MATERIAL DATA SHEET

Nickel Alloy IN718

Nickel Alloy IN718 is a precipitation-hardening nickel-chromium alloy is characterized by having good tensile, fatigue, creep and rupture strength at temperatures up to 700 °C (1290 °F). This material is ideal for many high temperature applications such as gas turbine parts, instrumentation parts, power and process industry parts etc. It also has excellent potential for cryogenic applications.

Parts built from Nickel Alloy IN718 can be easily post-hardened by precipitation-hardening heat treatments. In both as-built and age-hardened states the parts can be machined, spark-eroded, welded, micro shot-peened, polished and coated if required. Due to the layer-wise building method, the parts have a certain anisotropy.

General process data

Typical achievable part accuracy [1] [11] - *small parts*	approx. ± 40 – 60 µm approx. ± 1.6 – 2.4 x 10^{-3} inch
- *large parts*	± 0.2 %
Minimum wall thickness [2] [11]	typ. 0.3 - 0.4 mm typ. 0.012 – 0.016 inch
Surface roughness [3] [11] - *after shot-peening*	Ra 4 – 6.5 µm, Rz 20 - 50 µm Ra 0.16 – 0.25 x 10^{-3} inch Rz 0.78 – 1.97 x 10^{-3} inch
Surface roughness [3] [11] - *after polishing*	Rz up to < 0.5 µm Rz up to < 0.02 x 10^{-3} inch *(can be very finely polished)*
Volume rate [4] - *Parameter Set IN718_Performance (40 µm)*	4 mm^3/s (14.4 cm^3/h) 0.88 in^3/h

Physical & chemical properties of parts

Material composition	Ni (50 - 55 wt-%)	Al (0.20 - 0.80 wt-%)	Mn (≤ 0.35 wt-%)
	Cr (17.0 - 21.0 wt-%)	Co (≤ 1.0 wt-%)	P (≤ 0.015 wt-%)
	Nb (4.75 - 5.5 wt-%)	Cu (≤ 0.3 wt-%)	S (≤ 0.015 wt-%)
	Mo (2.8 - 3.3 wt-%)	C (≤ 0.08 wt-%)	B (≤ 0.006 wt-%)
	Ti (0.65 - 1.15 wt-%)	Si (≤ 0.35 wt-%)	Fe (balance)
Relative density	approx. 100 %		
Density	min. 8.15 g/cm^3 min. 0.294 lb/in^3		

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Mechanical properties of parts at 20 °C (68 °F) - as built

	Horizontal Axis (XY)	*Vertical Axis (Z)*
Tensile strength [7]	typ. 1060 ± 50 MPa (154 ± 7 ksi)	typ. 980 ± 50 MPa (142 ± 7 ksi)
Yield strength (Rp 0.2 %) [7]	typ. 780 ± 50 MPa (113 ± 7 ksi)	typ. 634 ± 50 MPa (92 ± 7 ksi)
Elongation at break [7]	typ. (27 ± 5) %	typ. (31 ± 5) %
Modulus of elasticity [7]	typ. 160 ± 20 GPa (23 ± 3 Msi)	*N/A* *N/A*
Hardness [8]	approx. 30 HRC approx. 287 HB	

Mechanical properties of parts at 20 °C (68 °F) - heat treated

	Heat treated per AMS 5662 [5]	*Heat treated per AMS 5664 [6]*
Tensile strength [7] - *in vertical direction (Z)*	min. 1241 MPa (180 ksi) typ. 1400 ± 100 MPa (203 ± 15 ksi)	min. 1241 MPa (180 ksi) typ. 1380 ± 100 MPa (200 ± 15 ksi)
Yield strength (Rp 0.2 %) [7] - *in vertical direction (Z)*	min. 1034 MPa (150 ksi) typ. 1150 ± 100 MPa (167 ± 15 ksi)	min. 1034 MPa (150 ksi) typ. 1240 ± 100 MPa (180 ± 15 ksi)
Elongation at break [7] - *in vertical direction (Z)*	min. 12 % typ. (15 ± 3) %	min. 12 % typ. (18 ± 5) %
Modulus of elasticity [7] - *in vertical direction (Z)*	170 ± 20 GPa 24.7 ± 3 Msi	170 ± 20 GPa 24.7 ± 3 Msi
Hardness [8]	approx. 47 HRC approx. 446 HB	approx. 43 HRC approx. 400 HB

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Mechanical properties of heat treated parts at high temp. (649 °C, 1200 °F) [11]

	Heat treated per AMS 5662 [5]	*Heat treated per AMS 5664* [6]
Tensile strength [9] - *in vertical direction (Z)*	min. 965 MPa (140 ksi) typ. 1170 ± 50 MPa (170 ± 7 ksi)	typ. 1210 ± 50 MPa (175 ± 7 ksi)
Yield strength (Rp 0.2 %) [9] - *in vertical direction (Z)*	min. 862 MPa (125 ksi) typ. 970 ± 50 MPa (141 ± 7 ksi)	typ. 1010 ± 50 MPa (146 ± 7 ksi)
Elongation at break [9] - *in vertical direction (Z)*	min. 6 % typ. (16 ± 3) %	typ. (20 ± 3) %
Stress-Rupture Properties [10] - *in vertical direction (Z)*	min. 23 hours at stress level 689 MPa (100 ksi) 51 ± 5 hours (final applied stress to rupture 792.5 MPa / 115 ksi)	81 ± 10 hours (final applied stress to rupture 861.5 MPa / 125 ksi)

Thermal properties of parts

	Heat treated per AMS 5662 [4]
Coefficient of thermal expansion - *over 25 - 200 °C (36 - 390 °F)*	approx. 12.5 - 13.0 x 10^{-6} m/m°C approx. 6.9 - 7.2 x 10^{-6} in/in°F
Coefficient of thermal expansion - *over 25 - 750 °C (36 - 930 °F)*	approx. 16.6 - 17.2 x 10^{-6} m/m°C approx. 9.2 - 9.6 x 10^{-6} in/in°F
Maximum operating temperature for parts under load	approx. 650 °C approx. 1200 °F
Oxidation resistance up to [11]	approx. 980 °C approx. 1800 °F

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[1] Based on users' experience of dimensional accuracy for typical geometries, e.g. ± 40 µm (1.6 x 10^{-3} inch) when parameters can be optimized for a certain class of parts or ± 60 µm (2.4 x 10^{-3} inch) when building a new kind of geometry for the first time. Part accuracy is subject to appropriate data preparation and post-processing.

[2] Mechanical stability is dependent on geometry (wall height etc.) and application.

[3] Due to the layer-wise building, the surface structure depends strongly on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect. The values also depend on the measurement method used. The values quoted here given an indication of what can be expected for horizontal (up-facing) or vertical surfaces.

[4] Volume rate is a measure of build speed during laser exposure. The total build speed depends on the average volume rate, the re-coating time (related to the number of layers) and other factors such as DMLS-Start settings.

[5] Heat treatment procedure per AMS 5662:

1. Solution Anneal at 980 °C (1800 °F) for 1 hour, air (/argon) cool.
2. Aging treatment; hold at 720 °C (1330 °F) 8 hours, furnace cool to 620 °C (1150 °F) in 2 hours, hold at 620 °C (1150 °F) 8 hours, air (/argon) cool.

[6] Heat treatment procedure per AMS 5664:

1. Solution Anneal at 1065 °C (1950 °F) for 1 hour, air (/argon) cool.
2. Aging treatment; hold at 760 °C (1400 °F) 10 hours, furnace cool to 650 °C (1200 °F) in 2 hours, hold at 650 °C (1200 °F) 8 hours, air (/argon) cool

[7] Tensile testing according to ISO 6892-1:2009 (B) Annex D, proportional test pieces, diameter of the neck area 5 mm (0.2 inch) , original gauge length 25 mm (1 inch).

[8] Rockwell C (HRC) hardness measurement according to EN ISO 6508-1 on polished surface. Note that measured hardness can vary significantly depending on how the specimen has been prepared.

[9] Elevated temperature tensile testing at 649 °C (1200 °F) in accordance with EN 10002-5 (92).

[10] Testing at 649 °C (1200 °F) in accordance with ASTM E139 (2006), smooth specimens. Test method as described in AMS 5662 (3.5.1.2.3.3): “The load required to produce an initial axial stress of 689 MPa (100 ksi) shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 hours minimum, thereafter, the stress shall be increased in increments of 34.5 MPa (5 ksi).”

[11] *Hint:* these properties were determined on an EOSINT M 270 IM Xtended and EOSINT M 280-400W. Test parts from following machine types EOSINT M 270 Dual Mode, EOSINT M 280-200W and EOS M 290-400W correspond with these data.