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.

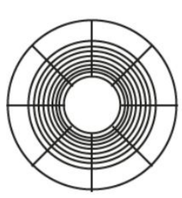
Properties	High Strength, High Temperature Resistance and High Hardness
Applications	Aerospace Components, Cutting Tools and prototypes and Molds and Dies

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/cm³

Melting Point		
1753 K	1480 ºC	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 cm³
Spool Type	BS300
Wire Coating	Copper

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

HT.1: Argon atmosphere Heat up to 820ºC	Slow Cooling in oven to RT

Age Hardening

HT.2: Argon atmosphere Heat up to 1025ºC	Hold for 2h Forced Air-cooling to RT

Tempering

HT.3 (Example): Argon atmosphere Heat up to 550ºC	Hold for 1h Slow Cooling to RT (Repeat 2x)

**Typical Parameters for a Sample of 160x60x30 mm*

Deposition Parameters

The following printing parameters were found to provide fully dense samples. Please use the provided “Density Profiles” and refer to the document “Printing Parameters and their effect on part density” for additional information.

Laser Power [W]	Velocity [mm/s]	Argon Flow [l/min]	Layer Height [mm]	Wire Speed [mm/s]	Energy Density [J/mm3]
1100	7.5	10	1.0	9.6	147

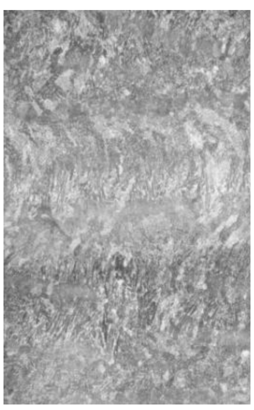
Meltio Material Datasheet

Meltio Tool Steel H11

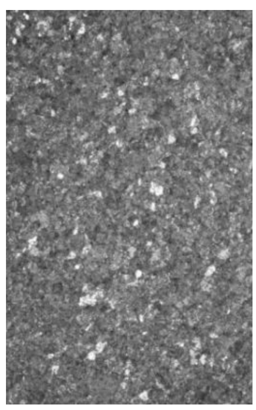
Tool Steel H11 / 1.2343

Micrography

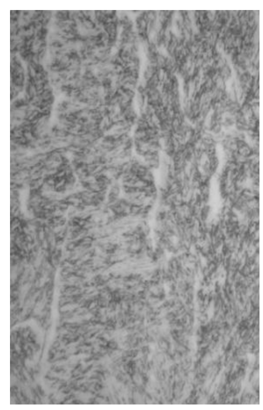
Tool Steel H11 displays tempered and fresh martensite, retained austenite, and columnar grain morphology aligned with the solidification front. Heat treatment reduces retained austenite and refines the grain to a primarily equiaxed shape, converting most of the martensite. Trace amounts of austenite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



As-printed XZ
100x Magnification



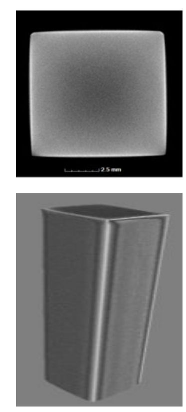
HT.1 + HT.2 + HT.3 XZ
100x Magnification



As-printed XZ
1000x 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

Left View

Front View

Relative density as 3D printed	99.89%

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 **(ASTM 1472)**	**Meltio XZ Properties** **(HT.1 + HT.2 + HT.3)**	**Meltio XZ Properties** **(As Printed)**
Ultimate Tensile strength (UTS) [MPa]	1990	2087 ± 2	1830 ± 105
Yield strength [MPa]	1650	1735 ± 101	1170 ± 90
Elongation [%]	10	12.18 ± 0.19	3.46 ± 0.36
		*Tests Carried Out In IDONIAL info@idonial.com	

		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
		*Tests Carried Out In IDONIAL info@idonial.com	

Meltio Material Datasheet

Meltio Tool Steel H11

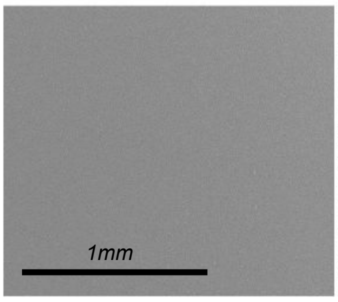
Tool Steel H11 / 1.2343

Cladding and Dual Material Applications

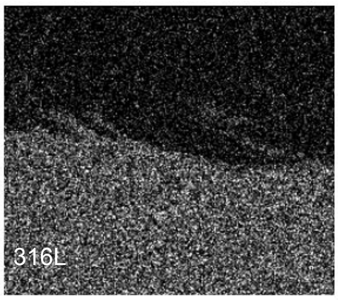
Tool Steel H11 is highly resistant to wear, deformation and heat, which makes it an excellent material for cladding or dual material applications where not the entire component requires these properties. H11 steel has excellent weldability and can be used to form a dense and well-bonded coating layer that provides high wear resistance, high Hardness and temperature resistance as well as good corrosion resistance.

Elemental Mapping

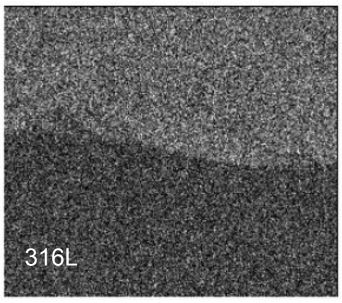
Elemental (EDX) Mapping is employed to characterize the dilution of the two materials. Meltio used as printed Stainless Steel 316L as the substrate without post processing. Results show low dilution between SS316L and H11.



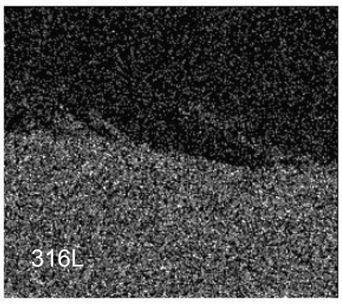
Cladding interface layer XZ
Electron Microscopy



Cladding interface layer XZ
Chromium EDX Map



Cladding interface layer XZ
Iron EDX Map

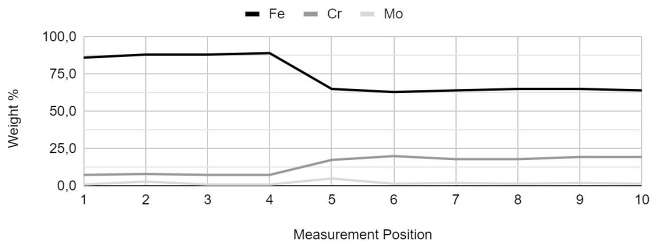


Cladding interface layer XZ
Nickel EDX Map

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.

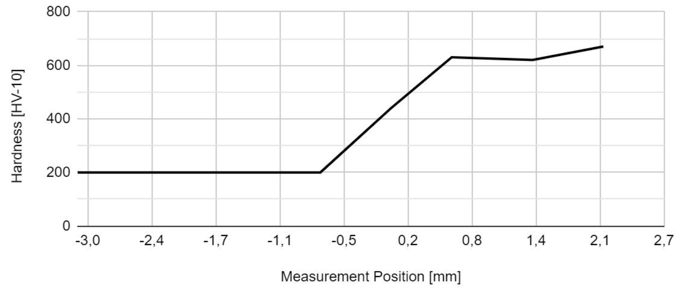
Measurement [Position]	Mo [wt%]	Cr [wt%]	Mn [wt%]	Fe [wt%]	Ni [wt%]
1	1.0	7.5	1.0	86.0	4.0
2	3.0	8.0	2.0	88.0	4.0
3	1.0	7.5	1.0	88.0	2.0
4	1.0	7.5	1.0	89.0	2.0
Interlayer					
5	5.0	17.5	1.0	65.0	10.0
6	1.5	20.0	1.0	63.0	14.0
7	2.0	18.0	2.0	64.0	11.0
8	1.5	18.0	1.0	65.0	13.0
9	2.0	19.5	1.0	65.0	11.0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



** 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.*

*** Any technical information or assistance provided herein is given and accepted at your own risk and neither Meltio nor its affiliates make any guarantees relating to it or because of it. Neither Meltio nor its affiliates shall be responsible for the use of this information, or any product, method or apparatus mentioned and you must make your own determination for its suitability and completeness for you application. Specifications are subject to change without notice.*