

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.

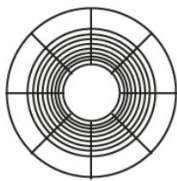
Properties	High Strength, High Temperature Resistance and High Hardness
Applications	Aerospace Components, Cutting Tools and prototypes and Molds and Dies

Wire Chemical Composition	Fe	C	Si	Mn	Cr	Mo	V
Weight Percent [%]	Bal.	0.38	1.0	0.4	5.0	1.1	0.45

Wire Density
7.81 g/cm ³

Melting Point		
1753 K	1480 °C	2700°F

Spool Specs



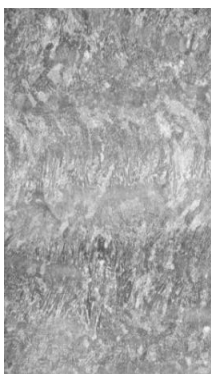
Meltio Materials are tightly spooled and packaged to ensure the best compatibility with Meltio systems.

Wire Diameter	1.0 mm
Weight on Spool	15 kg
Volume on Spool	1920 cm ³
Spool Type	BS300
Wire Coating	Copper

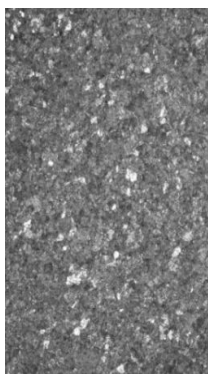
Relative density as 3D printed	> 99.9%
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Micrography

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.



Gen I As-printed XY
100x Magnification



Gen I HT XY
100x Magnification



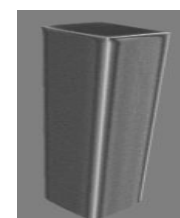
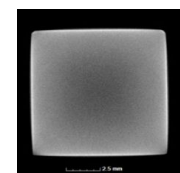
Gen II As-printed XY
100x Magnification

Published
in Q4

Gen II HT XY
100x Magnification

Tomography

Computed Tomography Scan of 3D printed sample part in H11 without detectable voids or defects. Resolution of 24 μm per pixel.



3D / Top View



Front View

*Tests Carried Out In IDONIAL
info@idonial.com

*Test Carried Out In CATEC
info@catec.aero

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Parametrization for Verified Density Profiles

The following fully dense printing parameters were obtained, based on a printed block of 30x60x20 mm. A sample from this block of 10x10x60 mm was extracted using EDM, and was analyzed using CT Scan on an external lab. Please use the provided “Materials Handbook” to know better the printing parameters relation and their effect on part density. These printing parameters are available in our slicers Meltio Horizon and Meltio Space.

	Laser Power [W]	Laser Wavelength (nm)	Velocity [mm/s]	Argon Flow [l/min]	Layer Height [mm]	Layer Width [mm]	Wire Speed [mm/s]	Input Energy Density [J/mm ³]	Deposition Rate [g/h]
IR	1100	976	5.0	10.0	1.0	1.0	6.4	220	144
Blue	1000	450	5.0	10.0	1.0	1.0	6.4	200	144

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

Quenching

Tempering

HT.1: Argon atmosphere Heat up to 820°C	Slow Cooling in oven to RT	HT.2: Argon atmosphere Heat up to 1025°C	Hold for 2h Forced Air-cooling to RT	HT.3 (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 Sample of 160x60x30 mm

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.

	UNE EN ISO 6892-1			
	Wrought Properties	Meltio XZ Properties	Meltio XZ Properties	
	(ASTM 1472)	(HT.1 + HT.2 + HT.3)	(As Printed)	
Ultimate Tensile strength (UTS) [MPa]	1990	2087 ± 2	1830 ± 105	IR
		Published in Q4		Blue
Yield strength [MPa]	1650	1735 ± 101	1170 ± 90	IR
		Published in Q4		Blue
Elongation [%]	10	12.18 ± 0.19	3.46 ± 0.36	IR
		Published in Q4		Blue
*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.

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		UNE EN ISO 6507-1		
	Wrought Properties (ASTM 1472)	Meltio Properties (HT.1 + HT.2 +HT.3)	Meltio Properties (As Printed)	
Hardness [HRC]	53	51	52	IR
		Published in Q4	49	Blue
*Tests Carried Out In IDONIAL info@idonial.com *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.

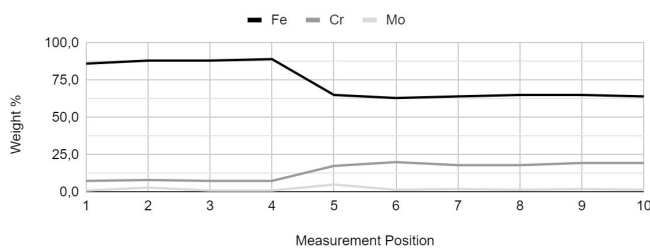
Cladding and Dual Material Applications

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.

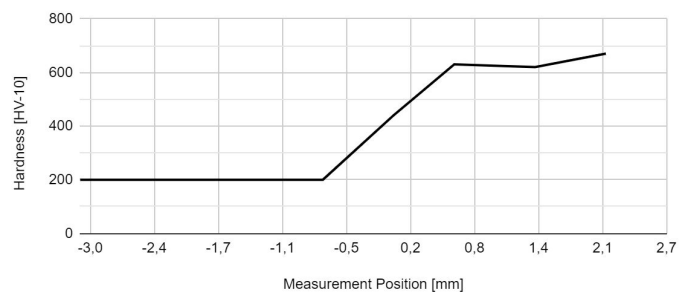
Measurement [Position]	Mo [wt%]	Cr [wt%]	Mn [wt%]	Fe [wt%]	Ni [wt%]
1	1.0	7.5	1.0	86.0	4.0
2	3.0	8.0	2.0	88.0	4.0
3	1.0	7.5	1.0	88.0	2.0
4	1.0	7.5	1.0	89.0	2.0
Interlayer					
5	5.0	17.5	1.0	65.0	10.0
6	1.5	20.0	1.0	63.0	14.0
7	2.0	18.0	2.0	64.0	11.0
8	1.5	18.0	1.0	65.0	13.0
9	2.0	19.5	1.0	65.0	11.0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

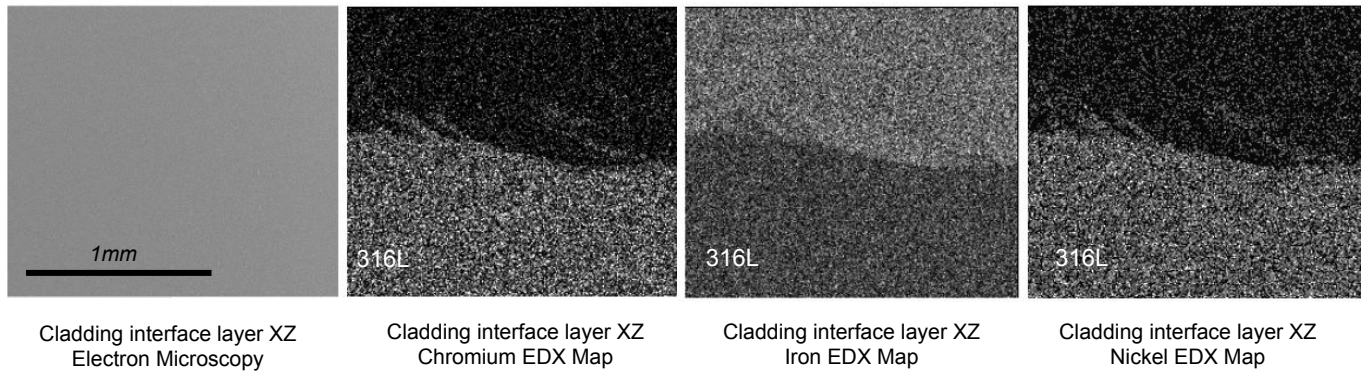


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Elemental Mapping

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.



* Meltio's work on material characterization is carried out using the Meltio M450 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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