Metal
Solutions

TRL 7
Premium

EOS ToolSteel 1.2709
Material Data Sheet

EOS ToolSteel 1.2709
Ultra High Strength Tool Steel for Demanding Molding Applications

EOS ToolSteel 1.2709 is an ultra high strength tooling grade maraging steel. Its excellent properties are enabled by forming intermetallic phases and precipitates in heat treatment. The properties enable succesful use in diverse applications including injection molding and cold and hot working.

Main Characteristics:

- Ultra high strength and hardness
- Properties adjustable with different heat treatment
- Excellent fatigue strength
- Good machinability

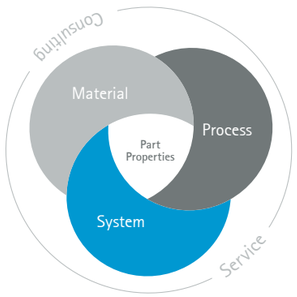
Typical Applications:

- Plastic injection molding
- Extrusion tools
- Hot pressing tools
- Die casting tools for aluminum and zinc alloys

The EOS Quality Triangle

EOS uses an approach that is unique in the AM industry, taking each of the three central technical elements of the production process into account: the system, the material and the process – together simply described as the Quality Triangle. EOS focuses on delivering reproducible part properties for the customer.

All of the data stated in this material data sheet is produced according to EOS Quality Management System and international standards.



Powder Properties

The chemical composition of EOS ToolSteel 1.2709 powder is in compliance with EN 1.2709.

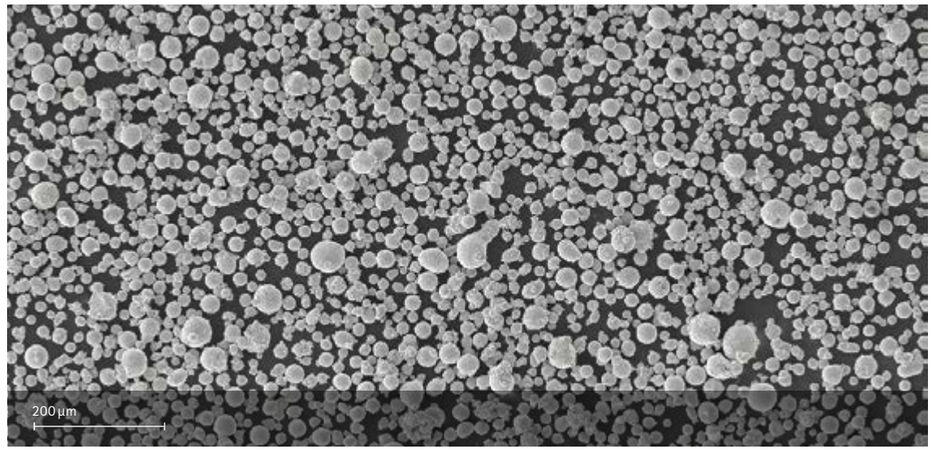
Powder chemical composition (wt.-%)

Element	Min.	Max.
Fe	Balance	
Ni	17.00	19.00
Co	8.50	10.00
Mo	4.50	5.20
Ti	0.80	1.20

Powder particle size

Generic particle size distribution	20-65 µm

SEM picture of EOS ToolSteel 1.2709 powder.



Process Information

System set-up	EOS M 290
EOS MaterialSet	1.2709 40µm HiPer M290/400W
EOSPRINT Material Set	1.2709_040_HiPerM291_1.00
Software requirements	EOSPRINT 2.7 or newer
Powder part no.	9011-0042
Recoater blade	Ceramic
Nozzle	Grid
Inert gas	Argon
Sieve	75 µm

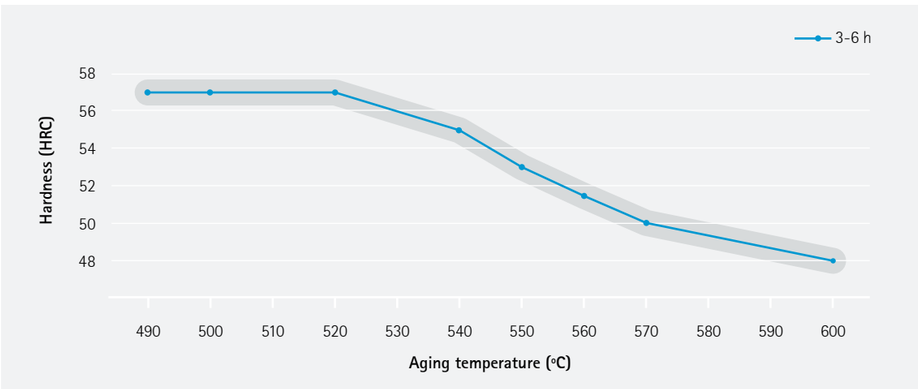
Additional information	
Layer Thickness	40 µm
Volume rate	4.1 mm^3/s
Typical dimensional change after HT	+ 0.1 %

Heat Treatment

EOS ToolSteel 1.2709 can be heat treated to match various needs of different applications. The two step heat treatment can be performed under vacuum or inert gas atmosphere. First step is solution annealing to minimize amount of austenite in the martensitic matrix. The needed hardness and strength is achieved through aging treatment where hardening takes place through forming of intermetallic phases and precipitates.

Solution Annealing:
2 h at 940 °C (±10 °C) measured from the part followed by rapid air cooling to room temperature (below 32 °C). Cooling rate 10-60 °C/min. Reaching room temperature before starting aging treatment is required to achieve desired microstructure.

Aging:
For peak hardness and strength 3-6 h at 510 °C (±10 °C) measured from the part followed by air cooling. Mechanical properties presented in this document achieved through this aging procedure. For bulky parts ensure uniformity of properties by increasing hold time up to 6 h. Also, to maximize fatigue strength, a hold time of 6 h is recommended.



If lower hardness and improved toughness is required, aging temperature can be increased according to figure above.

Chemical and Physical Properties of Parts

Chemical composition of built parts is compliant to EOS ToolSteel 1.2709 powder chemical composition.

Heat treated microstructure. Etched according to ASTM E407-07, recipe 94.

Defects	Result	Number of samples
Average defect percentage	0.03 %	55
Density, ISO3369	**Result**	**Number of samples**
Average density	>8.05 g/cm^3	20

The areal defect percentage was determined from cross-cuts of the built parts using an optical microscope fitted with a camera and analysis software. The analysis was carried out for sample area of 15 x 15 mm. The defects were detected and analyzed with an image capture/analysis software with an automatic histogram based filtering procedure on monochrome images. The density of the built specimen was measured according to ISO3369.

Mechanical Properties in Heat Treated State

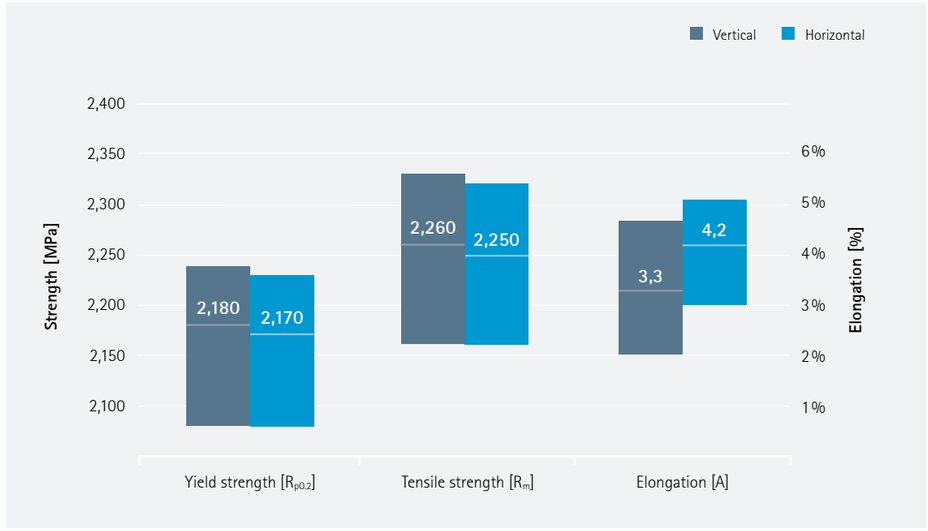
Mechanical properties ISO6892-1

	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation at break A [%]	Number of samples
Vertical	2,180	2,260	3.3	188
Horizontal	2,170	2,250	4.2	162

Hardness as per ISO6508

Hardness, HRC	57
Number of samples	45

Validation with three powder lots and three EOS M 290 systems. Data presented with tolerance interval limits that 90 % of the population fullfill with 95 % level of confidence.



Additional Data

Fatigue Strength

Fatigue strength determines a stress level where specimen fails at a defined number of stress cycles [ISO 12107]. Fatigue strength was estimated statistically according to ISO 12107.
Testing was performed according to ASTM E466. Fatigue results typically show large deviations due to the nature of the fatigue process [ISO 12107].

Fatigue strength at 1 x 10^7 cycles in heat treated state

Fatigue strength [MPa]	732

Impact Toughness

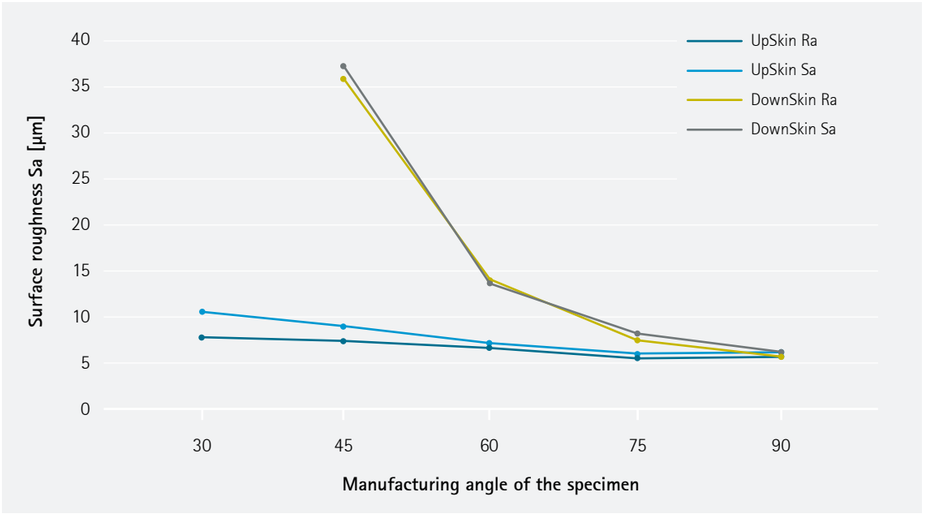
Impact toughness [J]	10

Heat treated and tested according to ISO 148-1, V-notch at room temperature.

Coefficient of Thermal Expansion ASTM E228

Temperature	25 – 100 °C	25 – 200 °C	25 - 300 °C	25 - 400 °C
CTE	10.72*10^{-6}/K	11.15*10^{-6}/K	11.50*10^{-6}/K	11.51*10^{-6}/K

Surface Roughness as Manufactured



The surface quality was characterized by optical measurement method according to internal procedure.
The 90 degree angle corresponds to vertical surface.

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Cover: This image shows a possible application.