AUBERT&DUVAL

Stellar TS700

Powder for additive manufacturing

STELLAR

MATERIAL OVERVIEW

Stellar TS700 is a 5% Chromium, precipitation hardening tool steel suitable for additive manufacturing of die casting tools and hot work tools. The main benefits with Stellar TS700 compared to the 18M300 and hot work steels such as H11/H13 steels is a higher maximal work temperature and a better temper resistance. The low carbon content ensures a good printability.

PHYSICAL PROPERTIES

Property	Unit	20°C	400°C
Density	g/cm^3	8.0	7.9
Thermal conductivity	W/(m*K)	18	23
Thermal expansion from 20°C	10^{-6} K^{-1}	-	12

Data for quenched and tempered material.

CHEMICAL COMPOSITION

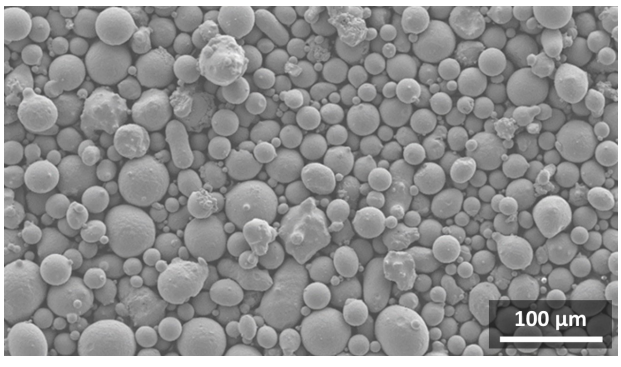
Wt%	Fe	C	Cr	Ni	Mo	Co
Min	Bal.	0	4	1.5	7	10
Max		0.05	5.75	3	9	13

POWDER CHARACTERISTICS

Laser Beam Melting (powder bed): 15-53 µm

Electron Beam Melting (powder bed): 45-106 µm

Directed energy deposition (LMD): 45-106 µm



Typical powder morphology.

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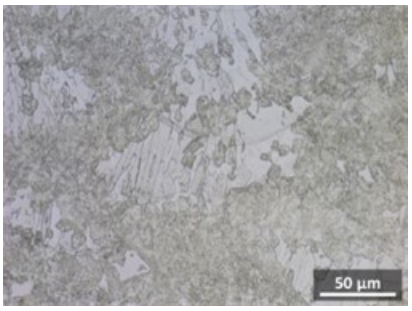
PDS_Stellar_TS700_EN_V1_2022

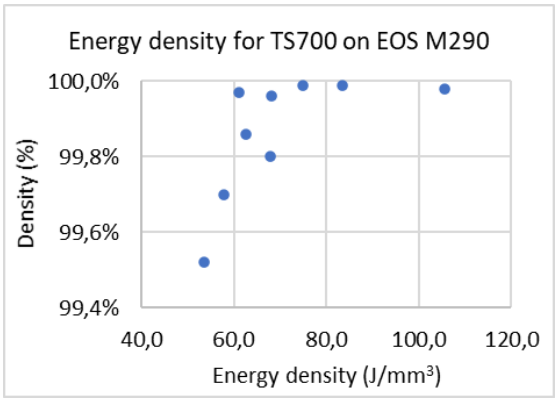
PRINTABILITY

Stellar TS700 has a wide process window, and the as-build hardness is around 38 HRC.

As-built microstructure of sample with <0.03% porosity

As-built microstructure etched with Catela reagent





Density measured by optical method

Parameter	Standard printing
Pre-heating of base plate	180°C to ensure lowest possible residual stresses.
Layer thickness	40 µm
Hatch distance	0.1 mm
Energy density	75-85 J/mm^3

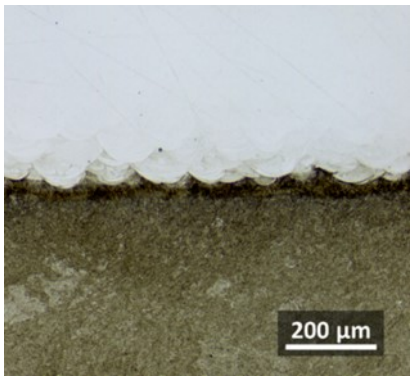
HYBRID PRINTING

Stellar TS700 can be printed directly onto a base of H11 (1.2343) steel hardened at 44 HRC. A higher base hardness ensures that it will not deform.

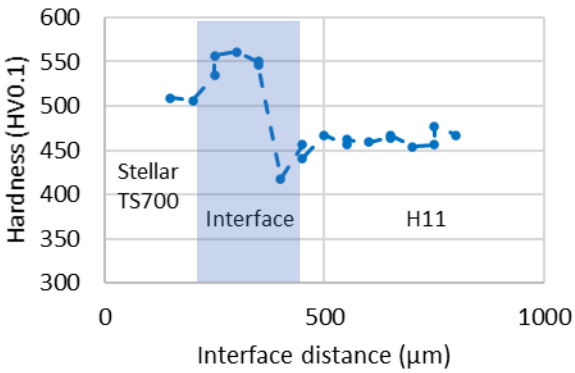
After heat treatment the hardness transition between Stellar TS700 and H11 is smooth over a width of 0.5-1 mm.

Stellar TS700 (as-built)

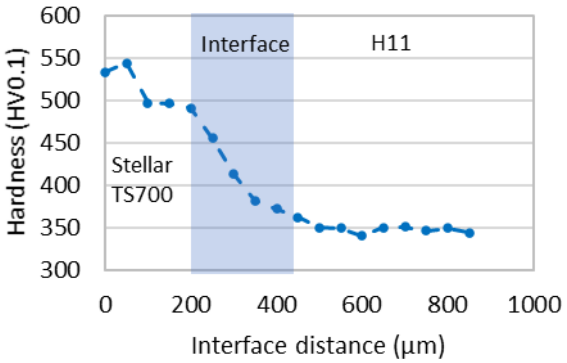
H11



Interface between Stellar TS700 (as-built) and H11



Hardness of the interface between Stellar TS700 to H11 as-printed



Hardness of the interface between Stellar TS700 to H11 after aging at 650°C

STRESS RELEIVING

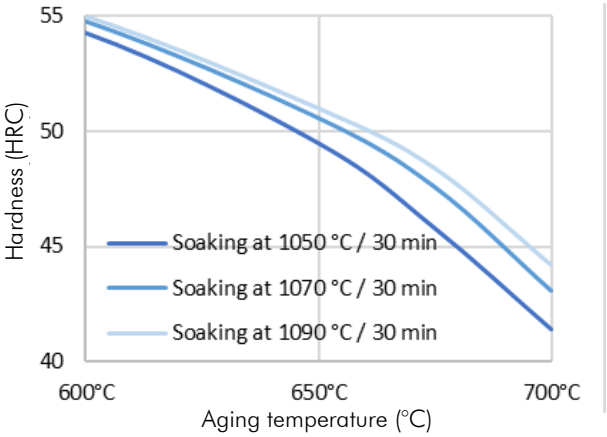
Stress relieving will reduce stresses but will also cause hardening if done at over 400°C, which can be undesirable if post machining is to be done.

SOLUTION TREATMENT

The solution treatment ensures a complete homogenization of the microstructure with high hardness and an excellent heat resistance.

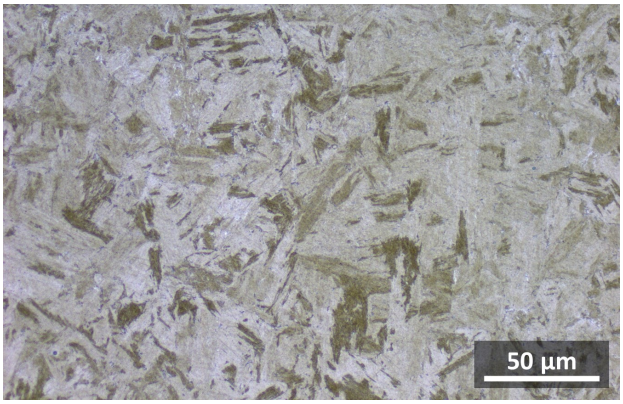
- Solution treatment by heating to 1050°C-1070°C with a preheating step and quenching in oil or using high pressure gas.
- Age at 600-700°C for 4 hours to reach the desired hardness.

HARDNESS FOR SOLUTION HT



Solution treatment at 1050°C/30min/Quench						
Aging	orientation	Rm N/mm²	Rp0.2 N/mm²	A%	HRC	CV (J)
650°C/4h	Horizontal	1828	1397	6.5	51.2	5
	Vertical	1878	1449	8.0	51.0	
675°C/4h	Horizontal	1619	1215	8.5	47.7	6
	Vertical	1676	1259	9.0	46.9	

Properties evaluated at a strain rate of 10-4 s-1, all other test conditions in accordance to NF EN 2002-1 and NF EN 2002-2. Yield Strength (YS) shown is Rp0.2% stress, Ultimate Tensile Strength (UTS) is stress at maximum force. Elongation was measured after failure as per the standards.

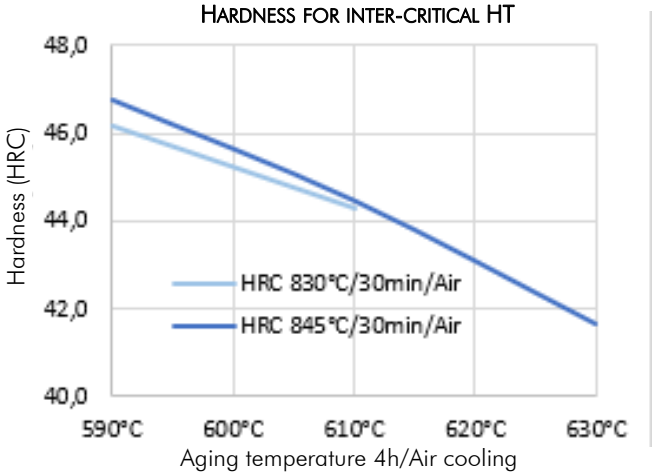


Microstructure after heat treatment at 1090°C + 680°C/4h giving a hardness of 48 HRC.

INTER-CRITICAL HEAT TREATMENT

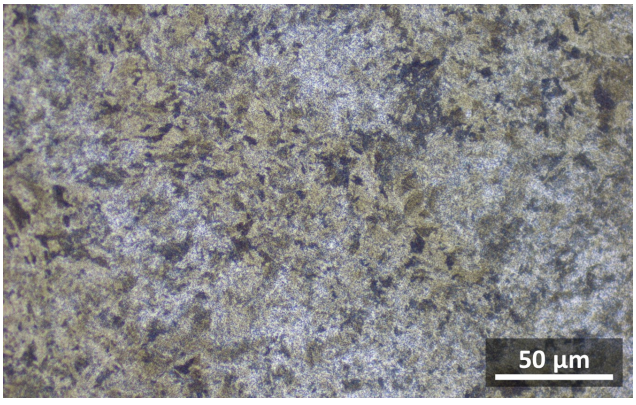
The inter-critical heat treatment with soaking between 830-845°C transforms remaining austenite grains to martensite without causing grain growth. This heat treatment gives a better ductility at the cost of a reduced maximum operating temperature.

HARDNESS FOR INTER-CRITICAL HT



Inter critical treatment at 840°/30min/Air					
Aging	Rm N/mm²	Rp0.2 N/mm²	A (%)	HRC	CV (J)
610°C/ 4h / Air	1450	1150	11	44.3	8
Same results in both directions					

Properties evaluated at a strain rate of 10-4 s-1, all other test conditions in accordance to NF EN 2002-1 and NF EN 2002-2. Yield Strength (YS) shown is Rp0.2% stress, Ultimate Tensile Strength (UTS) is stress at maximum force. Elongation was measured after failure as per the standards.



Microstructure after heat treatment at 845°C/30min/Air + 610°C/4h giving a hardness of 44.5 HRC

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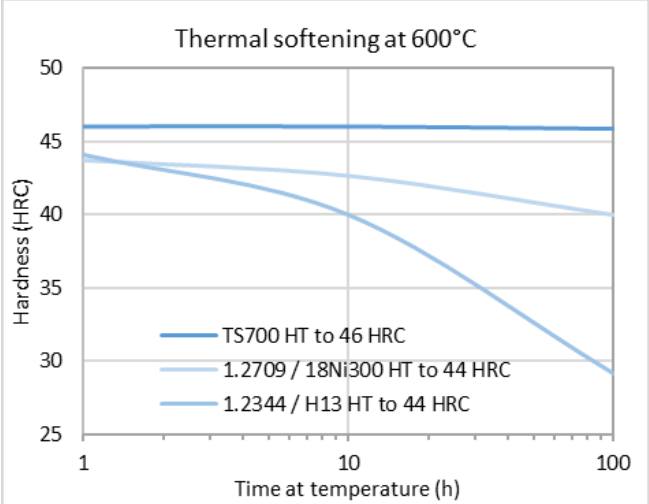
HEAT RESISTANCE

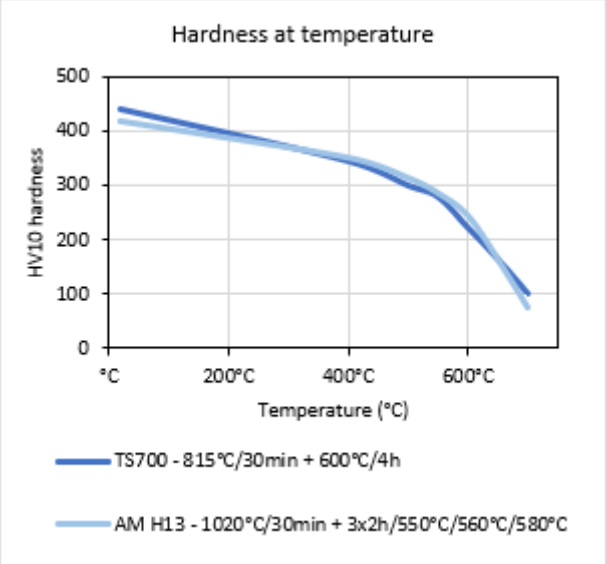
The mechanical properties of tool steels decrease by exposure at high temperature for extended periods. To ensure a good lifetime, it is important to assess the evolution of the properties with the temperature.

In aluminum die casting applications where the contact between the tool steel and the liquid aluminum can be several seconds per cycle, the total time at high temperature rapidly amounts to several tens of hours. Measuring the thermal softening at 600°C is therefore a relevant measure of the heat resistance.



HOT HARDNESS

The hot hardness is the hardness at elevated temperatures. Stellar TS700 has the same hardness behavior as commonly used H13 steel.



GRADE COMPARISON