

# Inconel 625

## Parameter set options

Layer thickness	Optimised for	Page
30 µm	Single laser per part	3
60 µm	Single laser per part	4
60 µm	Multiple lasers per part	5

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## 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 has a wide range of applications within industry and 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 exchanges

# Generic material data

## Typical wrought material properties

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

<sup>1</sup> 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](http://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 m³/h	One laser: 8.5 cm³/h	Four lasers: 34 cm³/h

**Material files:** In625\_500QS\_A30\_M\_##\_# (meander scan strategy)  
In625\_500QS\_A30\_S\_##\_# (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 <sup>1</sup>	
	Mean	Standard deviation	Mean	Standard deviation
<b>Bulk density</b> <sup>2</sup>	≥ 99.8%	-	-	-
<b>Ultimate tensile strength</b> <sup>3</sup>				
Vertical direction (Z)	864 MPa	3 MPa	827 MPa	3 MPa
<b>Yield strength</b> <sup>3</sup>				
Vertical direction (Z)	585 MPa	2 MPa	507 MPa	3 MPa
<b>Elongation after fracture</b> <sup>3</sup>				
Vertical direction (Z)	59%	<1%	69%	<1%
<b>Modulus of elasticity</b> <sup>3</sup>				
Vertical direction (Z)	139 GPa	3 GPa	147 GPa	3 GPa
<b>Hardness (Vickers)</b> <sup>4</sup>				
Horizontal direction (XY)	277 HV0.5	4 HV0.5	268 HV0.5	5 HV0.5
Vertical direction (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 and stripe scan strategy for horizontal samples. The mechanical property data 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.

- <sup>1</sup> 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.
- <sup>2</sup> Measured optically on a 10 mm × 10 mm × 10 mm sample at 75× magnification.
- <sup>3</sup> Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.
- <sup>4</sup> 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 <sup>3</sup> /h	One laser: 29.2 cm <sup>3</sup> /h	Four lasers: 116.8 cm <sup>3</sup> /h

**Material files:** In625\_500QS\_B60\_M\_##\_# (meander scan strategy)  
In625\_500QS\_B60\_S\_##\_# (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.

	Annealed <sup>1</sup>	
	Mean	Standard deviation
<b>Bulk density</b> <sup>2</sup>	≥ 99.5%	-
<b>Ultimate tensile strength</b> <sup>3</sup>		
Vertical direction (Z)	866 MPa	6 MPa
<b>Yield strength</b> <sup>3</sup>		
Vertical direction (Z)	532 MPa	5 MPa
<b>Elongation after fracture</b> <sup>3</sup>		
Vertical direction (Z)	52%	1%
<b>Modulus of elasticity</b> <sup>3</sup>		
Vertical direction (Z)	194 GPa	3 GPa
<b>Hardness (Vickers)</b> <sup>4</sup>		
Horizontal direction (XY)	244 HV0.5	7 HV0.5
Vertical direction (Z)	250 HV0.5	10 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 and stripe scan strategy for horizontal samples. The mechanical property data 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.

- <sup>1</sup> 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.
- <sup>2</sup> Measured optically on a 10 mm × 10 mm × 10 mm sample at 75× magnification.
- <sup>3</sup> Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.
- <sup>4</sup> Tested to ASTM E384-11 after polishing.

## Parameter set summary

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

**Material files:** In625\_500QS\_C60\_S\_##\_# (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 <sup>1</sup>	
	Mean	Standard deviation	Mean	Standard deviation
<b>Bulk density</b> <sup>2</sup>	≥ 99.8%	-	-	-
<b>Ultimate tensile strength</b> <sup>3</sup>				
Horizontal direction (XY)	1 021 MPa	8 MPa	958 MPa	9 MPa
Vertical direction (Z)	976 MPa	7 MPa	892 MPa	8 MPa
<b>Yield strength</b> <sup>3</sup>				
Horizontal direction (XY)	722 MPa	41 MPa	569 MPa	9 MPa
Vertical direction (Z)	639 MPa	6 MPa	528 MPa	8 MPa
<b>Elongation after fracture</b> <sup>3</sup>				
Horizontal direction (XY)	41%	1%	45%	1%
Vertical direction (Z)	50%	<1%	57%	1%
<b>Modulus of elasticity</b> <sup>3</sup>				
Horizontal direction (XY)	225 GPa	11 GPa	210 GPa	11 GPa
Vertical direction (Z)	218 GPa	12 GPa	216 GPa	8 GPa
<b>Hardness (Vickers)</b> <sup>4</sup>				
Horizontal direction (XY)	268 HV0.5	12 HV0.5	255 HV0.5	7 HV0.5
Vertical direction (Z)	271 HV0.5	14 HV0.5	256 HV0.5	8 HV0.5
<b>Surface roughness (Ra)</b> <sup>5</sup>				
Vertical direction (Z)	13 Ra	-	-	-

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 and stripe scan strategy for horizontal samples. The mechanical property data 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.

- <sup>1</sup> 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.
- <sup>2</sup> Measured optically on a 10 mm × 10 mm × 10 mm sample at 75× magnification.
- <sup>3</sup> Tested at ambient temperature to ASTM E8. Machined prior to testing. Values based on 16 samples.
- <sup>4</sup> Tested to ASTM E384-11 after polishing.
- <sup>5</sup> Tested to JIS B 0601-2001 (ISO 97).

[www.renishaw.com/additivemanufacturing](http://www.renishaw.com/additivemanufacturing)



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