Material data sheet

EOS NickelAlloy IN718

EOS NickelAlloy IN718 is a heat and corrosion resistant nickel alloy powder which has been optimized especially for processing on EOSINT M systems.

This document provides information and data for parts built using EOS NickelAlloy IN718 powder (EOS art.-no. 9011-0020) on the following system specifications:

- EOSINT M 270 Installation Mode *Xtended*
  with PSW 3.4 and default job IN718_020_default.job
- EOSINT M 270 Dual Mode
  with PSW 3.5 and EOS Original Parameter Set IN718_Surface 1.0

Description

Parts built from EOS NickelAlloy IN718 have chemical composition corresponding to UNS N07718, AMS 5662, AMS 5664, W.Nr 2.4668, DIN NiCr19Fe19NbMo3. This kind of 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 EOS NickelAlloy 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 layerwise building method, the parts have a certain anisotropy - see Technical Data for examples.

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Technical data

General process data

Typical achievable part accuracy [1]	
- small parts	approx. ± 40 – 60 µm approx. ± 1.6 – 2.4 x 10 $^{-3}$ inch
- large parts	± 0.2 %
Min. wall thickness [2]	typ. 0.3 - 0.4 mm typ. 0.012 – 0.016 inch
Surface roughness [3]	
- after shot-peening	R_a 4 – 6.5 µm, R_z 20 - 50 µm R_a 0.16 – 0.25 x 10 $^{-3}$ inch, R_z 0.78 – 1.97 x 10 $^{-3}$ inch
- after polishing	R_z up to < 0.5 µm R_z up to < 0.02 x 10 $^{-3}$ inch (can be very finely polished)
Volume rate [4]	2 mm³/s (7.2 cm³/h) 0.44 in³/h

[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, in accordance with EOS training.

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

[3] Due to the layerwise 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 recoating time (related to the number of layers) and other factors such as DMLS-Start settings.

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Physical and chemical properties of parts

Material composition	Ni (50 - 55 wt-%) Cr (17.0 - 21.0 wt-%) Nb (4.75 - 5.5 wt-%) Mo (2.8 - 3.3 wt-%) Ti (0.65 - 1.15 wt-%) Al (0.20 - 0.80 wt-%) Co (≤ 1.0 wt-%) Cu (≤ 0.3 wt-%) C (≤ 0.08 wt-%) Si, Mn (each ≤ 0.35 wt-%) P, S (each ≤ 0.015 wt-%) B (≤ 0.006 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	Heat treated per AMS 5662 [5]	Heat treated per AMS 5664 [6]
Tensile strength [7]			
- in horizontal direction (XY)	typ. 1060 ± 50 MPa (154 ± 7 ksi)		
- in vertical direction (Z)	typ. 980 ± 50 MPa (142 ± 7 ksi)	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 horizontal direction (XY)	typ. 780 ± 50 MPa (113 ± 7 ksi)		
- in vertical direction (Z)	typ. 634 ± 50 MPa (92 ± 7 ksi)	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 horizontal direction (XY)	typ. (27 ± 5) %		
- in vertical direction (Z)	typ. (31 ± 5) %	min. 12 % typ. (15 ± 3) %	min. 12 % typ. (18 ± 5) %

[5] Heat treatment procedure per AMS 5662:
Step1. *Solution Anneal* at 980 °C (1800 °F) for 1 hour, air (/argon) cool.
Step 2. *Ageing 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:
Step1. *Solution Anneal* at 1065 °C (1950 °F) for 1 hour, air (/argon) cool.
Step 2. *Ageing 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).

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Mechanical properties of parts at 20 °C (68 °F), continued

Modulus of elasticity [7]			
- in horizontal direction (XY)	typ. 160 ± 20 GPa (23 ± 3 Msi)		
- in vertical direction (Z)		170 ± 20 GPa 24.7 ± 3 Msi	170 ± 20 GPa 24.7 ± 3 Msi
Hardness [8]	approx. 30 HRC approx. 287 HB	approx. 47 HRC approx. 446 HB	approx. 43 HRC approx. 400 HB

[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.

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Mechanical properties of parts at high temperature (649 °C, 1200 °F)

	Heat treated per AMS 5662 [5]	Heat treated per AMS 5664 [6]
Tensile Strength (Rm) [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)

[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)."

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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
- 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

[11] Based on literature of conventional Ni-alloy with identical chemistry

Abbreviations

typ.	typical
min.	minimum
approx.	approximately
wt	weight

Notes

The data are valid for the combinations of powder material, machine and parameter sets referred to on page 1, when used in accordance with the relevant Operating Instructions (including Installation Requirements and Maintenance) and Parameter Sheet. Part properties are measured using defined test procedures. Further details of the test procedures used by EOS are available on request.

The data correspond to our knowledge and experience at the time of publication. They do not on their own provide a sufficient basis for designing parts. Neither do they provide any agreement or guarantee about the specific properties of a part or the suitability of a part for a specific application. The producer or the purchaser of a part is responsible for checking the properties and the suitability of a part for a particular application. This also applies regarding any rights of protection as well as laws and regulations. The data are subject to change without notice as part of EOS' continuous development and improvement processes.

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