CARPENTER ADDITIVE®

DATASHEET

PowderRange 718

Applicable specifications: ASTM F3055

Associated specifications: UNS N07718, DIN 2.4668, AMS5662, AMS5664

Type analysis

Single figures are nominal except where noted.

Nickel	50.00–55.00 %	**Iron**	Balance	**Chromium**	17.0–21.0 %
Niobium + Tantalum	4.75–5.50 %	**Molybdenum**	2.80–3.30 %	**Titanium**	0.65–1.15 %
Cobalt	1.00 %	**Aluminum**	0.20–0.80 %	**Manganese**	0.35 %
Silicon	0.35 %	**Copper**	0.30 %	**Carbon**	0.08 %
Nitrogen	0.03 %	**Oxygen**	0.03 %	**Phosphorus**	0.015 %
Sulfur	0.015 %	**Boron**	0.006 %		

Description

PowderRange 718 is known as the “workhorse” nickel-base superalloy, and is a key material for high temperature applications in aerospace, energy, and industrial applications. It is an age-hardenable alloy designed to display exceptionally high yield, tensile, and creep-rupture properties at temperatures up to 1300°F (704°C). The sluggish age-hardening response of 718 permits annealing without spontaneous hardening during heating and cooling, as well as highly customizable heat treatments and subsequent mechanical properties for different applications.

PowderRange 718 for additive manufacturing is highly processable due to good phase stability, minimal segregation, and low crack susceptibility. The latter two are due to Carpenter Additive’s tight control on residual elements. Although PowderRange 718 is precipitation hardenable, it still displays excellent mechanical properties in the as-processed state.

Key Properties:

- Tensile strength, fatigue resistance, and creep resistance up to 1300°F (704°C).
- Customizable properties through heat treatment
- Resistance to chlorides, stress corrosion, and sulfide stress cracking

Markets:

- Aerospace
- Energy
- Industrial

Applications:

- Jet engine and high-speed airframe parts
- Instrumentation devices
- Gas turbine components
- Oil and gas tooling
- Impellers for high temperature operation

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Powder properties

PART NUMBER	PowderRange 718 F	PowderRange 718 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	Vacuum Induction Melted, Argon 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

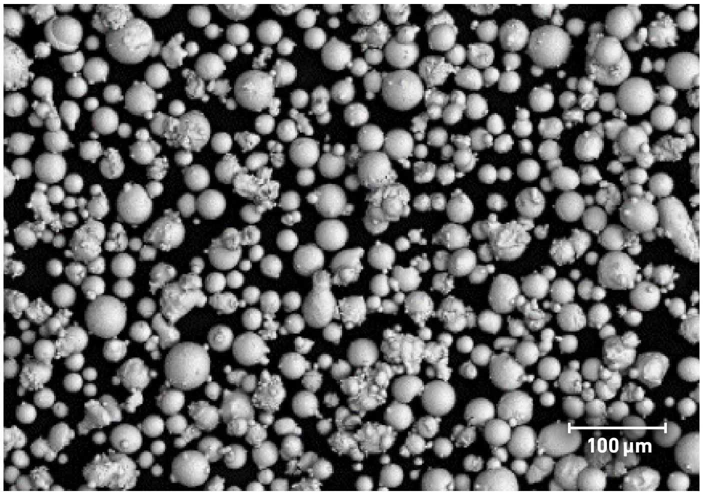

FIGURE 1 — SEM IMAGE OF TYPICAL POWDERRANGE 718 POWDER

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Additive manufacturing process guidance

ASTM F3055: ADDITIVE MANUFACTURING NICKEL ALLOY (UNS 07718) WITH POWDER BED FUSION	
Laser-Powder Bed Fusion (L-PBF)	PowderRange 718 for additive manufacturing 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 ≥ 50 J/mm³ is recommended.
Solution Anneal and Precipitation Heat Treatment condition (Sol/Pre)	Standard solution treatment and age hardening schedules can be used to obtain different combinations of tensile and stress rupture properties (e.g. AMS5662 and AMS5664). **Example AMS5662 Solution and Age Cycle:** Solution Anneal per AMS5662N section 3.4 by heating to approximately 1780°F (971°C) for approximately 1 hour followed by air cool. Precipitation heat treat per AMS5662N section 3.5.1.2 at 1325°F (718°C) for 8 hours followed by cooling at 100°F (56°C) per hour to 1150°F (621°C) and hold at least another 8 hours then air cool. **Schedules better tailored to the AM process thermal history may be available. Please contact Carpenter Technology for information.**
Hot Isostatic Pressed condition (HIP/Sol/Pre)	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 per ASTM F3055 section 13: minimum pressure of 14.5 ksi (100 MPa) at a temperature of approximately 2087°F (1141°C) for 240 minutes in argon. Follow with Solution Anneal and Precipitation Heat Treatment as described above or other heat treatment as desired.
Machinability	The alloy can be readily machined in either the annealed or the age-hardened condition. The age-hardened condition gives better chip action on chip breaker tools and produces a better finish. The annealed condition will give a slightly longer tool life. Because specific cutting forces are high, the machine tools used must have ample power and the cutting speed should be slow. The tools must have smooth finishes, be sharp, and be very rigid. To avoid work hardening, a continuous, smooth cutting action should be maintained; thus, the machines must have a minimum of backlash and the tool and workpiece must be rigidly supported. If possible, avoid very small cuts and feeds.

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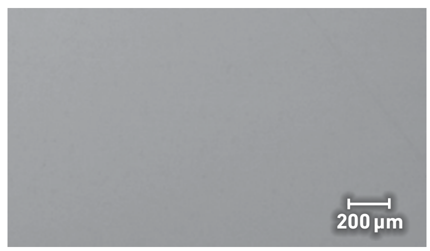
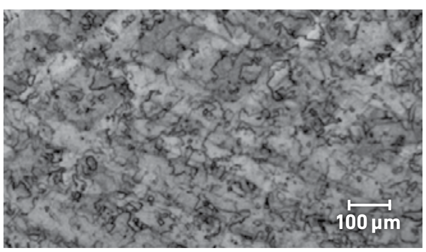
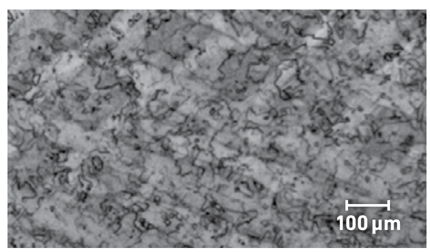
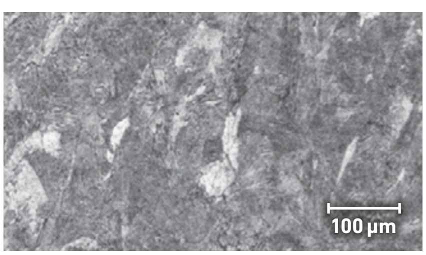
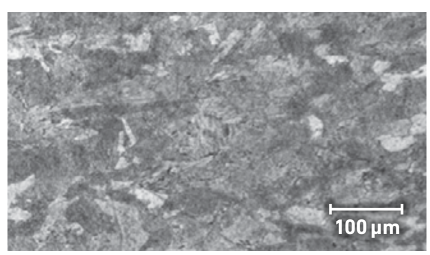
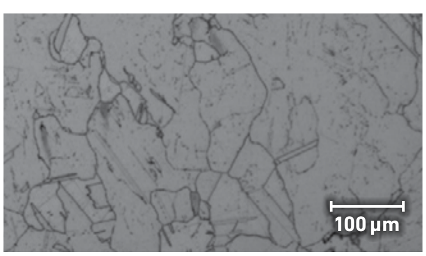
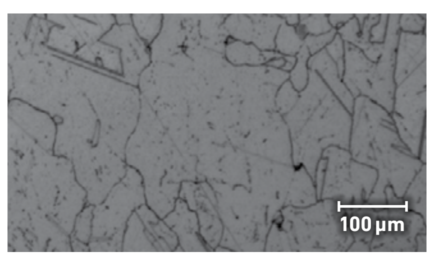
TYPICAL MICROSTRUCTURES

CONDITION	TRANSVERSE (X-Y PLANE)	LONGITUDINAL (Y-Z PLANE)	NOTES
As-built			Mean densities greater than 99.9%
HIP/Sol/Age			Up to 100% density
As-built, etched[6]			Clean weld tracks visible Minimal spatter porosity
Sol/Pre, etched[6]			Non-equiaxed / anisotropic grain size: ASTM 4[7] Delta phase present
HIP/Sol/Pre, etched[6]			Equiaxed grain sizes ASTM 2-7 (average 5)[7] No Delta phase present

[6] *Etched with Waterless Kalling's Reagent*
[7] *ASTM E112 Standard Test Method for Determining Average Grain Size*

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Typical achievable mechanical properties

ROOM TEMPERATURE MECHANICAL PROPERTIES[8]										
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	HRC
As-built	X and Y	112	770	154	1060	27	48	77.0	104	27
	Z	92	630	141	970	34	55	74.6	101	27
Sol/Pre	X and Y	158	1086	207	1425	13	20	13	17	43
	Z	150	1040	195	1350	17	29	15	21	43
HIP/Sol/Pre	X and Y	157	1080	203	1400	18	28	17	24	43
	Z	154	1060	199	1370	21	34	22	29	43
ASTM Spec.[9]	X and Y	136	940	180	1240	12	—	—	—	—
	Z	133	920	180	1240	12	—	—	—	—

[8] 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.

[9] ASTM F3055-14a Heat Treat Condition "D, F" Minimum Tensile Requirements

Corrosion resistance

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.

Nitric Acid	Good	**Sulfuric Acid**	Moderate
Phosphoric Acid	Moderate	**Acetic Acid**	Good
Sodium Hydroxide	Good	**Salt Spray (NaCl)**	Excellent
Sea Water	Moderate	**Sour Oil/Gas**	Good
Humidity	Excellent		

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Similar materials

COMPANY	ALTERNATIVE TITLE
Other Generic Names	Alloy 718, 718, Nickel 718
3D Systems	LaserForm Ni718
GE (Concept Laser)	Nickel 718
EOS	NickelAlloy IN718
DMG Mori (Realizer)	—
Renishaw	In718-0405
SLM Solutions	IN718

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

The information and data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his/her own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes. There is no representation that the recipient of this literature will receive updated editions as they become available.