

Supra 316Ti/4571

EN 1.4571, ASTM TYPE 316Ti / UNS S31635

General characteristics

Supra 316Ti/4571 is a titanium-stabilized, molybdenum-alloyed austenitic alternative to Supra 316L/4404 – mainly used for elevated temperature applications. Due to its titanium-stabilization this product is weldable in all thickness ranges without becoming susceptible to intergranular corrosion. It belongs to the standard CrNiMo stainless steel family.

Due to their molybdenum content, the austenitic CrNiMo standard grades can be used in applications with increased demand for corrosion resistance. Their well-balanced material properties make them suitable for the fabrication of many products. Due to its titanium content, Supra 316Ti/4571 can also be used at elevated temperatures.

Supra 316Ti/4571 is commonly available from many stainless steel stockists in many product forms and dimensions. Due to its titanium alloying, polishing options for Supra 316Ti/4571 are limited.

Typical applications

- Flue gas applications
- Flanges and valves

Products & dimensions

Cold rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
2B	Cold rolled, heat treated, pickled, skin passed	0.30-6.35	30-1610	0.30-6.35	300-2050
2BB	Bright-pickled	0.30-3.50	30-1530	0.30-3.00	600-1500
2C	Cold rolled, heat treated	0.80-6.00	30-1500		
2D	Cold rolled, heat treated, pickled	0.30-6.35	30-1610	0.40-6.35	400-1610
2E	Cold rolled, heat treated, mech. desc. pickled	0.40-6.00	30-1530	0.50-6.35	300-2050
2G	Ground	0.30-3.00	30-1500	0.30-3.00	600-1500

2H	Work hardened	0.05-6.00	3-1530	0.30-6.00	100-1530
2J	Brushed or dull polished	0.30-3.00	30-1500	0.30-3.00	600-1500
2M	Patterned	0.30-3.50	30-1530	0.30-3.50	600-1524
2R	Cold rolled, bright annealed	0.05-1.50	3-649		

Continuous hot rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1C	Hot rolled, heat treated, not descaled	2.40-10.00	50-1550		
1D	Hot rolled, heat treated, pickled	2.70-8.20	50-1592	2.70-12.70	300-2050
1E	Hot rolled, heat treated, mech. desc.	1.41-4.50	35-1610	1.41-4.50	35-1610
1G	Ground	2.40-3.00	750-1200	2.40-3.00	750-1200
1H	Hot rolled, temper rolled	5.10-5.80	100-1530		
1M	Patterned	2.40-3.00	750-1200	2.40-3.00	750-1200
1U	Black hot rolled	2.40-10.00	50-1550		

Quarto plate products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1D	Hot rolled, heat treated, pickled			5.00-130.00	400-3200
1G	Ground			8.00-12.99	400-3300

Chemical composition

The typical chemical composition for this grade is given in the table below, together with composition limits given for the product according to different standards. The required standard will be fully met as specified on the order.

The chemical composition is given as % by mass.

	C	Mn	Cr	Ni	Mo	N	Other
Typical	0.04		16.8	10.9	2.1		Ti
ASME II A SA-240	≤0.08	≤2.00	16.00-18.00	10.00-14.00	2.00-3.00	≤0.10	
ASTM A240	≤0.08	≤2.00	16.0-18.0	10.0-14.0	2.00-3.00	≤0.10	
EN 10028-7	≤0.08	≤2.00	16.5-18.5	10.5-13.5	2.00-2.50		
EN 10088-2	≤0.08	≤2.0	16.5-18.5	10.5-13.5	2.0-2.5		
EN 10088-3	≤0.08	≤2.00	16.5-18.5	10.5-13.5	2.00-2.50		
EN 10088-4	≤0.08	≤2.0	16.5-18.5	10.5-13.5	2.0-2.5		
IS 6911	≤0.08	≤2.0	16.0-18.0	10.0-14.0	2.00-3.00	≤0.10	

Corrosion resistance

Supra 316Ti/4571 has excellent corrosion resistance in solutions of many halogen-free organic and inorganic compounds over a wide temperature and concentration range. It can withstand many organic and diluted mineral acids depending on the temperature and concentration of the solution. Supra 316Ti/4571 may suffer from uniform corrosion in strong mineral acids, like hot concentrated nitric acid, or hot strong alkaline solutions. More detailed information on the corrosion properties of Supra 316Ti/4571 can be found in Outokumpu's Corrosion Tables published in the [Outokumpu Corrosion Handbook](#) and on www.outokumpu.com.

Due to its titanium content, the risk of sensitisation for intergranular corrosion is strongly reduced when compared to other austenitic

CrNi standards grades with normal carbon content.

In aqueous solutions containing halogenides, e.g. chlorides or bromides, pitting and crevice corrosion may occur depending on halogenide concentration, temperature, pH-value, concentration of oxidizing compounds, or crevice geometry, if applicable. The presence of corrosion-inhibiting or accelerating compounds like transition metal ions or organic compounds may influence the corrosion behavior of Supra 316Ti/4571.

Supra 316Ti/4571 is prone to chloride-induced stress corrosion cracking at temperatures over about 50 °C depending on the applied stress and the chloride concentration in the environment. Prior cold deformation of the structure under load increases the risk of stress corrosion cracking.

Supra 316Ti/4571 can be used for indoor and outdoor applications in rural, urban, and moderately corrosive industrial environments. When chloride contamination may be high, for instance in coastal areas, pitting and staining is possible. The best material performance is usually reached with the help of adequate design, correct post-weld treatment, and regular cleaning during use (if applicable).

Like all austenitic CrNiMo standard grades, also Supra 316Ti/4571 is normally not recommended for high temperature service due to its molybdenum content, which causes a risk of catastrophic oxidation in many high temperature applications. Nevertheless, Outokumpu Supra 316Ti/4571 shows excellent behaviour as structural material in the case of a fire because of its increased high temperature strength.

For more information on corrosion resistance, please refer to the Outokumpu Corrosion Handbook or contact the our corrosion experts.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
24	15±2	<0

Pitting Resistance Equivalent (PRE) is calculated using the following formula: $PRE = \%Cr + 3.3 \times \%Mo + 16 \times \%N$

Corrosion Pitting Temperature (CPT) as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions).

Critical Crevice Corrosion Temperature (CCT) is obtained by laboratory tests according to ASTM G 48 Method F

Mechanical properties

The mechanical properties of the available products in the soft annealed condition at room temperature are given in the table below. Moderate strengths can be reached at elevated temperatures (~550 °C / 1022 °F). Temperatures for excessive scaling are close to 850 °C/1562 °F. This grade, along with other austenitic corrosion-resistant steels, exhibits very high ductility and high elongation to fracture. It is not susceptible to brittle fracture in the solution annealed condition.

Cold rolled coil and sheet	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	Elongation ¹⁾ %	Impact strength J	Rockwell	HB	HV
Typical (thickness 1 mm)	285	310	615	70				
ASME II A SA-240	≥ 205		≥ 515				≤ 217	
ASTM A240	≥ 205		≥ 515			≤ 95HRB	≤ 217	
EN 10028-7	≥ 240	≥ 270	540 - 690	≥ 40				
EN 10088-2	≥ 240	≥ 270	540 - 690	≥ 40				
EN 10088-4	≥ 240	≥ 270	540 - 690	≥ 40				
IS 6911	≥ 205		≥ 515			≤ 95HRB	≤ 217	

Hot rolled coil and sheet	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	Elongation ¹⁾ %	Impact strength J	Rockwell	HB	HV
Typical (thickness 4 mm)	295	345	595	50			170	
ASME II A SA-240	≥ 205		≥ 515				≤ 217	
ASTM A240	≥ 205		≥ 515				≤ 217	
EN 10028-7	≥ 240	≥ 270	540 - 690	≥ 40				
EN 10088-2	≥ 240	≥ 270	540 - 690	≥ 40				
EN 10088-4	≥ 240	≥ 270	540 - 690	≥ 40				
IS 6911	≥ 205		≥ 515			≤ 95HRB	≤ 217	

Hot rolled quarto plate	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	Elongation ¹⁾ %	Impact strength J	Rockwell	HB	HV
Typical (thickness 15 mm)	260	300	570	50				
ASME II A SA-240	≥ 205		≥ 515			≤ 95HRB	≤ 217	
ASTM A240	≥ 205		≥ 515			≤ 95HRB	≤ 217	
EN 10028-7	≥ 220	≥ 260	520 - 670	≥ 40				
EN 10088-2	≥ 220	≥ 260	520 - 670	≥ 40				
EN 10088-4	≥ 220	≥ 260	520 - 670	≥ 40				
IS 6911	≥ 205		≥ 515			≤ 95HRB	≤ 217	

¹⁾Elongation according to EN standard:

A₈₀ for thickness below 3 mm.

A for thickness = 3 mm.

Elongation according to ASTM standard A₂ or A₅₀.

Physical properties

Physical properties according to EN 10088 are shown below.

Density	Modulus of elasticity	Thermal exp. at 100 °C	Thermal conductivity	Thermal capacity	Electrical resistance	Magnetizable
kg/dm ³	GPa	10 ⁻⁶ /°C	W/m°C	J/kg°C	μΩm	
8.0	200	16,5	15	500	0.75	No

Fabrication

Cold forming

Supra 316Ti/4571 can be readily formed and fabricated using a full range of cold forming operations. It can be used in heading, drawing, and bending. Any cold forming operations will increase the strength and hardness of the material.

Hot forming

Hot forming can be carried out in the 850 °C–1150 °C range. For maximum corrosion resistance, forgings should be annealed at 1070 °C and rapidly cooled in air or water after hot forming operations.

Machining

Better machinability performance is achieved using Prodec versions, which have been modified for improved machinability. Prodec is available as hot rolled plate and bar in 4401, 4404, 4436 and 4432.

Welding

Supra 316Ti/4571 has excellent weldability and is suitable for the full range of conventional welding methods (like MMA, MIG, MAG, TIG, SAW, LBW, or RSW), except gas welding.

Supra 316Ti/4571 has about 50% higher thermal expansion and lower heat conductivity compared to carbon steels. This means that larger deformation and higher shrinkage stresses may result from welding.

In thin sections, autogenous welding may be used. To ensure that the weld metal properties (e.g. strength, corrosion resistance) are equivalent to those of the parent metal, matching or slightly over-alloyed fillers should preferably be used.

The recommended filler metals are 19 12 3 Nb or 19 12 3L.

Post-weld heat treatment is generally not required. In special cases where there is high risk of stress corrosion cracking or fatigue, stress relief treatment may be considered.

In order to fully restore the corrosion resistance of the weld seam, the weld discoloration should be removed by pickling and passivation.

More detailed information concerning welding procedures can be obtained from the Outokumpu Welding Handbook, available from our sales offices.

Standards & approvals

The most commonly used international product standards are given in the table below.

Standard	Designation
ASME SA-240M Code Sect. II. Part A	TYPE 316Ti / UNS S31635
ASTM A240/A240M	TYPE 316Ti / UNS S31635
EN 10028-7, PED 2014/68/EU	1.4571
EN 10088-2	1.4571
EN 10088-3	1.4571
EN 10088-4	1.4571
IS 6911, AMENDMENT NO. 2	ISS 316 TI

Contacts & Enquiries

Contact your nearest sales office

www.outokumpu.com/contacts

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