# Meltio Nickel 625

Inconel 625 / ERNiCrMo-3 / S Ni 6625 / 2.4831

Nickel 625 is a superalloy that offers excellent strength, corrosion resistance, and heat resistance. It is a popular material choice in a wide range of applications, including aerospace, chemical processing, and naval industry, where it can withstand high temperatures and harsh environments. Among superalloys, Nickel 625 excels for its weldability, making it an ideal choice for cladding or repair of components working at high temperatures or requiring increased corrosion protection.

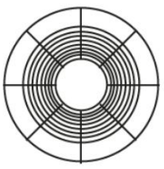
| | |
|---|---|
| **Properties** | Weldability, High Temperature Resistance and High Corrosion Resistance |
| **Applications** | Aerospace, Chemical Processing,Naval and Oil & Gas |

| **Wire Chemical Composition** | Ni | C | Si | Mn | Cr | Fe | Mo | Nb | S |
|---|---|---|---|---|---|---|---|---|---|
| **Weight Percent [%]** | Bal. | 0.02 | 0.2 | 0.2 | 22.0 | 1.0 | 9.0 | 2.5 | 0.01 |

| **Wire Density** |
|---|
| 8.20 g/cm³ |

| **Melting Point** | | |
|---|---|---|
| 1565 - 1625 K | 1290 - 1350 °C | 2350 - 2460°F |

## Spool Specs



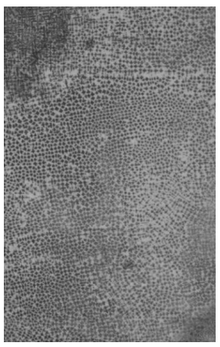
Meltio Materials are tightly spooled and packaged to ensure the best compatibility with Meltio systems.

| | |
|---|---|
| **Wire Diameter** | 1.0 mm |
| **Weight on Spool** | 15 kg |
| **Volume on Spool** | 1829 cm³ |
| **Spool Type** | BS300 |
| **Wire Coating** | Uncoated |

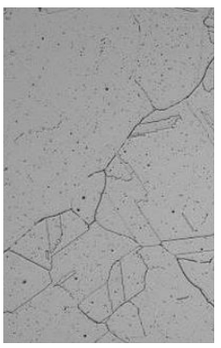
| | |
|---|---|
| Relative density as 3D printed IR Laser | > 99.7% |

## Micrography

The micrographs shows no significant micro-structural defects. Grains exhibit diverse sizes and no preferential orientation. Notable features include the presence of twins from thermal treatment, enhancing strength and toughness.



As-printed XY
100x Magnification



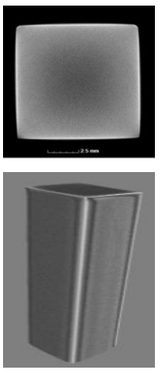
HT XY
100x Magnification

As-printed XY
100x Magnification

| ***IR Laser*** | ***Blue Laser*** |
|---|---|
| Tests Carried Out In IDONIAL<br>info@idonial.com | |

## Tomography

Computed Tomography Scan of 3D printed sample part in Ni 625 without detectable voids or defects. Resolution of 24 µm per pixel.



3D / Top View

Front View

| ***IR Laser*** |
|---|
| *Test Carried Out In CATEC*<br>info@catec.aero |

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## Deposition Parameters

The following printing parameters were obtained through rigorous testing. The **Infrared Profile** was derived from a 30 × 60 × 20 mm printed block, from which a 10 × 10 × 60 mm sample was extracted using EDM and analyzed via CT scan in an external laboratory. The **Blue Profile** was obtained from three scenarios (30 × 60 × 20 mm, 55 × 70 × 70 mm, and 250 × 250 × 30 mm) to ensure reliable unattended printing with maximum quality and energy density. Internally, samples were tested using Liquid Penetrant Testing (LPT) to evaluate surface-breaking defects on newly exposed internal surfaces after sectioning. Additional analyses, including Micrography, CT scan, and Structural testing, are conducted by an external lab.

These profiles are valid for 90% of solid parts, with a minimum part size of 30 × 30 mm. Their performance depends on geometry, overhangs, material, thickness, and base material. Profiles serve as a reference for specific applications, but operator expertise remains essential for achieving optimal print quality for the specific application. Adjustments may be necessary to overcome challenges or deviations from standard shapes.

The **Blue Profiles are under continuous development**, with updates released at least quarterly to enhance performance and reliability. The data presented reflects the current state, and improvements are ongoing. In case of doubts about performance or specific requirements, please contact the **Meltio Process Team** for guidance.

These printing parameters are available in **Meltio Horizon** and **Meltio Space** slicers latest release.

| Technology | Revisión name | Laser Power [W] | Velocity [mm/s] | Argon Flow [l/min] | Layer Height [mm] | Layer Width [mm] | Wire Speed [mm/s] | Input Energy Density [J/mm3] | Deposition Rate [g/h] | Volume rate [cc/h |
|---|---|---|---|---|---|---|---|---|---|---|
| **IR Laser 976 nm** | **V.D.** | 1100 | 6.6 | 10.0 | 1.2 | 1.0 | 10.08 | 137.5 | 220 | 26.83 |
| **Blue laser 450 nm** | **Solid 1.2x1.4 Rev 13 2025-01-13** | 1000 | 9 | 15 | 1.2 | 1.4 | 20.9 | 66.13 | 446 | 54.39 |

## Heat Treatment

To achieve the best mechanical properties Nickel 625 should be heat-treated after 3D printing. The standard heat treatment process for Nickel 625 involves two steps: Solution Annealing and Age Hardening. Solution annealing removes internal stresses that have been formed during 3D printing. Machining may take place before or after the solution annealing. Once the component has been age hardened its machinability could be compromised.

## Heat treatment -1

### Solution Annealing

| | |
|---|---|
| Protective atmosphere<br>Heat up to 1150ºC | Hold for 2h<br>Fast cooling to RT |

### Age Hardening

| | |
|---|---|
| Protective atmosphere<br>Heat up to 700ºC in 1h<br>Hold at 700ºC during 24h | Cooling in oven to RT |

*Typical Parameters for a Sample of 160x60x30 mm*

## Heat treatment -2 According ASTM A494

### Solution Annealing

| | |
|---|---|
| Protective atmosphere<br>Heat up to 1150ºC | Rapid cooling in water or pressurized argon gas to RT |

# Meltio Nickel 625

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## Mechanical Properties

Results show that specimens printed using Meltio's wire-laser metal 3D printed process perform at the same level as samples made with conventional manufacturing methods. Testing is carried out in the less favorable XZ direction to ensure the values are applicable across complete part.

| | | | *ASTM E8M* | | |
|---|---|---|---|---|---|
| | **Wire Properties** | **Wrought Properties** ***(ASTM B446)*** | **Meltio XZ Properties IR Laser** ***(HT-1)*** | **Meltio XZ Properties Blue Laser** ***(As printed)*** | **Meltio Xy Properties Blue Laser** ***(As printed)*** |
| **Ultimate Tensile strength (UTS) [MPa]** | 800 | 827 | 739 ± 19 | 775.5 | 722.2 |
| **Yield strength [MPa]** | 520 | 414 | 323 ± 15 | 492.5 | 415.6 |
| **Elongation [%]** | 35 | 30 | 58.4 ± 3.9 | 50.2 | 52 |
| | | | Tests Carried Out In IDONIAL info@idonial.com | | |

The following Mechanical Properties were obtained, based on a printed block of 160x30x70 mm using the Verified Density Parametrization, from it 16 ASTM E8M samples were extracted using EDM and were analyzed by an external laboratory.

| | | *UNE EN ISO 6507-1* |
|---|---|---|
| | **Wrought Properties** ***(ASTM B446)*** | **Meltio Properties IR Laser** ***(HT-1)*** |
| **Hardness [HV10]** | 220 | 160 ± 3 |
| | | *Tests Carried Out in CETEMET* i+d+i@cetemet.es |

Based on a printed block of 30x60x20 mm using Verified Density Parametrization. A sample from this block of 10x10x60 mm was extracted using EDM, and was analyzed by an external lab.

## Charpy V-Notch Test

The Charpy V-notch test is a standardised high strain rate test that determines the amount of energy absorbed by a material during fracture. The energy absorbed is a measure of the notch toughness of the material. The results obtained with Meltio Ni 625 show the high performance of the alloy even at low temperatures.

| | *ASTM E23* |
|---|---|
| | **Meltio XZ Properties IR Laser** ***(HT-1)*** |
| **Temperature [ºC]** | - 60 |
| **Energy Absorbed [J]** | 230 ± 10 |
| | *Tests Carried Out In IDONIAL* info@idonial.com |

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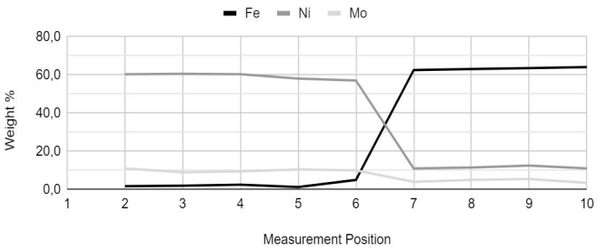
## Cladding and Dual Material Applications With IR Laser

Nickel 625 is highly resistant to wear, deformation and heat, which makes it an excellent material for cladding or dual material applications where not the entire component requires these properties. Nickel 625 has excellent weldability and can be used to form a dense and well-bonded coating layer that provides high wear resistance as well as excellent corrosion and temperature resistance.

## Elemental Distribution

Composition Mapping of Nickel 625 Cladding on SS316L. Measurements were spaced 150 µm.Apart with measurement 5 coinciding with the interface of the two materials.

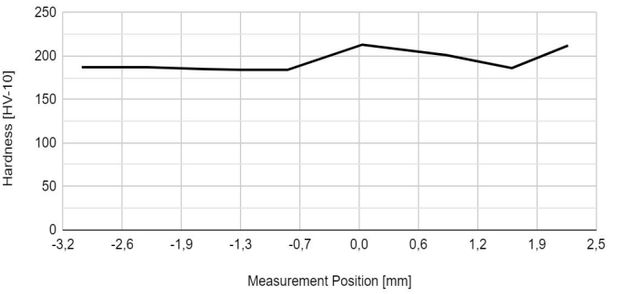
| Measurement [Position] | Nb [wt%] | Mo [wt%] | Mn [wt%] | Fe [wt%] | Ni [wt%] |
|---|---|---|---|---|---|
| 1 | 3.5 | 11.0 | 0.5 | 1.8 | 60.3 |
| 2 | 3.8 | 9.0 | 0.1 | 2.0 | 60.5 |
| 3 | 4.0 | 9.5 | 0.5 | 2.5 | 60.3 |
| 4 | 6.5 | 10.5 | 0.8 | 1.3 | 58.0 |
| **Interlayer** | | | | | |
| 5 | 4.0 | 10.0 | 0.5 | 5.0 | 57.0 |
| 6 | 0.5 | 4.0 | 1.5 | 62.5 | 11.0 |
| 7 | 1.5 | 5.0 | 1.0 | 63.0 | 11.5 |
| 8 | 0.5 | 5.5 | 1.5 | 63.5 | 12.5 |
| 9 | 0.5 | 3.5 | 1.5 | 64.0 | 11.0 |
| 10 | 1.0 | 4.0 | 1.5 | 64.5 | 11.5 |




## Hardness Profile

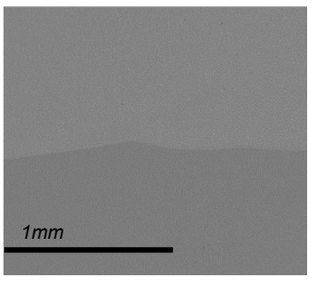
Hardness was measured across the material transition and results indicate that a single cladding layer is sufficient to achieve good and stable properties.

| Hardness [HV10] | Distance [mm] | Material [txt] |
|---|---|---|
| 212 | 2.2 | Nickel 625 |
| 186 | 1.6 | |
| 201 | 0.9 | |
| 213 | 0.0 | **Interlayer** |
| 184 | -0.8 | Stainless Steel 316L |
| 184 | -1.3 | |
| 185 | -1.7 | |
| 187 | -2.3 | |
| 187 | -3.0 | |

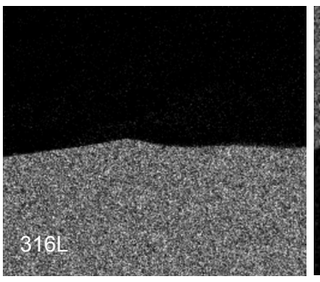



## Elemental Mapping

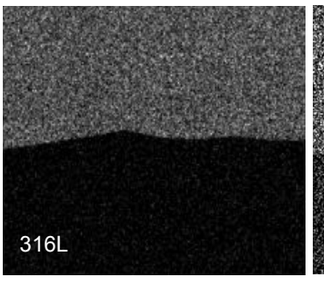
Elemental (EDX) Mapping is employed to characterize the dilution of the two materials. Meltio used as deposited Stainless Steel 316L as the substrate without post processing. Results show low dilution between the materials.



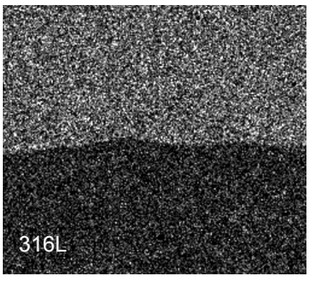

Cladding interface layer XZ
Electron Microscopy




Cladding interface layer XZ
Iron EDX Map




Cladding interface layer XZ
Nickel EDX Map




Cladding interface layer XZ
Molybdenum EDX Map

** Meltio's current work on material characterization is carried out using the Meltio M600 and it remains under constant development. Specifications provided herein may not reflect the latest state of our research. For further information and questions please contact us via info@meltio3d.com.*

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