AUBERT&DUVAL

STELLAR
Metal powders by AUBERT & DUVAL

Stellar TS700

Powder for Additive Manufacturing

MATERIAL OVERVIEW

Stellar TS700 is a 5% Chromium, precipitation hardening tool steel adapted for additive manufacturing. The main benefits with Stellar®TS700 compared to the 18Ni300 and hot work steels such as H11/H13 steels is a higher maximal work temperature and a better heat resistance. The low carbon content ensures a good printability. The grade could be suitable for:

- Aluminum extrusion dies
- Aluminum die casting tools
- Hot work tools

KEY 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.

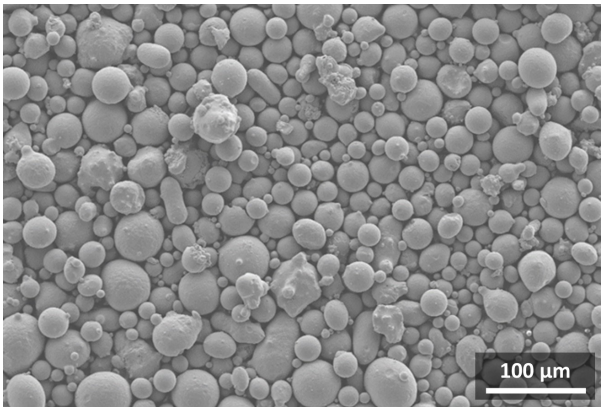
CHEMICAL COMPOSITION

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

POWDER CHARACTERISTICS

Particle size distributions:

Laser Powder Bed Fusion (LPBF): 15-53 µm
Electron Beam Melting (EBM): 45-106 µm
Directed Energy Deposition (DED): 45-106 µm
Custom size distributions available on request



Typical powder morphology.

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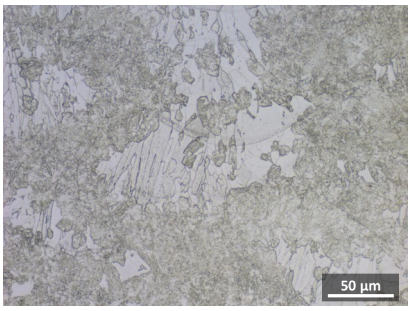
PRINTABILITY

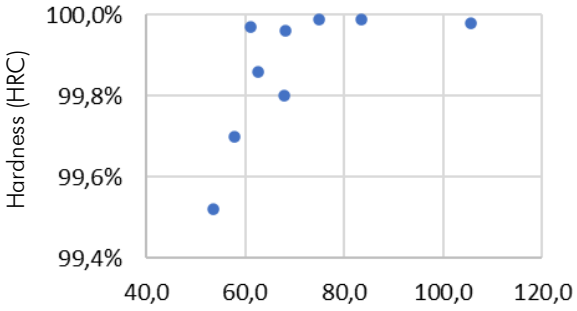
Stellar TS700 has a wide process window, and the as-build hardness is around 38 HRC.

As-built microstructure of sample with <0.03% porosity

As-built microstructure etched with Catela reagent



ENERGY DENSITY FOR STELLAR TS700 ON EOS



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/mm³

STRESS RELIEVING

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

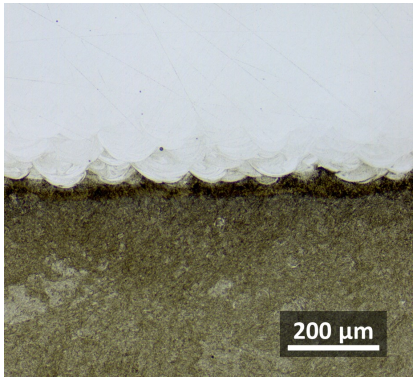
HYBRID PRINTING

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

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

Stellar TS700 (as-built)

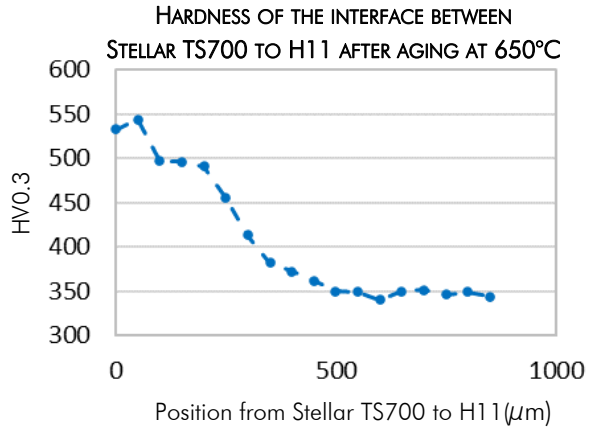
H11



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



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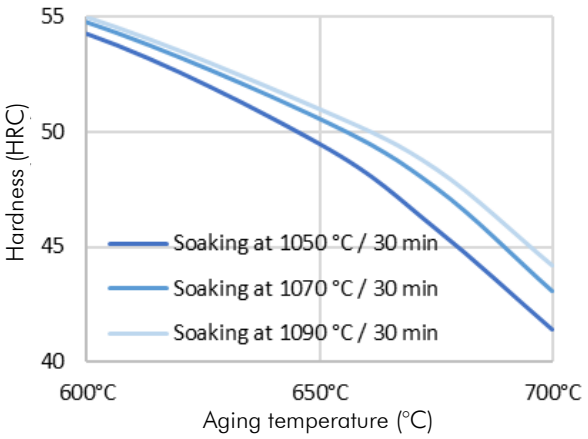
SOLUTION TREATMENT

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

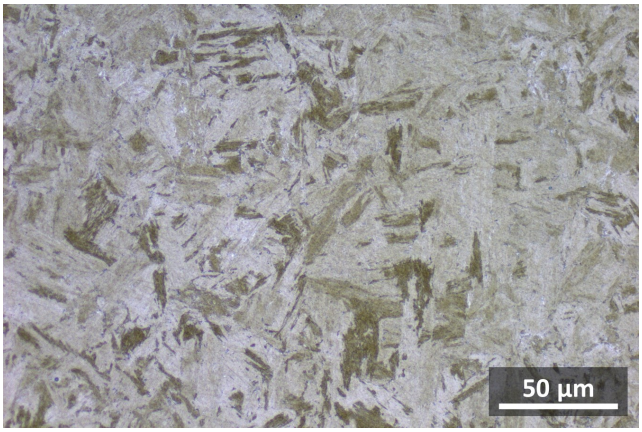
- Solution treatment by heating to 1050°C-1070°C with a preheating step and quenching in oil or using high pressure gas.
- Age at 600-700°C for 4 hours to reach the desired hardness.

HARDNESS FOR SOLUTION HEAT TREATMENT



Solution treatment at 1050°C					
Aging	Orientation	Rm N/mm²	Rp0.2 N/mm²	A (%)	HRC
650°C/4h/Air	Horizontal	1828	1397	6	51
	Vertical	1878	1449	8.0	51
675°C/4h/Air	Horizontal	1619	1215	8.5	48
	Vertical	1676	1259	9.0	47

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.



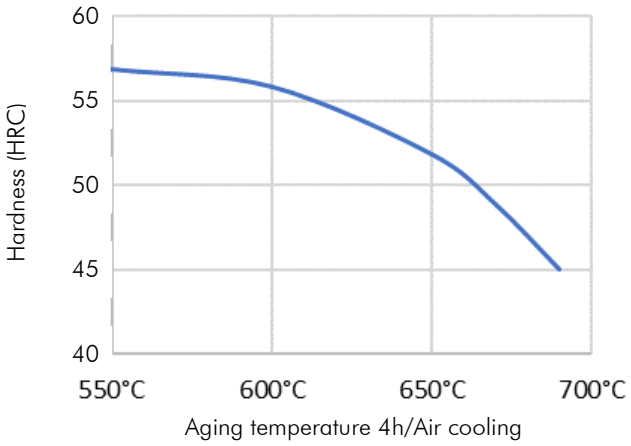
Microstructure after heat treatment at 1090°C/30min/ Quench + 680°C/4h/Air giving a hardness of 48 HRC.

DIRECT AGE TREATMENT

A direct aging is a simpler heat treatment giving a slightly higher hardness at the price of a slightly lower toughness.

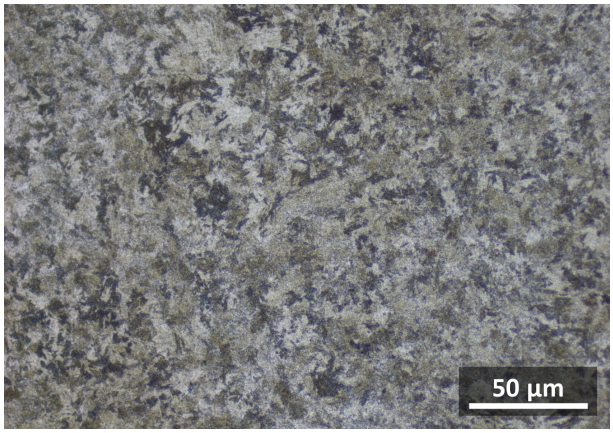
- Age directly after printing at 550-700°C for 4 hours with air cooling to reach the desired hardness.

HARDNESS FOR DIRECT AGE



Direct age treatment					
Aging	Orientation	Rm N/mm²	Rp0.2 N/mm²	A (%)	HRC
620°C/4h/Air	Horizontal	2133	1623	8	55
	Vertical	2156	1694	8	55
690°C/4h/Air	Horizontal	1549	1110	9	46
	Vertical	1567	1139	9	46

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



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

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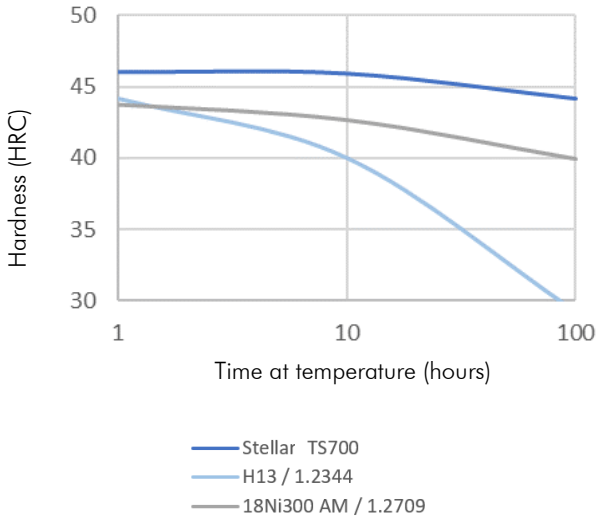
HEAT RESISTANCE

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.

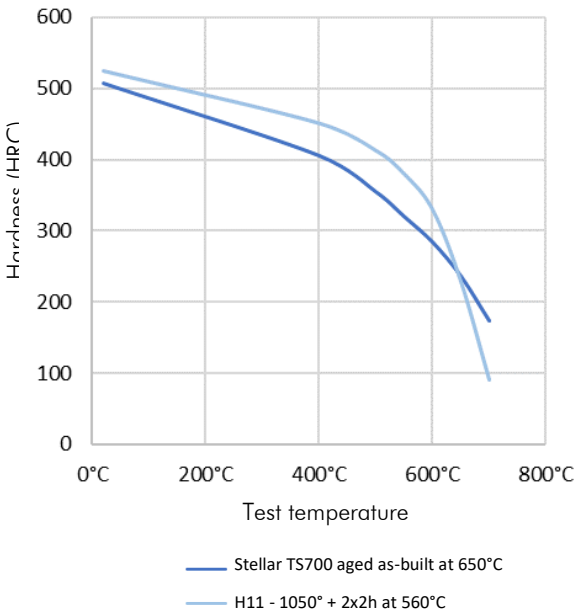
THERMAL SOFTENING AT 600°C



HOT HARDNESS

The hot hardness is the hardness measured at elevated temperatures. Stellar TS700 preserves the hardness better at temperature spikes above 650°C than conventional hot work steels.

HARDNESS AT TEMPERATURE



GRADE COMPARISON

Comparison of additively manufactured materials heat treated to around 45 HRC.

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