Meltio ERCuNiAl (Marine Bronze)

ERCuNiAl / G CU 6328 (CuAl9Ni5Fe3Mn2) / 2.0923

Copper-Nickel-Aluminum wire is designed for high strength and durability. It offers excellent mechanical properties and corrosion resistance, ideal for demanding environments. This alloy ensures optimal performance in applications requiring wear and corrosion resistance.

General Properties

Wire Diameter	Weight on Spool	Spool Type	Wire Coating	Melting Point	Wire Density	Recom. Build plate	Drive Wheels	Inertization[3]
1.0 mm	15 kg	BS300	Uncoated	1100 ºC	8.00 g/cm³	304 Steel	1.0 V-Groove	Local

Standard Chemical Composition

Cu	Al	Mn	Fe	Ni	Si	Pb	Zn
Bal.	8.5-9.5	0.6-3.5	3.0 - 5.0	4.0 - 5.5	0.1 max	0.02 max	0.1 max

Specification: AWS 5.7 ERCuNiAl

ISO/ASTM 52942:2020: Group C [5]

Tested Print Hollow Profiles

Laser	Profile name	Meltio TRL[4]	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	146.6	196	24.81	-	-
450 nm	Rev 35 2025-04-24	Qualified	1000	83.33	341	42.5	99.98	70/-
	Rev 3 2025-06-06	Qualified	1400	51.02	882	110	-	-

* 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	Blue Laser 1.0kW			
		Heat Treatment		As Printed	
		XY	XZ	XY	XZ
Ultimate Tensile Strength [MPa]	690	678 ± 7	691 ± 7	778 ± 60	725 ± 80
Yield Strength [MPa]	280	331 ± 4	291 ± 4	498 ± 13	435 ± 20
Elongation [%]	16	26 ± 1	26 ± 1	21 ± 8	22 ± 13
Hardness [HV-10]	-	-	-	-	191

Reference Standards

	Wrought (ASTM B283/B283M-24)
Ultimate Tensile Strength [MPa]	565
Yield Strength [MPa]	255
Elongation [%]	32
Hardness [HV-10]	152

Meltio Material Datasheet

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Internal Structure ²

Micrography

The images show an acicular α-phase with Widmanstätten morphology in bright tones, alongside darker regions of retained martensite β'. Needle size variations suggest thermal effects from layer overlap. At higher magnifications, dispersed precipitates, possibly k-phases, are observed

HT condition:

The microstructure consists of an **α-phase** matrix (light phase), with retained **β' phase** (dark phase), and a significant amount of possible **K-phases (Fe_3Al/NiAl)** located intergranularly and along grain boundaries.

Blue Laser

As-printed XZ
100x Magnification

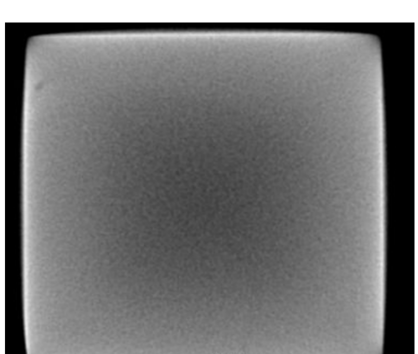
As-printed XY
100x Magnification

HT XZ
100x Magnification

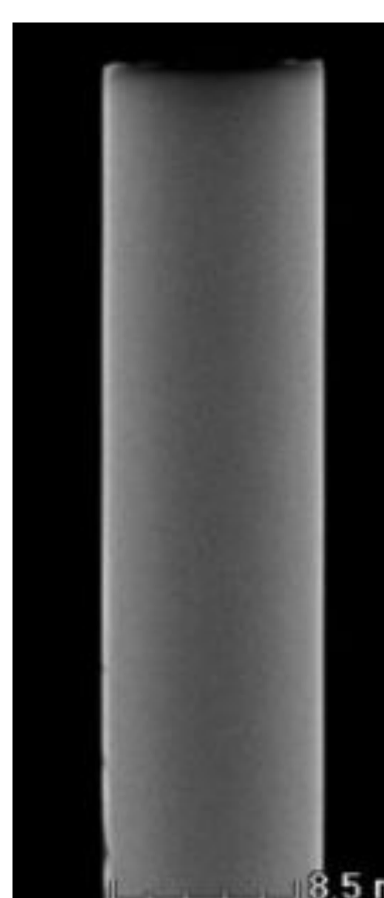
HT XY
100x Magnification

Tomography

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



3D / Top View



Front View

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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. Testing is carried out in the less favorable XZ direction to ensure the values are applicable across complete part.

Mechanical Properties were obtained, based on a printed block of 95x155x55 mm using the **Rev 35 2025-04-24** profile for the Blue laser, from it 16 ASTM E8M samples were extracted using EDM and were analyzed by an external laboratory. (*AIDIMME* aidimme@aidimme.es)

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. (*IDONIAL* info@idonial.com).

Heat Treatment

To achieve the best mechanical and corrosion-resistant properties, Marine Bronze should be heat-treated after 3D printing. The standard heat treatment process for Marine Bronze involves two steps: Solution Annealing and Aging. Solution annealing helps homogenize the microstructure and dissolve segregated phases formed during 3D printing, while Aging enhances strength and stability of the alloy. Machining can be performed either before or after the solution annealing stage, depending on the dimensional tolerance requirements of the part.

Solution Annealing		Age Hardening	
Inert atmosphere Heat up to 900ºC	Hold 0.5 hour Slow Cooling to RT	Inert atmosphere Heat up to 800ºC	Hold 3 hour Slow Cooling 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

2.Internal Structure

Micrography

The micrography were obtained from a 10x10x60 mm printed block using the **Rev 35 2025-04-24** 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. (*SERMET3D* info@sermet3d.com)

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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3.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.

4.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.

5. 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.

ERCuNiAl (Marine Bronze) is designated within **Group C**, corresponding to copper alloys.