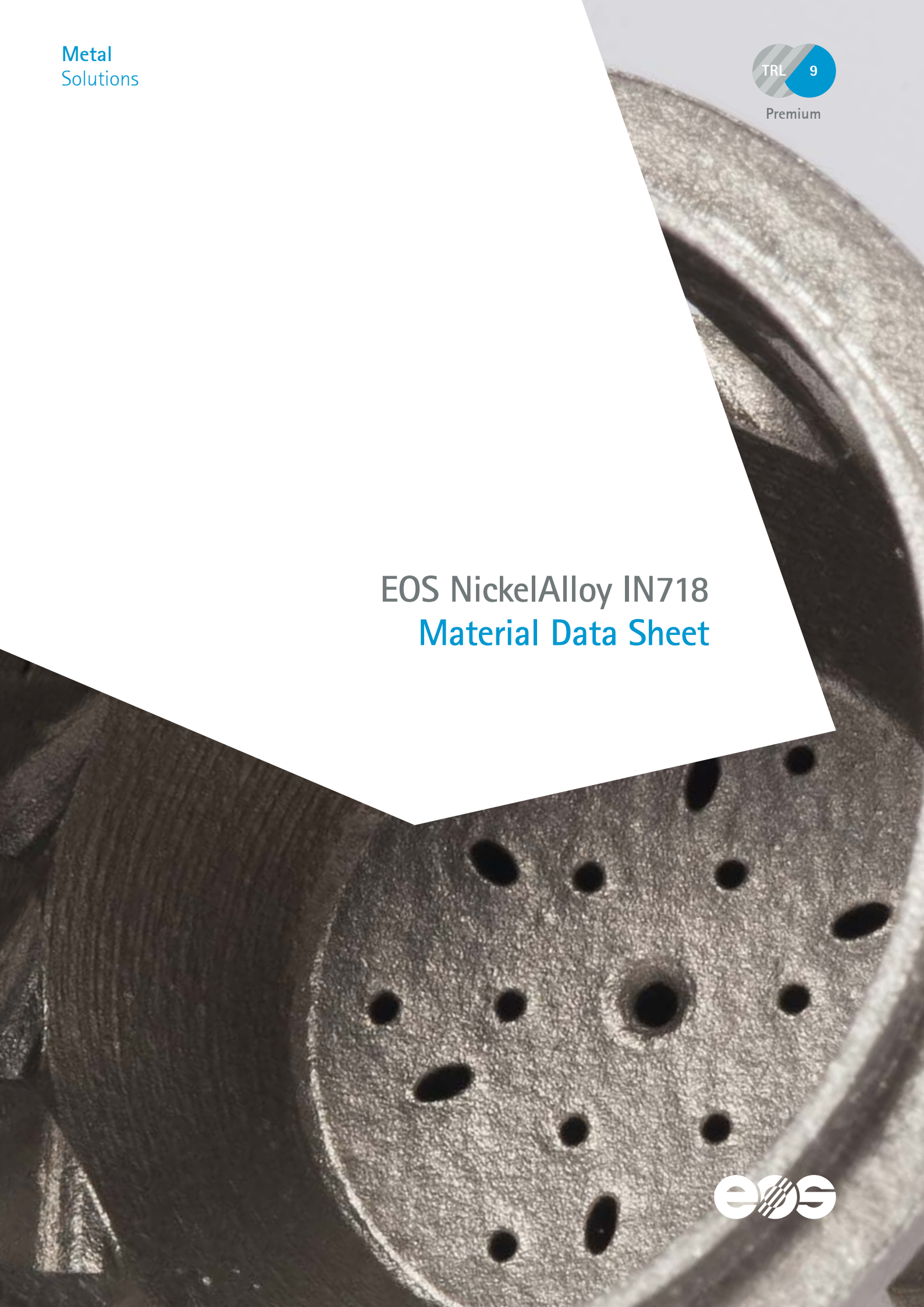
Metal
Solutions

TRL 9
Premium

EOS NickelAlloy IN718
Material Data Sheet



EOS NickelAlloy IN718
High Temperature Strength and Corrosion Resistance

EOS NickelAlloy IN718 is a precipitation-hardening nickel-chromium alloy that is characterized by having good tensile, fatigue, creep and rupture strength at temperatures up to 700 °C (1.290 °F). Parts built from EOS NickelAlloy IN718 can be easily post-hardened by precipitation-hardening heat treatments.

Main Characteristics:

- Good tensile, fatigue, creep and rupture strength at temperatures up to 700 °C (1.290 °F)
- Parts are easily precipitation hardened
- Parts can be machined, spark-eroded, welded, micro shot-peened, polished and coated in both as-built and age-hardened states

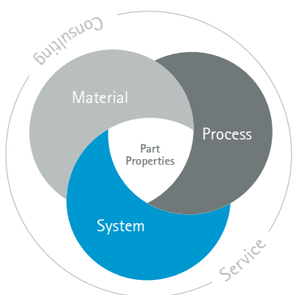
Typical Applications:

- Gas turbine components
- Instrumentation parts
- Power industry parts
- Process industry parts

The EOS Quality Triangle

EOS uses an approach that is unique in the AM industry, taking each of the three central technical elements of the production process into account: the system, the material and the process – together simply described as the Quality Triangle. EOS focuses on delivering reproducible part properties for the customer.

All of the data stated in this material data sheet is produced according to EOS Quality Management System and international standards.



Powder Properties

The chemical composition of EOS NickelAlloy IN718 is in compliance with UNS N07718, AMS 5662, AMS 5664, W.Nr 2.4668, DIN NiCr19Fe19NbMo3.

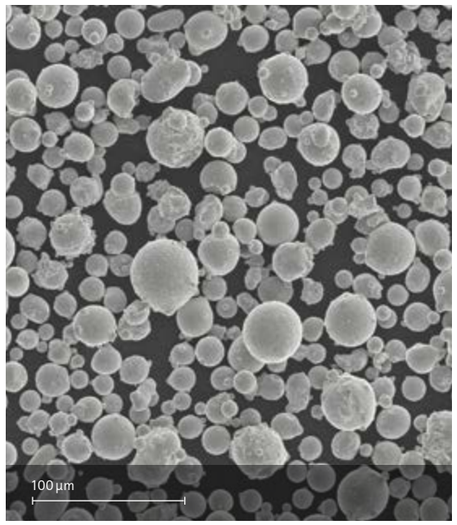
Powder chemical composition (wt.-%)

Element	Min.	Max.
Fe	Rem.	
Ni	50.00	55.00
Cr	17.00	21.00
Nb	4.75	5.50
Mo	2.80	3.30
Ti	0.65	1.15
Al	0.20	0.80
Co	-	1.00
Cu	-	0.30
Si	-	0.35
Mn	-	0.35
Ta	-	0.05
C	-	0.08
S	-	0.015
P	-	0.015
B	-	0.006
Pb	-	0.0005
Se	-	0.0020
Bi		0.00003

Powder particle size

Generic particle size distribution	20-55 µm

SEM picture of EOS NickelAlloy IN718 powder.



Process Information

System set-up	EOS M 290
EOS material set	IN718 Performance 2.0
EOSPAR name	IN718_040_PerformanceM291_2xx
Software requirements	EOSPRINT 1.7 or newer, EOSPRINT 2.6 or newer, EOSYSTEM 2.9 or newer
Powder part no.	9011-0020
Recoater blade	EOS HSS Blade
Nozzle	EOS Grid Nozzle
Inert gas	Argon
Sieve	63 µm

Additional information	
Layer thickness	40 µm
Volume rate	4.2 mm³/s
Min. wall thickness	Typical 0.3 - 0.4 mm

Heat Treatment

Heat treatment procedure conform to Aerospace Material Specification AMS 2774 and AMS 5662.
As manufactured microstructure for additively manufactured IN718 consists of gamma phase (γ). Heat treatment for IN718 is required to produce desired microstructure and part properties (gamma double prime precipitates, γ"). Heat treatment is also used to relieve stresses.

Step 1:
Solution Annealing: hold at 954 °C (1.750 °F) for 1 hour per 25 mm (0.98 inch) of thickness, air (/argon) cool

Step 2:
Ageing Treatment: hold at 718 °C (1.325 °F) 8 hours, furnace cool to 621 °C (1.150 °F) and hold at 621 °C (1.150 °F) for total precipitation time of 18 hours, air (/argon) cool

Chemical and Physical Properties of Parts

Heat treated microstructure. Etched according to ASTM E407-07.

Defects	Result	Number of samples
Average defect percentage	0.03 %	10
Density, ISO3369	**Result**	**Number of samples**
Average density	min 8.15 g/cm³	10

Mechanical Properties in Heat Treated State

Tensile properties heat treated (acc. AMS 2774 and AMS 5662)

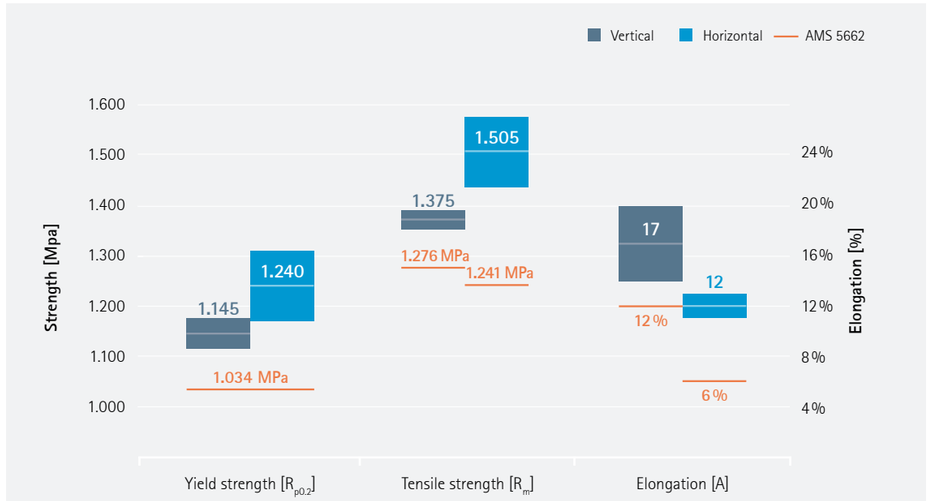
	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation at break A [%]	Number of samples
Vertical	1.145	1.375	17	54
Horizontal	1.240	1.505	12	26

Hardness as per ISO 6508-1

Hardness, HRC	47
Number of samples	45

Hardness as per DIN EN ISO 6506-1:2014

Hardness, HB	466
Number of samples	10



** T90: Tolerance intervals provide upper and lower bounds where 90 % of the population falls with 95 % confidence. Tolerance intervals are based on validation data / QA statistics and are not directly transferrable to other systems.*

Tensile properties as manufactured

	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation at break A [%]	Number of samples
Vertical	650	970	32	41
Horizontal	800	1090	25	36

Additional Data

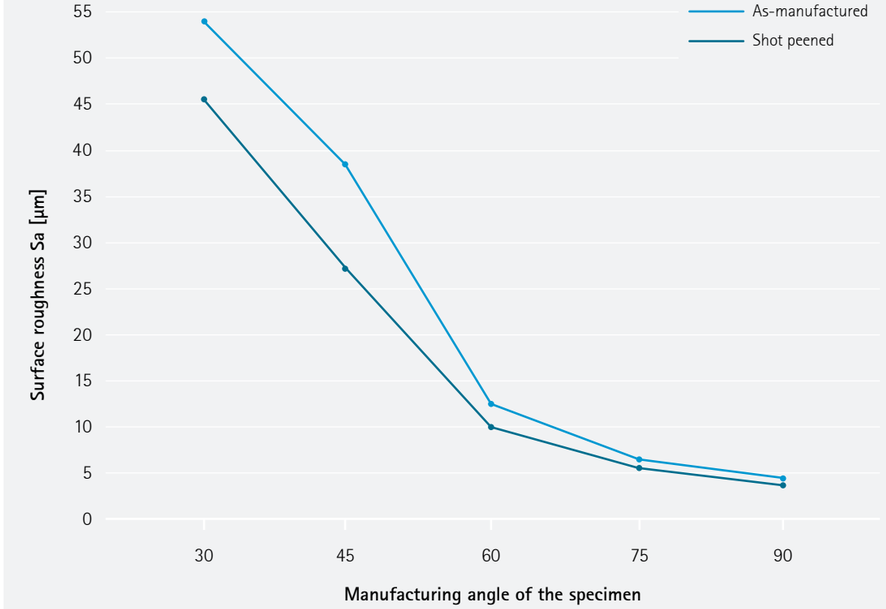
Coefficient of Thermal Expansion ASTM E228-17

Temperature	25-100 °C	25-200 °C	25-300 °C	25-400 °C	25-500 °C	25-600 °C	25-700 °C
CTE	13,1*10^{-6}/K	13,7*10^{-6}/K	14,1*10^{-6}/K	14,4*10^{-6}/K	14,7*10^{-6}/K	15,0*10^{-6}/K	15,5*10^{-6}/K

Surface Roughness

Horizontal surface	As-manufactured Sa 4.5 µm	Shot Peened Sa 3.8 µm
Vertical and angled surfaces according to figure		

Surface roughness



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Status 02/2020 (V1.0, CR696, 2020-02)

Cover: This image shows a possible application.

Metal
Solutions

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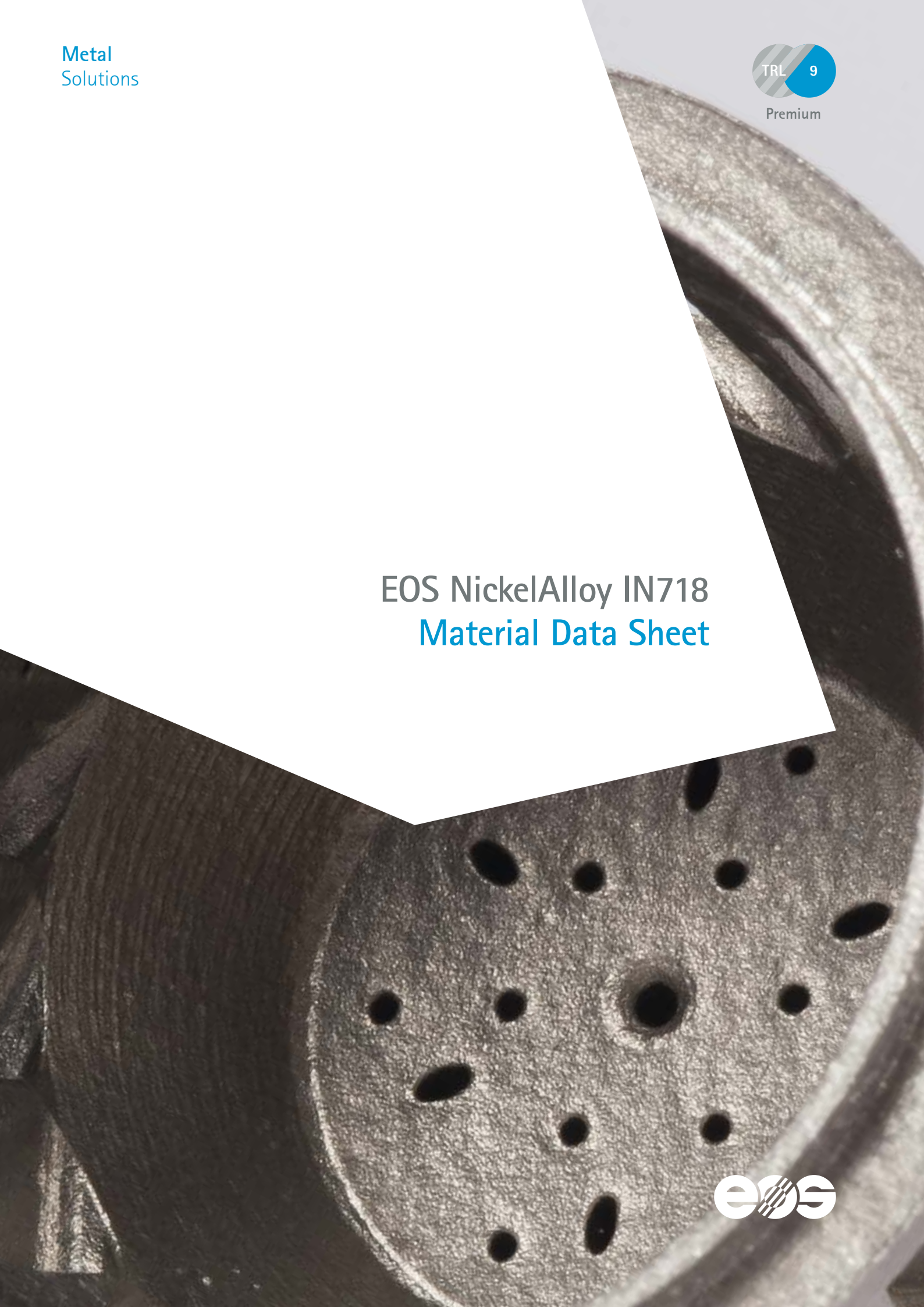
EOS NickelAlloy IN718
Material Data Sheet



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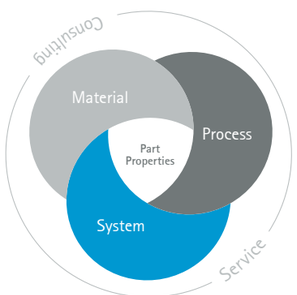

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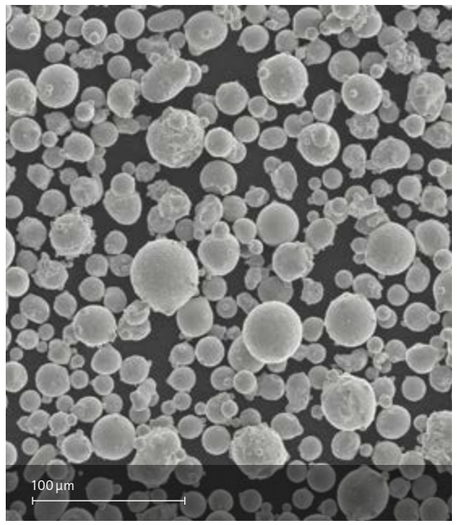

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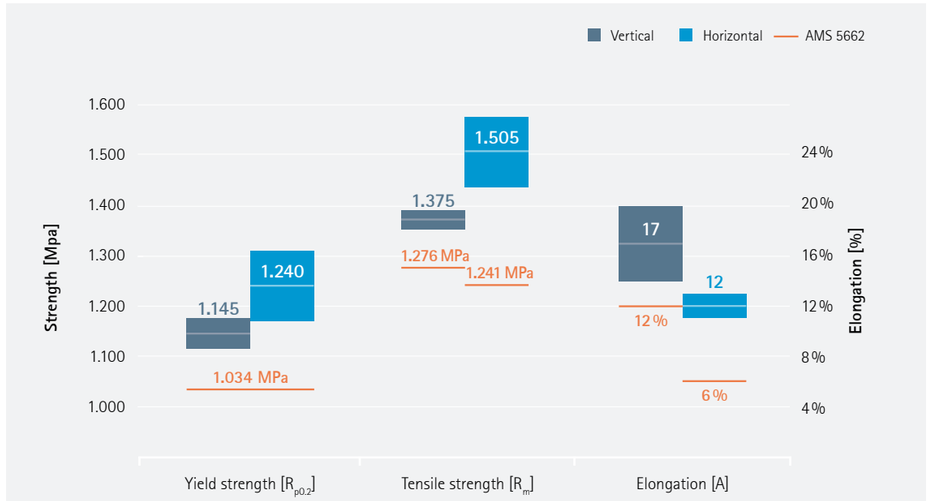

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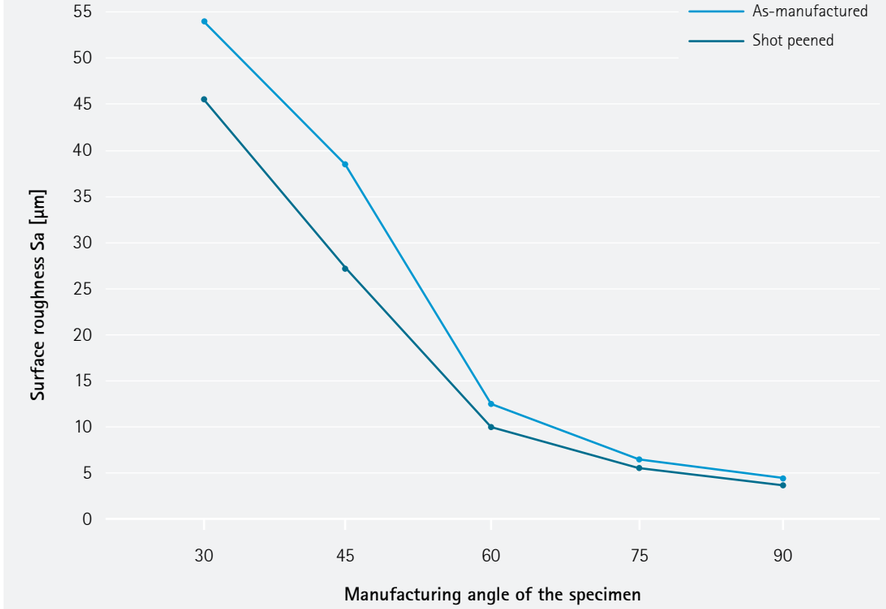

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Status 02/2020 (V1.0, CR696, 2020-02)

Cover: This image shows a possible application.

Metal
Solutions

TRL 3
Core

EOS NickelAlloy IN718
for EOS M 300-4

EOS NickelAlloy IN718
EOS M 300-4 | 40 µm

EOS NickelAlloy IN718 is a precipitation-hardening nickel-chromium alloy that is characterized by having good tensile, fatigue, creep and rupture strength at temperatures up to 700 °C (1,290 °F).

Project Partner Isar Aerospace

Main Characteristics

- Parts are easily precipitation hardened
- Parts can be machined, spark-eroded, welded, micro shot-peened, polished and coated
- Chemical composition corresponding to UNS N07718, AMS 5662, AMS 5664, W.Nr 2.4668, DIN NiCr19Fe19NbMo3

Typical Applications

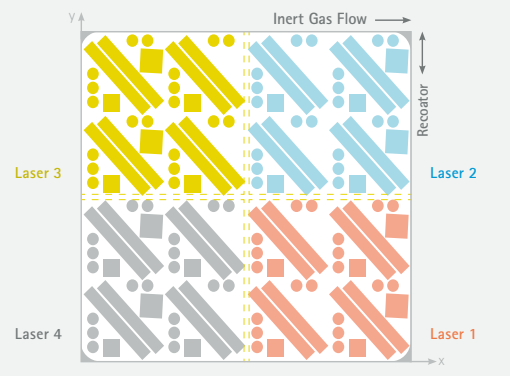
- Gas turbine components
- Instrumentation parts
- Power industry parts
- Process industry parts

Product Information

DMLS System	EOS M 300-4
Material	EOS NickelAlloy IN718
Process	40 µm layer thickness
Inert Gas	Argon
Recoater blade	HSS, two-sided recoating
Volume rate	up to 4 x 4.2 mm³/s

Layout of test job

Part properties based on 2 test jobs each for the as manufactured and heat treated data.



Typical part properties	Yield strength $Rp_{0.2}$ [MPa]	Tensile strength Rm [MPa]	Elongation at break A [%]	Number of samples
As manufactured vertical	634	957	36	158
As manufactured horizontal	796	1,092	27	62
Heat treated vertical	1,141	1,370	20	159
Heat treated horizontal	1,267	1,531	15	44
Max. pore size	< 100 µm			64
Porosity	< 0.05 %			64

Mechanical properties tested according to EN ISO 6892-1 B10. The values in the table are average values. Heat treatment procedure in accordance with AMS 5662.

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Status 11/2020

EOS NickelAlloy IN718

EOS NickelAlloy IN718 is a heat and corrosion resistant nickel alloy powder intended for processing on EOS DMLS systems.

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

- EOS DMLS system: M400 SF
- EOSYSTEM: EOSPRINT v.1.2/HCS v.2.2.40
- EOS Parameter set IN718_040_FlexM400_1.11

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.

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Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

Technical Data

Powder properties

Material composition

Element	Min	Max
Ni	50	55
Cr	17.0	21.0
Nb	4.75	5.5
Mo	2.8	3.3
Ti	0.65	1.15
Al	0.20	0.80
Co	-	1.0
Cu	-	0.3
C	-	0.08
Si, Mn	-	0.35
P, S	-	0.015
B	-	0.006
Fe	-	Balance

Max. particle size

Particles > 63µm [1]	max. 0.3 wt.-%

[1] Sieve analysis according to DIN ISO 4497 or ASTM B214.

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General process data

Layer thickness	40 µm
Volume rate [2]	4.2 mm³/s (15.2 cm³/h)

[2] The volume rate is a measure of build speed during laser exposure of the skin area. The total build speed depends on this volume rate and many other factors such as exposure parameters of contours, supports, up and downskin, recoating time, Home-In or LPM settings.

Physical and chemical properties of parts

Part density [3]	min. 8.15 g/cm3
Surface roughness after shot peening [4]	Ra < 6.5 µm; Rz < 50.0 µm

[3] Weighing in air and water according to ISO 3369.
[4] Measurement according to ISO 4287. The numbers were measured at the horizontal (up-facing) and all vertical surfaces of test cubes. Due to the layerwise building the roughness strongly depends on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect.

Tensile data at room temperature [5, 6]

	As built	**Heat treated [7]**
Ultimate tensile strength, Rm	1040 MPa	1470 MPa
Yield strength, Rp0.2	710 MPa	1200 MPa
Elongation at break A	26 %	15 %

[5] The numbers are average values and are determined from samples with horizontal and vertical orientation.
[6] 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).
[7] Heat treatment procedure conform to Aerospace Material Specification AMS 2774D and AMS 5662:
1. Solution Anneal at 954 °C (1750 °F) for 1 hour per 25mm (0.98 inch) of thickness, air (/argon) cool.
2. Ageing treatment; hold at 718 °C (1325 °F) 8 hours, furnace cool to 621 °C (1150 °F) and hold at 621 °C (1150 °F) for total precipitation time of 18 hours., air (/argon) cool.

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Abbreviations

min. minimum

max. maximum

wt. weight

Legal notes

The quoted values refer to the use of this material with above specified EOS DMLS system, EOSYSTEM software version, parameter set and operation in compliance with parameter sheet and operating instructions. All measured values are average numbers. Part properties are measured with specified measurement methods using defined test geometries and procedures. Further details of the test procedures used by EOS are available on request. Any deviation from these standard settings may affect the measured properties.

The data correspond to EOS knowledge and experience at the time of publication and they are subject to change without notice as part of EOS' continuous development and improvement processes.

EOS does not warrant any properties or fitness for a specific purpose, unless explicitly agreed upon. This also applies regarding any rights of protection as well as laws and regulations.

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