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.

General Properties

Wire Diameter	Weight on Spool	Spool Type	Wire Coating	Melting Point	Wire Density	Recom. Build plate	Drive Wheels	Inertization[4]
1.0 mm	15 kg	BS300	Uncoated	1290-1350 ºC	8.40 g/cm³	304 Steel	1.0 V-Groove	Local

Chemical Composition

Ni	C	Si	Mn	Cr	Fe	Mo	Nb	S
Bal.	0.02	0.2	0.2	22.0	1.0	9.0	3.3	0.01

ISO/ASTM 52942:2020: Group F [6]

Tested Print Profiles

Laser	Profile name	Meltio TRL[5]	Laser Power [W]	Energy Density [J/mm3]	Deposition Rate [g/h]	Volume rate [cc/h]	Relative Density [%]	Max Pore/Defect [µm]
976 nm	**Verified Density**	Proven	1100	138.89	240	28.57	99.70	-
450 nm	**Rev 13 2025-04-04**	Qualified	1000	66.13	501	59.52	99.88	92 / 162
	Rev 5 2025-06-16	Qualified	1400	66.47	641	75.83	-	-

* Printing profiles available in our official Slicers: **Meltio Horizon** for standalone Printers and **Meltio Space** for Laser Integration Kits.
** Profiles developed for the 1.4Kw blue head will be available for Meltio Space for laser integration kits.

Structural Properties [1]

ASTM E8/E8M UNE EN ISO 6892-1 UNE EN ISO 6507-1	Wire	Infrared Laser		Blue Laser 1.0kW					
		Heat Treatment -1		Heat Treatment -2		Heat Treatment -1		As Printed	
		XY	XZ	XY	XZ	XY	XZ	XY	XZ
Ultimate Tensile Strength [MPa]	800	-	739 ± 19	903.6±8.4	746.5±50.7	848.4±14.1	768.7±24.8	834.4±17.1	785±12.6
Yield Strength [MPa]	520	-	323 ± 15	503.9±42	513.5±11.9	405.2±24	392.5±39.8	540.3±29.8	500±14.3
Elongation [%]	35	-	58.4 ± 3.9	40.4±2.7	18.95±7.7	51.43±4.8	34.85±3.6	46±6.4	38.8±3.9
Hardness [HV-10]	-	–	160 ± 3	-	-	-	-	222	-

Reference Standards

	Casting (ASTM A494)	Wrought *(ASTM B564-22)*	Wrought *(ASTM B446)*
Ultimate Tensile Strength [MPa]	485	690	827
Yield Strength [MPa]	275	276	414
Elongation [%]	25	30	30
Hardness [HV-10]	-	-	220

Charpy Test [2]

ASTM E23 **(XZ)**	Infrared Laser	
	As printed	Heat Treated
Temperature [ºC]	-	- 60
Energy Absorbed [J]	230 ± 10	

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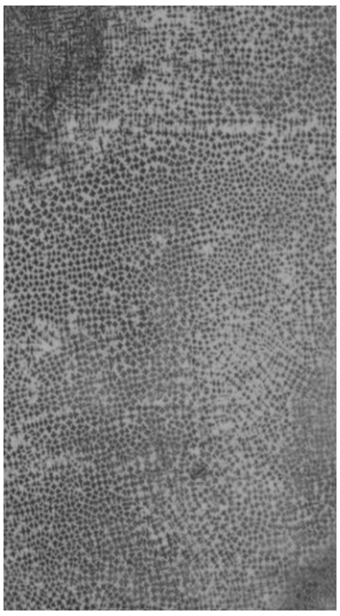
Internal Structure [3]

Micrography

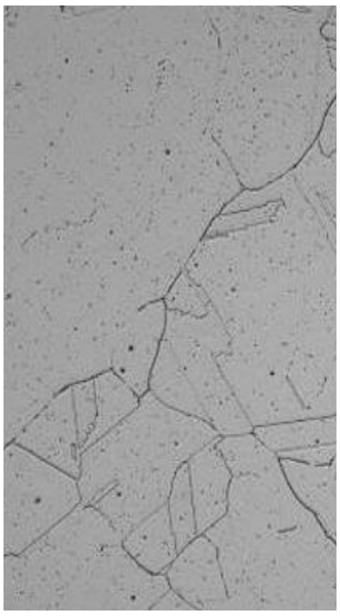
IR: The microstructural analysis of Nickel 625 reveals a dendritic gamma-phase (γ) morphology, with variable orientation throughout the sample. In sections where dendrites are aligned parallel to the polishing plane, secondary arms can be identified with an interdendritic spacing of 1.5 to 2 µm, which is characteristic of high solidification rates.

Blue: The microstructural analysis of Nickel 625 in the *As-Built* condition reveals a structure predominantly composed of gamma phase (γ), characterized by dendritic morphology with various orientations throughout the sample. After applying the HT heat treatment, a complete dissolution of the solidification dendrites is observed, resulting in a more homogeneous matrix with a high density of twins and the presence of precipitates within the grains and along their boundaries. In contrast, the HT2 treatment does not produce significant microstructural changes compared to the *As-Built* state, with the original dendritic structure remaining mostly unaltered.

IR Laser



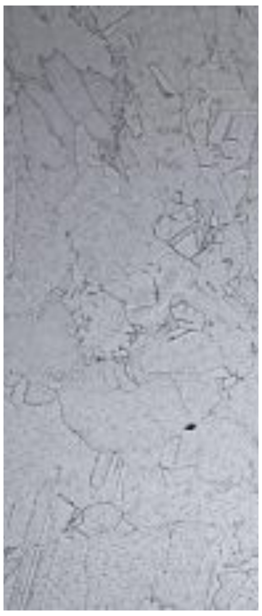
As-printed XY
100x Magnification



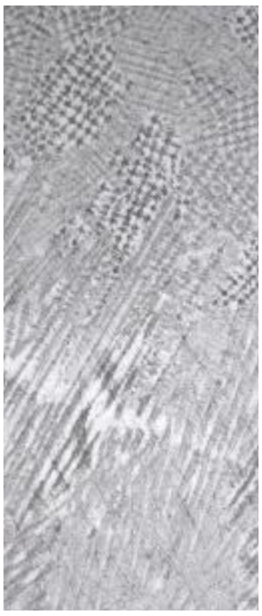
HT XY
100x Magnification

Blue Laser

As-printed XY
100x Magnification



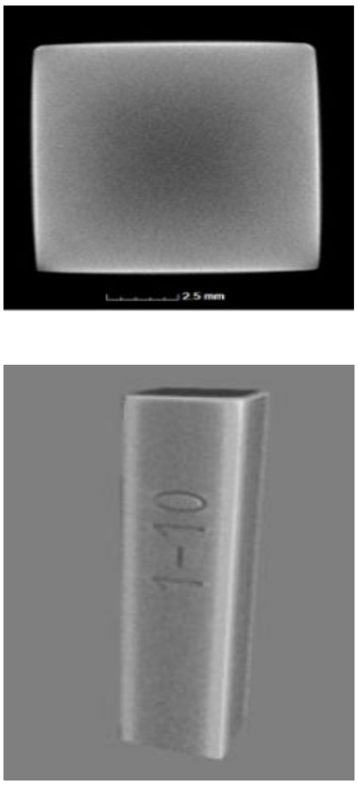
HT-2 XY
100x Magnification



HT-2 XY
100x Magnification

Tomography

CT Scan of 3D printed sample part in Nickel 625 using IR Laser without detectable voids or defects. Resolution of 24 µm per pixel.



3D / Top View

Front View

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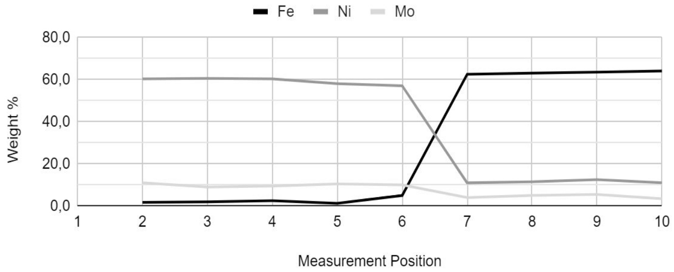
Cladding and Dual Material Applications With IR Laser

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.

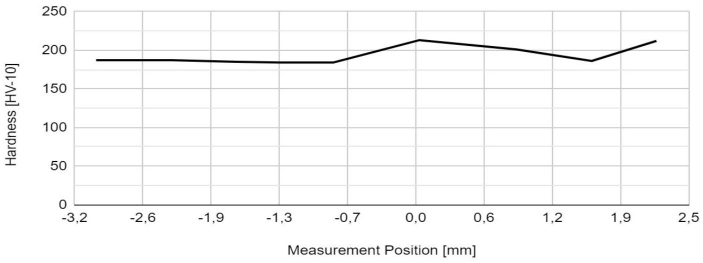
Measurement [Position]	Nb [wt%]	Mo [wt%]	Mn [wt%]	Fe [wt%]	Ni [wt%]
1	3.5	11.0	0.5	1.8	60.3
2	3.8	9.0	0.1	2.0	60.5
3	4.0	9.5	0.5	2.5	60.3
4	6.5	10.5	0.8	1.3	58.0
Interlayer					
5	4.0	10.0	0.5	5.0	57.0
6	0.5	4.0	1.5	62.5	11.0
7	1.5	5.0	1.0	63.0	11.5
8	0.5	5.5	1.5	63.5	12.5
9	0.5	3.5	1.5	64.0	11.0
10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



Hardness Profile

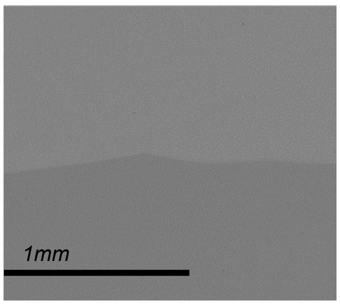
Hardness was measured across the material transition and results indicate that a single cladding layer is sufficient to achieve good and stable properties.

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	

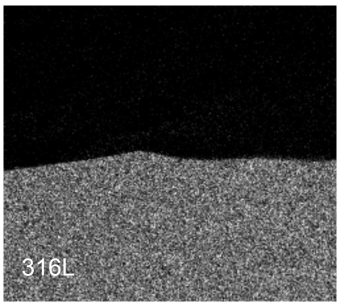


Elemental Mapping

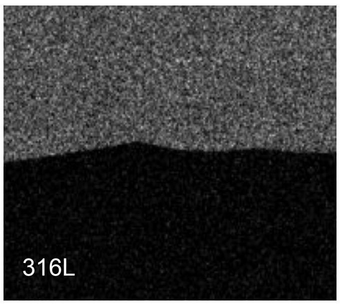
Elemental (EDX) Mapping is employed to characterize the dilution of the two materials. Meltio used as deposited Stainless Steel 316L as the substrate without post processing. Results show low dilution between the materials.



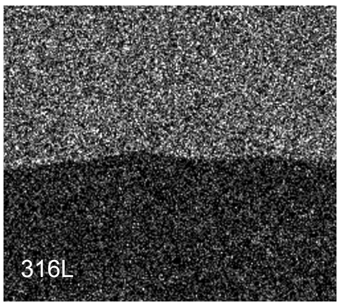
Cladding interface layer XZ
Electron Microscopy



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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1.Structural Properties

Tensile Tests

Specimens printed using Meltio's wire-laser metal 3D printed process perform at the same level as samples made with conventional manufacturing methods. Results show low deviations and near isotropic properties even in the as-printed state without the application of heat-treatments.

Mechanical Properties were obtained, based on a printed block of 160x30x70 mm using the Verified Density Parametrization for IR Laser and a printed block of 95x155x55 mm using the **Rev 13 2025-04-04** profile for the Blue laser, from it 16 ASTM E8M samples were extracted using EDM and were analyzed by an external laboratory. (*IDONIAL* info@idonial.com)

Hardness

Based on a printed block of 30x60x20 mm using Verified Density Parametrization. A sample from this block of 10x10x60 mm was extracted using EDM. from it UNE-EN ISO 6507-1 and was analyzed by an external laboratory. (*CETEMET* i+d+i@cetemet.es).

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		Age Hardening	
Protective atmosphere Heat up to 1150ºC	Hold for 2h Fast cooling to RT	Protective atmosphere Heat up to 700ºC in 1h Hold at 700ºC during 24h	Cooling in oven to RT

Typical Parameters for a ASTM E8M cylinder sample of 4 mm diameter and 10 mm long extracted by EDM from a printed block for Tensile Tests

Heat Treatment -2

Solution Annealing		Age Hardening	
Protective atmosphere Heat up to 1010ºC	Hold for 1h Cooling to RT	Protective atmosphere Hold at 650ºC during 16h	Cooling in oven to RT

2.Charpy 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.

3.Internal Structure

Micrography

The micrography were obtained from a 10x10x60 mm printed block using the Verified Density Profile for IR laser and **Rev 13 2025-04-04** profile for the Blue laser. The metallographic analysis followed ASTM E3-11:2017 standards, ensuring proper preparation and examination of the microstructure and were analyzed by an external laboratory. (*IDONIAL* info@idonial.com)

Tomography

The tomography images were obtained from a 10x10x60 mm printed block using the Verified Density Profile for IR laser and were analyzed by an external laboratory. (*CATEC* info@catec.aero)

Relative Density

Characterizing materials for its Blue Laser technology using 300x400x60 mm 304L steel build plates. Relative density and pore size are evaluated through micrography following NASA-STD-6030 "Additive Manufacturing Requirements for Spaceflight Systems," based on a 250x250x30 mm printed specimen. The results comply with NASA-STD-6030, showing an overall porosity fraction below 0.25% by volume and were analyzed by an external laboratory. (*IDONIAL* info@idonial.com , *CETEMET* i+d+i@cetemet.es , AIMEN comunicacion@aimen.es)

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4.Inertization

Inertization of Meltio M600 machinery can be performed in two ways: localised inertisation or full chamber inertization. Both options are designed to ensure a controlled environment during the 3D printing process and prevent oxygen contamination of reactive materials.

Localised Inertization:
In this mode, the shielding gas is supplied locally through the shield nozzle located in the deposition head, with a flow rate of approximately 15 L/min. This method is suitable for most applications where oxygen control in the work area is necessary without requiring a completely isolated environment.

Full Chamber Inertization:
For more demanding applications, it is possible to perform a full chamber inertization. In this case, the chamber must be preconditioned before the printing process is started, reaching an oxygen concentration of 50 ppm. It is essential to control the oxygen concentration in the chamber, as reactive materials can absorb oxygen even when the part is hot, not only when it is in the melt pool.

The choice of inertisation method depends on the properties of the material to be used and the specific requirements of the printing process, ensuring the highest quality and integrity of the manufactured parts.

5.Meltio TRL Classification System

The manufacturing process of Copper and Aluminum using Meltio's Blue Laser technology has certain limitations. Currently, thin-walled geometries (produced in a single pass) can be reliably manufactured. However, solid or bulky components present challenges due to variations in material behavior and thermal properties as the volume and mass increase. While small solid volumes of these materials can be printed, scalability remains an area of ongoing development.

Additionally, the technological readiness of Copper and Aluminum printing is currently between **Technology Readiness Level (TRL) 3 and 4,** indicating that it is still in the experimental validation and optimization stages. In contrast, other Meltio materials, such as steels, nickel and titanium alloys, have reached higher maturity levels, ranging from TRL 7 to 9, with validated applications in industrial environments.

To clearly communicate the development and readiness level of materials within the Meltio ecosystem, an internal classification system has been established, aligned with the standard Technology Readiness Levels (TRL). This framework offers a structured reference for customers, partners, and integrators regarding the current validation stage and industrial applicability of each material.

Meltio Tier	TRL	Description
Meltio Explore	1–3	Exploratory phase focused on researching new alloys and process configurations. Designed for R&D environments aiming to push the boundaries of the technology.
Meltio Develop	4–6	Active development stage. Functional results have been achieved, with evolving process parameters. Suitable for concept validation and pre-industrial applications.
Meltio Qualified	7-8	Material and process qualified for demanding applications. High repeatability and reliability, ready for integration into real-world production environments.
Meltio Proven	9	Fully validated in industrial settings. Material used in end-use parts with proven performance in actual production. Represents the highest level of technological maturity.

6. Material Classification (ISO/ASTM 52942:2020)

The metallic material specified in this technical data sheet is classified in accordance with ISO/ASTM 52942:2020 – Additive Manufacturing — Metallic Materials — Classification. This standard defines a harmonised system for the designation and categorisation of metallic materials used in additive manufacturing, ensuring consistent identification and traceability.

Grade Nickel 625 is designated within **Group F**, corresponding to nickel-based superalloys.