10 wt% > 106 μm ⁽²⁾
MINIMUM PARTICLE SIZE	Max 10 vol% < 15 μm ⁽³⁾	Max 10 wt% < 45 μm ⁽²⁾
LSD PERCENTILE	D10, D50, D90 ⁽³⁾ , reported	
ATOMIZATION	Nitrogen Gas Atomized	
APPARENT DENSITY (G/CM³)	Measured according to ASTM B212 ⁽⁴⁾ and reported	
HALL FLOW (S/50G)	Measured according to ASTM B213 ⁽⁵⁾ and reported	

¹ ASTM/ISO 52900: Laser — Powder Bed Fusion (L-PBF), Electron-Beam Powder Bed Fusion (EB-PBF), Directed Energy Deposition (DED)

² ASTM B214 Standard Test Method for Sieve Analysis for Metal Powders

³ ASTM B822 Standard Test Method for Particle Size Distribution of Metal Powders and Related Compounds by Light Scattering

⁴ ASTM B212 Standard Test Method for Apparent Density of Free-Flowing Metal Powders Using the Hall Flowmeter Funnel

⁵ ASTM B213 Standard Test Method for Flow Rate of Metal Powders Using the Hall Flowmeter Funnel

Testing of powder will fulfill certification requirements to Nadcap Materials Testing and ISO/IEC 17025 Chemical, per relevant ASTM procedures

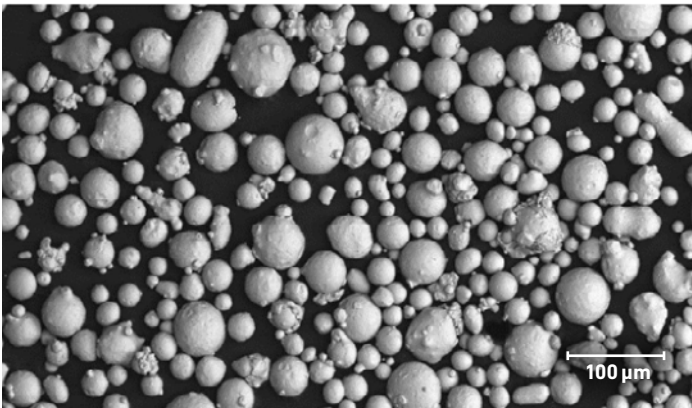


FIGURE 1—SEM IMAGE OF TYPICAL POWDERRANGE M300 POWDER

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Additive manufacturing process guidance

ASTM/ISO 52900: LASER-POWDER BED FUSION (L-PBF)

**Laser-Powder Bed Fusion
(L-PBF)
As-built**

PowderRange M300 is compatible with all commercially available L-PBF equipment.

To achieve mean, as-built density >99.9%, 20 to 60 µm layer thicknesses and Specific Energy $\geq 65 \text{ J/mm}^3$ is recommended.

**Stress Relief,
Solution Anneal and Age
(SR/Sol/Age)**

PowderRange M300 is typically stress relieved and solution annealed simultaneously following L-PBF. Annealing and solution treating are performed simultaneously by heating to 1500-1600°F (816-870°C) for a minimum of 30 minutes at temperature, followed by air cooling to room temperature.

Following Solution Annealing, PowderRange M300 is typically aged at 900°F (482°C) for a minimum of 3 hours followed by air cooling.

Schedules tailored better to the AM process thermal history may be available. Please contact Carpenter Technology for information.

**Hot Isostatic
Pressed condition
(HIP/Sol/Age)**

We recommend HIP as standard practice for microstructure homogenization; removal of residual spatter-induced voids, trapped gas porosity in powder and keyhole porosities; as well as to heal any shrinkage-induced micro-cracks in the material.

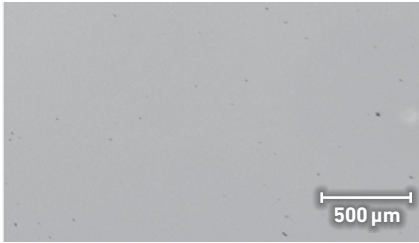
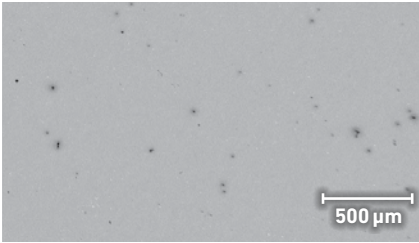
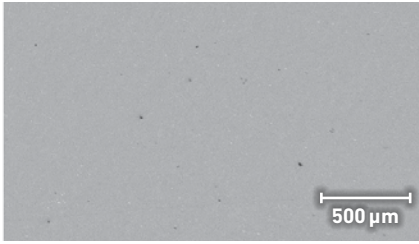
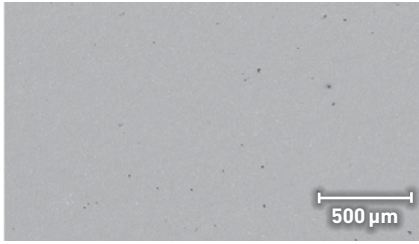
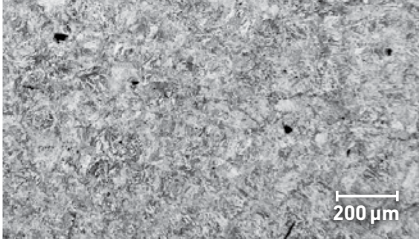
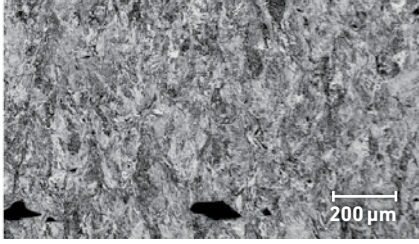
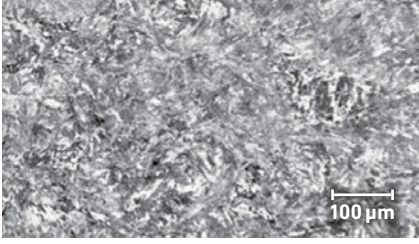
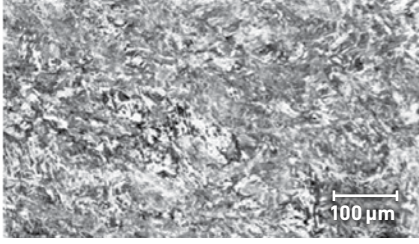


To achieve up to full density (100%): Process components under inert atmosphere at not less than 14.5 ksi (100 MPa) at approximately 2050°F (1220°C); hold at the selected temperature for approximately 240 minutes or more.

Follow with Solution and Age treatment as described above.

Machinability

PowderRange M300 is readily machined in the Solution Annealed condition (see above). Limited machining can be performed in the fully treated condition. Annealed hardness is typically 30 Rc.

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TYPICAL MICROSTRUCTURES			
CONDITION	TRANSVERSE (X-Y PLANE)	LONGITUDINAL (Y-Z PLANE)	NOTES
As-built			Mean densities greater than 99.8%
HIP/Sol			Mean densities up to 100%
As-built, etched⁽⁶⁾			Lath martensite microstructure Minimal spatter porosity Some evidence of weld lines visible
Sol/Age, etched⁽⁶⁾			Recrystallized equiaxed grain structure minimizes anisotropy
HIP/Sol/Age, etched⁽⁶⁾			Lath martensite microstructure

⁶ Etched with Ralph's etchant

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Typical achievable mechanical properties

ROOM TEMPERATURE MECHANICAL PROPERTIES ⁽⁷⁾										
FORM	ORIENTATION	0.2% YIELD STRENGTH $\sigma_{0.2\%}$		ULTIMATE TENSILE STRENGTH σ_{UTS}		ELONGATION IN 4D	REDUCTION OF AREA	IMPACT ENERGY		HARDNESS
		ksi	MPa	ksi	MPa	%	%	FT-LBS	J	HRB
As-built	X and Y	148	1020	183	1262	16	61	30	41	29
	Z	153	1055	183	1262	15	57	29	39	
SR/Sol/Age	X and Y	307	2117	317	2186	6	27	7	9	54
	Z	307	2117	317	2186	6	29	7	9	
HIP/Sol/Age	X and Y	296	2041	309	2130	6	25	7	9	52
	Z	294	2027	309	2130	4	20	5	7	
Reference Material ⁽⁸⁾	X and Y	290	2000	294	2027	11	58	—	—	52
	Z									

⁷ Average of a minimum of 5 samples taken from across the extents of a build plate in each orientation and for each heat treatment. Testing performed in accordance with ASTM E8/E8M-16a (tensile), ASTM E23-18 (impact energy) and ASTM E18-19 (hardness). Additional data may be available through a wide range of consortia and other collaborations. Please contact Carpenter Additive for additional information.

⁸ Forged Bar: <https://www.carpentertechnology.com/en/product-solutions/cartech-nimark-alloy-300/#>

Corrosion resistance

IMPORTANT NOTE:

Important Note: The following 4-level rating scale (Excellent, Good, Moderate, Restricted) is intended for comparative purposes only and is derived from experiences with wrought product. Additive manufactured material may perform differently; corrosion testing is recommended. Factors that affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish, and dissimilar metal contact.

Corrosion resistance of PowderRange M300 is limited. To discuss high strength, stainless steel alloy options please contact Carpenter Additive.

Humidity Restricted

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Similar materials

COMPANY	ALTERNATIVE TITLE
Other generic names	Maraging Steel, ISO X3NiCoMo-Ti18-9-5
3D Systems	LaserForm Maraging Steel
GE Additive (Concept Laser)	M300
EOS	ToolSteel 1.2709
DMG Mori (Realizer)	—
Renishaw	1.2709
SLM Solutions	1.2709

**For additional information, please
contact your nearest sales office:**

info@carpenteradditive.com | 610 208 2000

The mechanical and physical properties of any additively-manufactured material are strongly dependent on the processing conditions used to produce the final part. Significantly differing properties can be obtained by utilizing different equipment, different process parameters, different build rates and different geometries. The properties listed are intended as a guide only and should not be used as design data.

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