# Inconel® 625

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## Material & Process Capability

Inconel® 625 is a solid solution strengthened nickel-based superalloy. It is characterized by having excellent tensile, creep, and rupture properties, particularly at high temperatures. IN625 has good corrosion resistance in various corrosive environments. The Velo3D intelligent additive printing solution uniquely enables companies to build the parts they need without compromising design or quality - resulting in complex parts higher in performance than traditional casting techniques or other additive methods.

## General Process

In addition to its strength, IN625 is characterized by its superb fatigue, creep, and rupture resistance in extreme environments. IN625 is difficult to shape and machine using subtractive manufacturing techniques. This data sheet specifies the expected mechanical properties and characteristics of this alloy when manufactured on a Velo3D Sapphire System. All data is based on parts built using Velo3D standard 50 µm layer thickness parameters, using Praxair Tru-Form 625-2, a Velo3D-approved powder. Parts built from IN625 on a Sapphire System can be heat treated like those manufactured by other methods.

| | |
|---|---|
| Density, g/cc (lbs/cubic in) | 8.19 (0.296) |
| Relative Density, percent | 99.9+ |
| Surface Finish[1], $S_a$, µm (µin) | <15 (590) |

## Mechanical Properties at Room Temperature

| Tensile Properties[2] | | | | Ultimate Tensile Strength, MPa (ksi) | | Yield (0.2% Offset), MPa (ksi) | | Elongation At Break, percent | |
|---|---|---|---|---|---|---|---|---|---|
| Process Recipe | TBR (cc/h)[3] | State | Sample Size[7] | Mean | Min | Mean | Min | Mean | Min |
| 500W/50 µm | 28 | As-printed | 8 | 945 (137) | 940 (136) | 644 (93) | 640 (93) | 42.7 | 41.5 |
| | | Solution Anneal 1[4] | 26 | 906 (131) | 895 (130) | 545 (79) | 535 (78) | 48.1 | 44 |
| 1kW/50 µm | 45 | As-printed | 30 | 875 (127) | 870 (126) | 576 (84) | 560 (81) | 41.7 | 40 |
| | | Solution Anneal 2[5] | 30 | 837 (121) | 835 (121) | 379 (54) | 375 (54) | 55.3 | 52.5 |
| | | HIP[6] | 30 | 831 (121) | 830 (120) | 381 (55) | 378 (55) | 56.2 | 53 |

**1.** For angles >25° from horizontal, actual finish depends on orientation and process selected **2.** Mechanical & test samples printed in vertical orientation, machined to ASTM E8 (round specimen #3) **3.** TBR: Theoretical Build Rate (TBR) is a per-laser build rate calculated from the process conditions of bulk core as *scan speed x hatch spacing x layer thickness*. This value represents a single laser only and is reported for comparison purposes across different materials and recipes, but does not correspond to true build rate, which is dependent on geometry and system characteristics (i.e. number of lasers, recoat times, etc.) **4.** Stress relief at 900 °C (1650 °F) for 1 hour. Solution anneal at 1010 °C (1850 °F) for 1 hour. **5.** Solution Anneal per AMS7000: product solution annealed in accordance with AMS2774 under inert or vacuum atmosphere at 1177 °C± 14°C (2150°F±25°F) for 60±10 minutes; cooled at a rate equal to an air cooling or faster to 649°C (1200°F) and cooled from 649°C (1200°F) at any rate. **6.** Hot Isostatic Pressing per AMS7000: HIP under inert atmosphere at 14,500 psi (100 MPa) minimum within 1149 °C to 1204 °C (2100 °F to 2200 °F), hold at selected temperature within ±14 °C (±25 °F) for 3 to 5 hours; cool under inert atmosphere in autoclave to below 649 °C (1200 °F). Cool from 649 °C (1200 °F) at any rate. **7.** Data collected from single Sapphire printer.

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| Hardness, HRB | | | | |
|---|---|---|---|---|
| Process Recipe | State | Sample Size[7] | Mean | Min |
| 1kW/50 µm | As-printed | 4 | 96 | 95 |
| | Solution Anneal 2[5] | 4 | 88 | 87 |
| | HIP[6] | 4 | 88 | 87 |

**1.** For angles >25° from horizontal, actual finish depends on orientation and process selected **2.** Mechanical & test samples printed in vertical orientation, machined to ASTM E8 (round specimen #3) **3.** TBR: Theoretical Build Rate (TBR) is a per-laser build rate calculated from the process conditions of bulk core as *scan speed x hatch spacing x layer thickness*. This value represents a single laser only and is reported for comparison purposes across different materials and recipes, but does not correspond to true build rate, which is dependent on geometry and system characteristics (i.e. number of lasers, recoat times, etc.) **4.** Stress relief at 900 °C (1650 °F) for 1 hour. Solution anneal at 1010 °C (1850 °F) for 1 hour. **5.** Solution Anneal per AMS7000: product solution annealed in accordance with AMS2774 under inert or vacuum atmosphere at 1177 °C± 14°C (2150°F±25°F) for 60±10 minutes; cooled at a rate equal to an air cooling or faster to 649°C (1200°F) and cooled from 649°C (1200°F) at any rate. **6.** Hot Isostatic Pressing per AMS7000: HIP under inert atmosphere at 14,500 psi (100 MPa) minimum within 1149 °C to 1204 °C (2100 °F to 2200 °F), hold at selected temperature within ±14 °C (±25 °F) for 3 to 5 hours; cool under inert atmosphere in autoclave to below 649 °C (1200 °F). Cool from 649 °C (1200 °F) at any rate. **7.** Data collected from single Sapphire printer.