Meltio Invar 36

Invar 36 / Alloy 36 / 1.3990

Invar is a type of nickel-iron alloy that is known for its unique properties, including low coefficient of thermal expansion and high dimensional stability over a wide range of temperatures. These characteristics make it a valuable material in various applications that require precision and stability, such as precision instruments, scientific measuring devices, cryogenics, composite molds and aerospace components.

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	1340 ºC	8.10 g/cm³	304 Steel	1.0 U-Groove	Local

Chemical Composition

Fe	C	Ni	Mn	Nb	Ti
Bal.	0.35	36.0	1.0	2.5	1.0

Tested Print Profiles

Laser	Profile name	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**	1100	183	175	21.6	99.99	-

* Printing profiles available in our official Slicers: **Meltio Horizon** for standalone Printers and **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			
		Heat Treatment		As Printed	
		XY	XZ	XY	XZ
Ultimate Tensile strength [MPa]	990	-	-	-	522 ± 14
Yield strength [MPa]	870	-	-	-	337 ± 22
Elongation [%]	9	-	-	-	24 ± 2
Hardness [HV-30]	-	–	–	-	147

Reference Standards

	Wrought (ASTM A658)
Ultimate Tensile strength [MPa]	500
Yield strength [MPa]	241
Elongation [%]	31
Hardness [HV-30]	127

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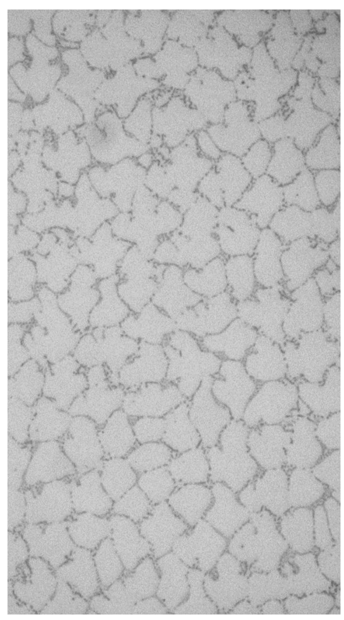
Internal Structure ²

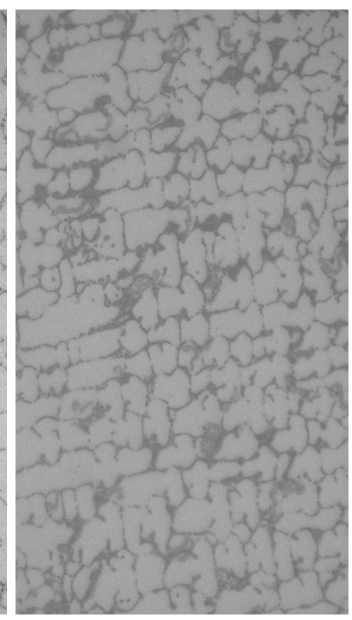
Micrography

The as printed microstructure of Invar is heterogeneous and mostly austenite with nickel dissolving in γ-Fe.

IR Laser



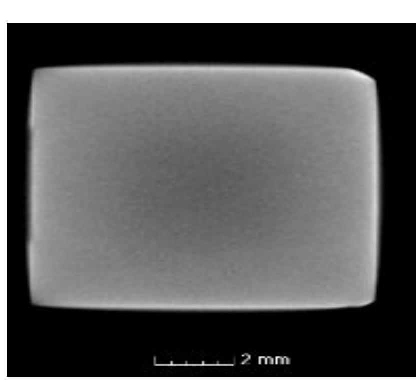
As-printed XZ
1000x Magnification



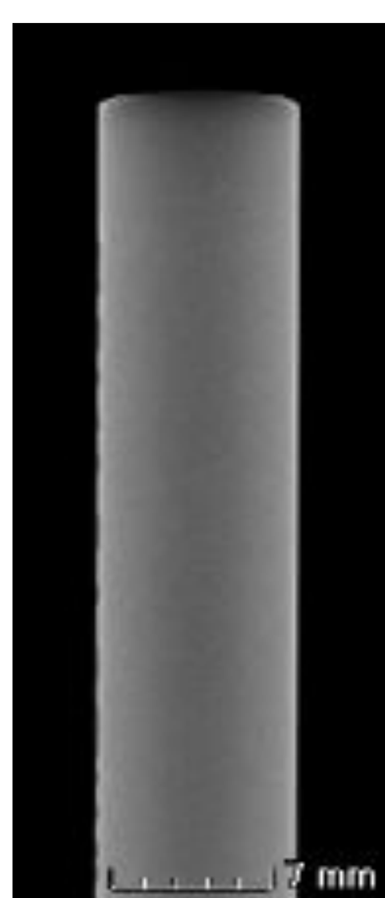
As-printed XY
1000x Magnification

Tomography

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



3D / Top View



Front View

Meltio Material Datasheet

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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 160x30x70 mm using the Verified Density Parametrization for IR 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. (*IDONIAL* info@idonial.com).

Heat Treatment

Owing to the use of Invar in precision components, it is often recommended to subject it to an annealing heat-treatment after 3D printing. This is necessary as the 3D printing process introduces residual stresses, which affects the material's performance. After annealing, the sample should pass through an aging process to improve and achieve suitable mechanical properties.

Annealing		Aging	
Protective atmosphere Heat up to 800ºC	Hold for 1h Cooling to RT	Protective atmosphere Heat up to 425ºC	Hold at 425ºC during 2h Cooling in oven to RT

2.Internal Structure

Micrography

The micrography were obtained from a 10x10x60 mm printed block using the Verified Density Profile for IR 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.