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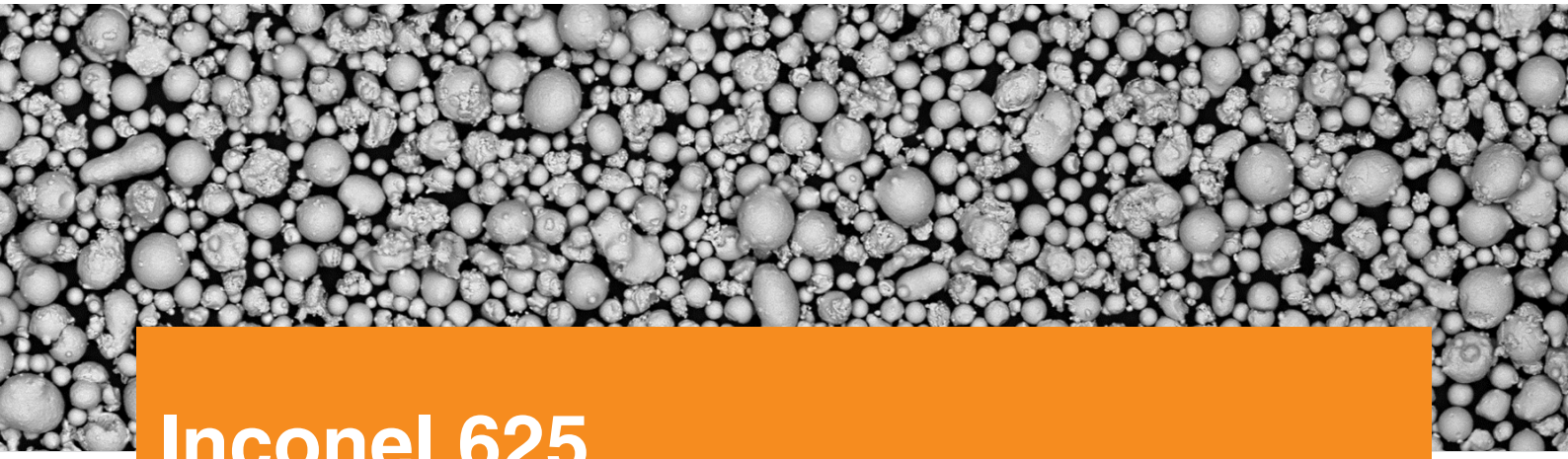

Inconel 625

Parameter set options

Layer thickness	Optimised for	Laser mode	Page
30 µm	Single laser per part	Modulated	4
60 µm	Single laser per part	Continuous wave	5
60 µm	Multiple laser per part	Continuous wave	6

To download the latest material files, visit **www.renishaw.com/softwarelicensing.**

Material description

Inconel 625 alloy comprises nickel alloyed with chromium of mass fraction up to 23% and molybdenum up to 10%, along with other minor elements. The addition of niobium, acting with molybdenum, gives the alloy high strength and toughness when annealed.

Inconel 625 is particularly suitable for seawater applications and applications where corrosion and oxidation resistance at high temperatures is required. Like Inconel 718, Inconel 625 is suitable for applications where good tensile, creep, and rupture strength is required.

Material properties

- High creep resistance
- Very high corrosion and oxidation resistance at high temperatures
- High fatigue strength in seawater
- Excellent welding characteristics
- Non-magnetic

Applications

- Automotive
- Aerospace and defence
- Chemical process industry
- Marine engineering
- Oil and gas industry
- Nuclear
- Seawater heat exchangers

Disclaimer

The mechanical property data featured in this document were obtained from tests performed in Renishaw's laboratories and they indicate the mechanical properties that can be achieved. The data is not intended as a guaranteed minimum specification.

Glossary of terms

Term	Definition
Scan strategy	Determines the path the laser will take to melt the cross-sectional area of the parts featured in each layer of the build process.
Meander	A scan strategy that takes the form of a straight-line vector path that bounces back and forth from each side of the part border. Meander strategy is quick and ideal for parts with a small XY cross section.
Stripe	A scan strategy where the area within the part border is split into strips and a meander technique is used within each strip. Stripe is ideal for parts with a large XY cross section.

Typical wrought material properties

Material property	Wrought material value
Density	8.4 g/cm^3
Thermal conductivity	9 W/mK to 11 W/mK
Melting temperature	1 290 °C to 1 350 °C
Coefficient of thermal expansion [1]	13×10^{-6} K^{-1}

[1] In the range of 20 °C to 200 °C.

Recommended composition of powder

Element	Mass (%)
Nickel	Balance
Chromium	20.00 to 23.00
Molybdenum	8.00 to 10.00
Iron	≤ 5.00
Niobium	3.15 to 4.15
Cobalt	≤ 1.00
Manganese	≤ 0.50
Silicon	≤ 0.50
Aluminium	≤ 0.40
Titanium	≤ 0.40
Carbon	≤ 0.10
Phosphorus	≤ 0.02
Sulphur	≤ 0.02

Recommended powder size distribution: 15 µm to 45 µm.

The values shown in this table are for ASTM standard composition powder. Renishaw powders are supplied to a tighter specification to minimise batch-to-batch variations. Results quoted in this data sheet are from samples produced using Renishaw's tighter-specification powder. To purchase powder from Renishaw, visit the online store at **www.renishaw.com/shop**.

Please contact Renishaw for further information about specifications or if you require support in qualifying non-Renishaw powders.

Parameter set summary

Layer thickness	Optimised for	Laser mode	Gas flow rate	Build rate	
30 µm	Single laser per part	Modulated	190 m^3/h	One laser: 8.5 cm^3/h	Four lasers: 34 cm^3/h

Material files: In625_500QS_A30_M_01_B (meander scan strategy)
In625_500QS_A30_S_01_B (stripe scan strategy)

Properties of additively manufactured components

NOTE: This parameter set is optimised for bulk density. The material properties in this table are indicative only. Further modification of the material file may be required to suit your application.

		As built	Annealed [1]
Bulk density [2]		≥ 99.8%	-
Ultimate tensile strength [3]	Vertical (Z)	864 MPa ±3 MPa	827 ±3 MPa
Yield strength [3]	Vertical (Z)	585 MPa ±2 MPa	507 ±3 MPa
Elongation after fracture [3]	Vertical (Z)	59% ±<1%	69% ±<1%
Modulus of elasticity [3]	Vertical (Z)	139 GPa ±3 GPa	147 GPa ±3 GPa
Hardness (Vickers) [4]	Horizontal (XY)	277 HV0.5 ±4 HV0.5	268 HV0.5 ±5 HV0.5
	Vertical (Z)	291 HV0.5 ±7 HV0.5	275 HV0.5 ±5 HV0.5

Mechanical test samples were created using four lasers, one laser per sample and with no downstream processing. Meander scan strategy was used for vertical samples.

1 Annealing method used for testing: Under vacuum, heat at 8 °C/min to 1 048 °C ± 10 °C, then hold temperature for one hour. Gas quench with argon at 1 bar to room temperature.

2 Measured optically on 10 mm × 10 mm × 10 mm samples at 75× magnification.

3 Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.

4 Tested to ASTM E384-11 after polishing.

Parameter set summary

Layer thickness	Optimised for	Laser mode	Gas flow rate	Build rate	
60 µm	Single laser per part	Continuous wave	190 m^3/h	One laser: 29.2 cm^3/h	Four lasers: 116.8 cm^3/h

Material files: In625_500QS_B60_M_02_A (meander scan strategy)
In625_500QS_B60_S_02_A (stripe scan strategy)

Properties of additively manufactured components

NOTE: This parameter set is optimised for bulk density. The material properties in this table are indicative only. Further modification of the material file may be required to suit your application.

		As built	Annealed [1]
Bulk density [2]		≥ 99.8%	-
Ultimate tensile strength [3]	Horizontal (XY)	1 040 MPa ±6 MPa	971 MPa ±9 MPa
	Vertical (Z) – Meander	959 MPa ±9 MPa	866 MPa ±6 MPa
	Vertical (Z) – Stripe	-	900 MPa ±8 MPa
Yield strength [3]	Horizontal (XY)	724 MPa ±8 MPa	584 MPa ±8 MPa
	Vertical (Z) – Meander	618 MPa ±10 MPa	532 MPa ±5 MPa
	Vertical (Z) – Stripe	-	539 MPa ±7 MPa
Elongation after fracture [3]	Horizontal (XY)	37% ±4%	49% ±3%
	Vertical (Z) – Meander	49% ±2%	52% ±1%
	Vertical (Z) – Stripe	-	59% ±1%
Modulus of elasticity [3]	Horizontal (XY)	203 GPa ±14 GPa	187 GPa ±15 GPa
	Vertical (Z) – Meander	172 GPa ±19 GPa	194 GPa ±3 GPa
	Vertical (Z) – Stripe	-	179 GPa ±12 GPa
Hardness (Vickers) [4]	Horizontal (XY)	263 HV0.5 ±5 HV0.5	262 HV0.5 ±8 HV0.5
	Vertical (Z)	277 HV0.5 ±9 HV0.5	264 HV0.5 ±6 HV0.5
Surface roughness [5]	Vertical (Z) (Median Ra)	12 µm ±1 µm	10 µm ±1 µm
	Vertical (Z) (Median Rz)	87 µm ±11 µm	72 µm ±10 µm
Plastometrex yield strength [6]	Horizontal (XY)	-	504 µm ±54 µm
Plastometrex ultimate tensile strength [6]	Horizontal (XY)	-	934 µm ±36 µm

Mechanical test samples were created using four lasers, one laser per sample and with no downstream processing. Meander scan strategy was used for vertical samples. Stripe scan strategy was used for horizontal samples.

1 Annealing method used for testing: Under vacuum, heat at 8 °C/min to 1 048 °C ±10 °C, then hold temperature for 1 hour. Gas quench with argon at 1 bar to room temperature.

2 Measured optically on 10 mm × 10 mm × 10 mm samples at 75× magnification.

3 Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.

4 Tested to ASTM E384-11 after polishing.

5 Tested on as-built vertical surfaces using laser interferometry. Tested to JIS B 0601 2001 (ISO 4287:1997).

6 Plastometrex's standard indentation procedure was used to generate the data. Indents were carried out on 10 mm × 10 mm × 10 mm samples. Values are based on 5 indents from 3 samples.

Parameter set summary

Layer thickness	Optimised for	Laser mode	Gas flow rate	Build rate
60 µm	Multiple laser per part	Continuous wave	190 m^3/h	Four lasers: 116.8 cm^3/h

Material files: In625_500QS_C60_S_02_A (stripe scan strategy)

Properties of additively manufactured components

NOTE: This parameter set is optimised for bulk density. The material properties in this table are indicative only. Further modification of the material file may be required to suit your application.

		As built	Annealed [1]
Bulk density [2]		≥ 99.8%	-
Ultimate tensile strength [3]	Horizontal (XY)	1 042 MPa ±3 MPa	981 MPa ±5 MPa
	Vertical (Z)	976 MPa ±7 MPa	897 MPa ±4 MPa
Yield strength [3]	Horizontal (XY)	718 MPa ±3 MPa	592 MPa ±6 MPa
	Vertical (Z)	639 MPa ±6 MPa	539 MPa ±8 MPa
Elongation after fracture [3]	Horizontal (XY)	42% ±1%	50% ±3%
	Vertical (Z)	50% ±1%	58% ±1%
Modulus of elasticity [3]	Horizontal (XY)	191 GPa ±11 GPa	194 GPa ±7 GPa
	Vertical (Z)	218 GPa ±12 GPa	179 GPa ±13 GPa
Hardness (Vickers) [4]	Horizontal (XY)	263 HV0.5 ±5 HV0.5	260 HV0.5 ±10 HV0.5
	Vertical (Z)	277 HV0.5 ±10 HV0.5	266 HV0.5 ±7 HV0.5
Surface roughness [5]	Vertical (Z) (Median Ra)	11 µm ±1 µm	11 µm ±1 µm
	Vertical (Z) (Median Rz)	83 µm ±9 µm	83 µm ±9 µm

Mechanical test samples were created using four lasers, one laser per sample and with no downstream processing. The scan strategy used for vertical samples is indicated in the table above. Stripe scan strategy was used for horizontal samples.

1 Annealing method used for testing: Under vacuum, heat at 8 °C/min to 1 048 °C ±10 °C, then hold temperature for 1 hour. Gas quench with argon at 1 bar to room temperature.

2 Measured optically on 10 mm × 10 mm × 10 mm samples at 75× magnification.

3 Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.

4 Tested to ASTM E384-11 after polishing.

5 Tested on as-built vertical surfaces using laser interferometry. Tested to JIS B 0601 2001 (ISO 4287:1997).

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