

# Meltio Tool Steel H11

Tool Steel H11 / 1.2343

Tool Steel H11 is one of the most commonly used tool steels. It is a hot-work steel that is used to make hot-working tools such as forging, die-casting, extrusion, and plastic molds due to its resistance to thermal fatigue cracking and high-temperature abrasion. In addition to hot-working tools, it is also used to produce cutting tools and in the aerospace industry for mechanical components.

## General Properties

Wire Diameter	Weight on Spool	Spool Type	Wire Coating	Melting Point	Wire Density	Recom. Build plate	Drive Wheels	Inertization <sup>3</sup>
1.0 mm	15 kg	BS300	Copper	1480 °C	7.81 g/cm <sup>3</sup>	304 Steel	1.0 V-Groove	Local

## Standard Chemical Composition

Fe	C	Si	Mn	Cr	Mo	V	Ni	Cu	P	S
Bal.	0.33 - 0.43	0.8 - 1.2	0.2 - 0.5	4.75- 5.50	1.10 - 1.60	0.30 - 0.60	0.3 max	0.25 max	0.03 max	0.03 max

Specification: ASTM A681

ISO/ASTM 52942:2020: Group A<sup>5</sup>

## Tested Print Profiles

Laser	Profile name	Meltio TRL <sup>4</sup>	Laser Power [W]	Energy Density [J/mm <sup>3</sup> ]	Deposition Rate [g/h]	Volume rate [cc/h]	Relative Density [%]	Max Pore/Defect [µm]
976 nm	Verified Density	Proven	1100	220	141	21.64	99.8	-
450 nm	Rev 27 2025-04-24	Develop	1000	128	243	30.73	99.9	9.05 / 91.58
	Rev3 2025-06-13	Develop	1400	128.2	307	39.31	-	-

\* 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<sup>1</sup>

ASTM E8/E8M UNE EN ISO 6892-1 UNE EN ISO 6507-1	Wire	Infrared Laser				Blue Laser 1.0kW			
		Heat Treatment		As Printed		Heat Treatment		As Printed	
		XY	XZ	XY	XZ	XY	XZ	XY	XZ
Ultimate Tensile Strength [MPa]	-	-	2087 ± 2	-	1830 ± 105	WIP	WIP	WIP	WIP
Yield Strength [MPa]	-	-	1735 ± 101	-	1170 ± 90	WIP	WIP	WIP	WIP
Elongation [%]	-	-	12.18±0.19	-	3.46 ± 0.36	WIP	WIP	WIP	WIP
Hardness [HRC]	55	-	51	-	52	-	-	50	-

## Reference Standards

	Wrought (ASTM 1472)
Ultimate Tensile Strength [MPa]	1990
Yield Strength [MPa]	1650
Elongation [%]	10
Hardness [HRC]	53

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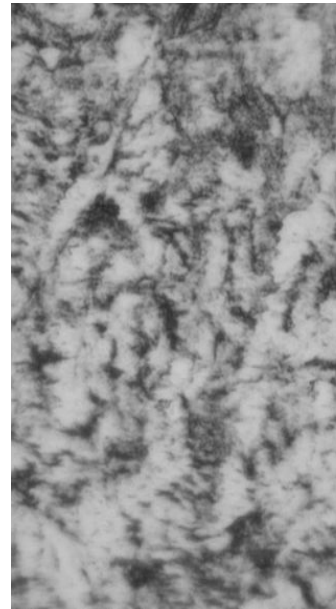
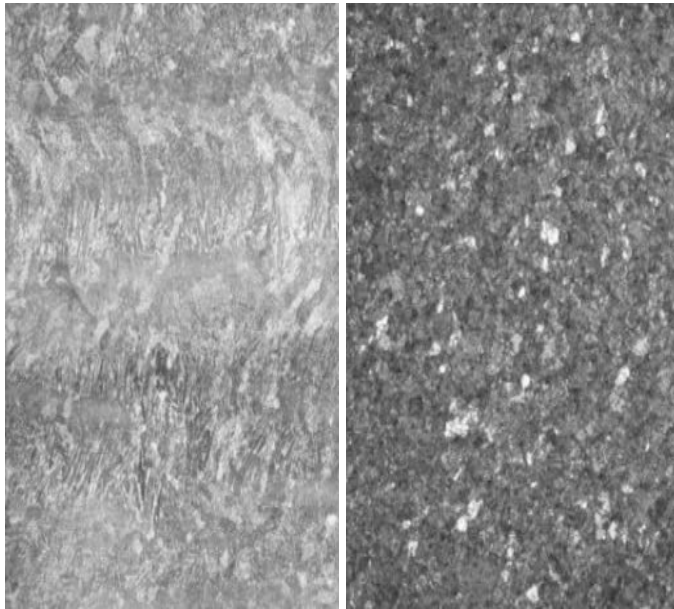
## Internal Structure <sup>2</sup>

### Micrography

Tool Steel H11 displays tempered and fresh martensite, retained austenite, and columnar grain morphology aligned with the solidification front. Heat treatment reduces retained austenite and refines the grain to a primarily equiaxed shape, converting most of the martensite. Trace amounts of austenite may remain undetectable with light microscopy.

*IR Laser*

*Blue Laser*



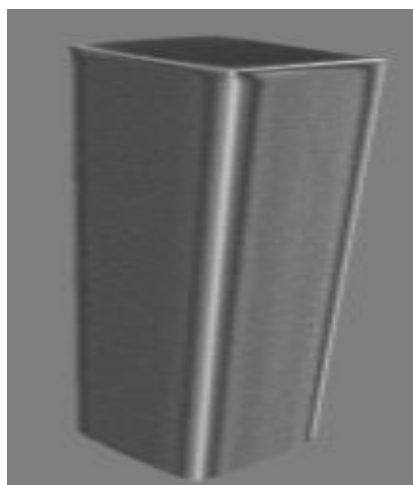
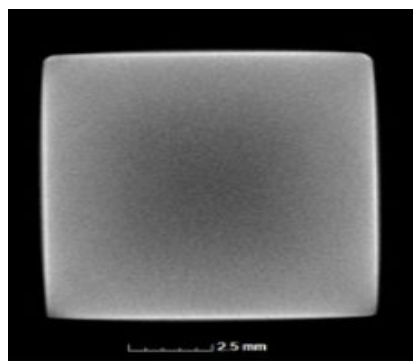
As-printed XY  
100x Magnification

HT XY  
100x Magnification

As-printed XY  
100x Magnification

### Tomography

CT Scan of 3D printed sample part in H11 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

Tool Steel H11 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. H11 steel has excellent weldability and can be used to form a dense and well-bonded coating layer that provides high wear resistance, high Hardness and temperature resistance as well as good corrosion resistance.

### Elemental Distribution

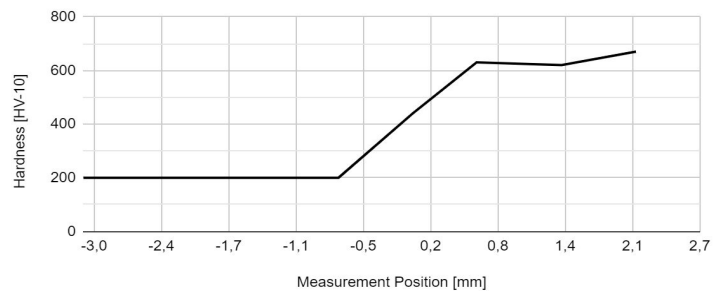
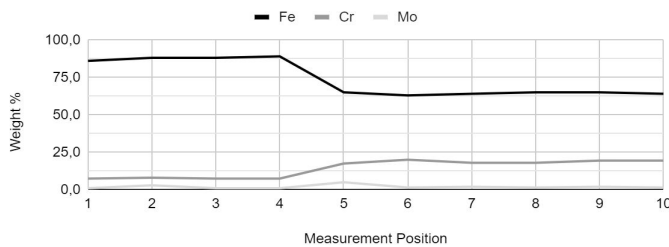
Composition mapping of H11 cladding on SS316L. Measurements were spaced 150 µm. Apart with measurement 5 coinciding with the interface of the two materials.

Measurement [Position]	Mo [wt%]	Cr [wt%]	Mn [wt%]	Fe [wt%]	Ni [wt%]
1	1.0	7.5	1.0	86.0	4.0
2	3.0	8.0	2.0	88.0	4.0
3	1.0	7.5	1.0	88.0	2.0
4	1.0	7.5	1.0	89.0	2.0
<b>Interlayer</b>					
5	5.0	17.5	1.0	65.0	10.0
6	1.5	20.0	1.0	63.0	14.0
7	2.0	18.0	2.0	64.0	11.0
8	1.5	18.0	1.0	65.0	13.0
9	2.0	19.5	1.0	65.0	11.0
10	1.5	19.5	1.0	64.0	12.0

### Hardness Profile

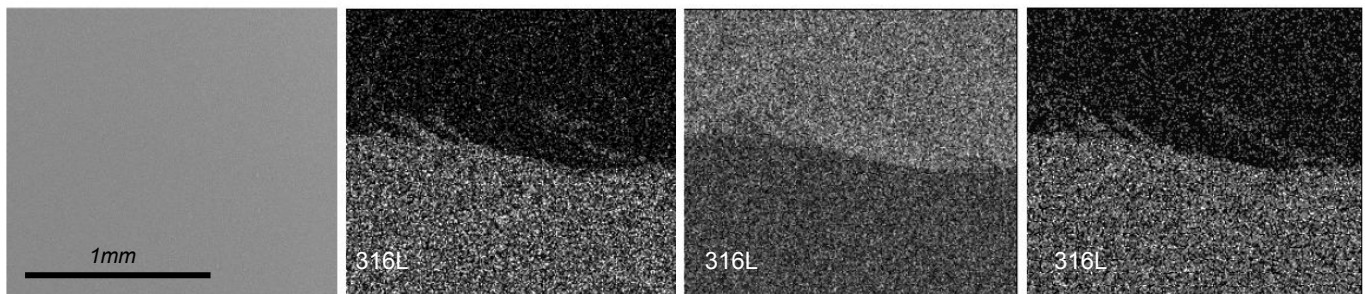
Hardness was measured across the material transition and results indicate that a single cladding layer is sufficient to achieve good and stable properties.

Hardness [HV10]	Distance [mm]	Material [txt]
670	2.1	Tool Steel H11
620	1.4	
630	0.6	
440	0.0	Interlayer
200	-0.7	Stainless Steel 316L
200	-1.4	
200	-1.8	
200	-2.2	
200	-3.1	



### Elemental Mapping

Elemental (EDX) Mapping is employed to characterize the dilution of the two materials. Meltio used as printed Stainless Steel 316L as the substrate without post processing. Results show low dilution between SS316L and H11.



Cladding interface layer XZ  
Electron Microscopy

Cladding interface layer XZ  
Chromium EDX Map

Cladding interface layer XZ  
Iron EDX Map

Cladding interface layer XZ  
Nickel EDX Map

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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 and a printed block of 95x155x55 mm using the **Rev 27 2025-04-25** 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](mailto: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](mailto:info@idonial.com) , CETEMET [i+d+i@cetemet.es](mailto:i+d+i@cetemet.es)*).

## Heat Treatment

Tool Steel H11 is an Air-Hardening tool steel which during 3D printing reaches its hardened state. In this state machinability is affected and there is a high risk of cracking due to the reduced ductility. Consequently, a heat-treatment cycle is typically necessary, except for cladding applications or small feature addition. The ideal cycle should begin with an annealing step prior to removing the part from the build plate. The material will be softened and free of internal stresses, making easy to machine. After machining, the part should then undergo hardening and a suitable tempering cycle to achieve the desired hardness.

### Annealing

Argon atmosphere Heat up to 820°C	Slow Cooling in oven to RT
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### Quenching

Argon atmosphere Heat up to 1025°C	Hold for 2h Forced Air-cooling to RT
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### Tempering

(Example): Argon atmosphere Heat up to 550°C	Hold for 1h Slow Cooling to RT (Repeat 2x)
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*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 Verified Density Profile for IR laser and **Rev 23 2025-03-13** 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](mailto: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](mailto: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](mailto:info@idonial.com) , CETEMET [i+d+i@cetemet.es](mailto:i+d+i@cetemet.es) , AIMEN [comunicacion@aimen.es](mailto: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
<b>Meltio Explore</b>	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.
<b>Meltio Develop</b>	4–6	Active development stage. Functional results have been achieved, with evolving process parameters. Suitable for concept validation and pre-industrial applications.
<b>Meltio Qualified</b>	7-8	Material and process qualified for demanding applications. High repeatability and reliability, ready for integration into real-world production environments.
<b>Meltio Proven</b>	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.

Grade H11 is designated within **Group A**, corresponding to tool steels.