

UR™ 316Ti

UR™ 316Ti: A Ti stabilized 18Cr - 11Ni - 2 Mo austenitic stainless steel

UR™ 316Ti is a titanium stabilized austenitic stainless steel which is insensitive to intergranular corrosion. molybdenum improves its resistance to localized corrosion.

UR™ 316Ti is an austenitic grade, containing some residual ferrite and titanium carbo - nitrides after solution annealing (1050 - 1150°C / 1922 - 2102°F) and water quenching.

PROPERTIES

STANDARDS

- > EURONORM: EN 1.4571 X6CrNiMo 17 - 12 - 2
> ASTM: A240TP 316Ti - UNS S31635

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Mo	N	Ti
0.04	17	10.5	> 2.0	-	5x%(C+N) up to 0.70

PHYSICAL PROPERTIES

Density: 8000 kg/m³

Interval temperature (°C)	Thermal expansion 10 ⁻⁶ K ⁻¹	T °C (°F)	Resistivity (μΩ.cm)	Thermal conductivity (W.m ⁻¹ .K ⁻¹)	Specific heat (J kg ⁻¹ K ⁻¹)	Young modulus E (GPa)	Shear modulus G (GPa)
20 - 100	16.5	20 (68)	75	15	500	200	77
20 - 200	17.5	100 (212)	79	16	500	194	75
20 - 300	18	200 (392)	87	17.5	520	186	71
20 - 400	18.5	300 (572)	94	19	530	179	68
20 - 500	19	400 (752)	98	20.5	540	172	65
		500 (932)	102	22	540	165	62

PROPERTIES

MECHANICAL PROPERTIES

Tensile properties after solution annealing heat treatment

°C	°F	Minimum guaranteed values*							Typical values (10 mm plates)					
		YS 0.2%		YS 1%		UTS		Elongation	YS 0.2%		YS 1%		UTS	
		MPa	ksi	MPa	ksi	MPa	ksi		%	MPa	ksi	MPa	ksi	MPa
20	68	220	32	260	38	520/ 670	76/98	40/60**	270	39	310	45	560	82
100	212	185	27	218	32	470	77/69	35	250	36	-	-	525	77
200	392	167	24	196	29	440	64	30			-	-		
300	572	145	21	175	26	430	63	30	200	29	-	-	-	-
400	752	135	20	164	24			25	170	25			425	62
500	932	129	19	158	23	-	-	20	-	-	-	-	-	-

*Following EN10088 hot rolled plates ** typical. The EN guaranteed values are valid for a thickness from 5 up to 75 mm

Impact values

Temperature °C (°F)	- 40 (- 40)	+20 (+68)
KCV (J/cm ²) minimum	112	125

Typical creep strength values

Temperature °C (°F)	550 (1022)		600 (1112)		650 (1202)		700 (1292)	
Rupture time (h)	10 ³	10 ⁴	10 ³	10 ⁴	10 ³	10 ⁴	10 ³	10 ⁴
σ _R (MPa)	400	310	250	180	210	160	150	90

IN SERVICE CONDITIONS

CORROSION RESISTANCE

Standardized corrosion tests (special request may be discussed)

TEST	NAME	CORROSION	RESULTS
ASTM A 262 A		Intergranular	Step or dual structure
ASTM A 262 B	STREICHER	Intergranular	Not recommended
ASTM A 262 E DIN 50914 RCCM	STRAUSS	Intergranular	No cracking after bending
ASTM G48A		Pitting	Not recommended
ASTM G48B	ASTM G78	Crevice	Not recommended

DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled plate	Coils or Plates Cut to length	Clad plate
Thickness	5 to 150 mm 3/16" to 6"	Consult Aperam	Consult Industeel
Width	Up to 3800 mm* Up to 150"		
Length	Up to 16000 mm Up to 52"		

Indicative dimensional programme - *Width related to thickness, please consult for specific request.

HOT FORMING

Hot forming should be carried out in a temperature range of 1150 - 800°C (2102 - 1472°F). If the final forming temperature falls below 950°C (1742°F), an annealing solution (1050 - 1150°C, 1922 - 2102°F) is necessary. The cleanliness of the surface is very important (avoid oil contamination). A neutral or slightly oxidising atmosphere is required. Due to the low thermal conductivity, the holding time of temperature may be longer than for a carbon steel (~50%). Quenching must be done fastly after forming.

COLD FORMING

The alloy can be cold formed without any problem. The cold hardening of the steel explains why it may require more powerfull equipments than for a structural steel. Molybdenum bearing implies also some more powerfull equipments than Cr - Ni austenitic stainless steels.

WELDING

The alloy can be easy welded without hot cracking phenomenon, using an adequate filler metal (from 5 to 15% ferrite). The alloy is not sensitive to cold cracking phenomenon. All welding processes can be used including filler processes.

Filler material

- > **Electrode: E316L - 15 or E316L - 16 (ASME Sect II - Part C SFA5 - 4)**
- > **Wire: ER 316L (ASME Sect II - Part C SFA 5 - 9)**

Filler material stabilized with Niobium may be used when specific properties of alloy UR™ 316Ti are required.

- > **Electrode E318 - 15 or E318 - 16**
- > **Wire ER318**

A post - weld heat treatment is not necessary. Preheating and post heating are not necessary. 200°C (392°F) is the maximum interpass temperature. Post - weld pickling and passivation treatment are necessary.

MACHINING

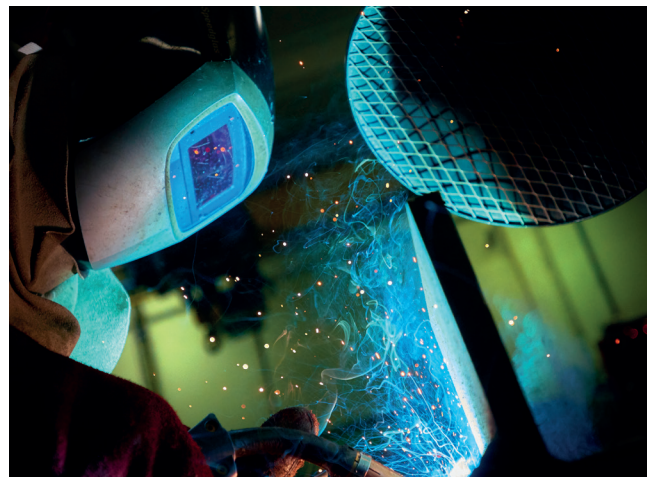
Due to its cold work hardening, the alloy is less machinable than structural steel or than a 13% Cr martensitic stainless steel.

PICKLING

A nitric - hydrofluoric acid bath (10 - 20% HNO₃ - 1,5 - 5% HF) at 20 - 60°C (68 - 142°F) is used for the pickling treatment. A 10 - 20% H₂SO₄ - 1,5 - 5% HF pickling bath may also be used. Passivation - decontamination treatments may be performed with a 10 - 20% weight nitric acid solution.

CUTTING

- > **Thermal cutting (plasma, thermal sawing...).**
After cutting pickling or grinding are necessary to eliminate the oxide formed layer.
- > **Mechanical cutting (shearing, stamping, cold sawing...).**



Operation	Tool	Lubrication	CONDITIONS		
			Depth of cut mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Turning	High speed steel	Cutting oil	6 (0.23)	0.5 (0.019)	10 - 15 (33 - 49)
			3 (0.11)	0.4 (0.016)	15 - 21 (49 - 69)
			1 (0.04)	0.2 (0.008)	22 - 27 (72 - 88)
	Carbide	Dry or cutting oil	6 (0.23)	0.5 (0.019)	60 - 70 (197 - 230)
			3 (0.11)	0.4 (0.016)	75 - 85 (246 - 279)
			1 (0.04)	0.2 (0.008)	90 - 100 (295 - 328)

PLATE PROCESSING

			Blade width mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Cutting	High speed steel	Cutting oil	1.5 (0.06)	0.03 - 0.05 (0.0012 - 0.0020)	14 - 19 (46 - 62)
			3 (0.11)	0.04 - 0.06 (0.0016 - 0.0024)	15 - 20 (49 - 66)
			6 (0.23)	0.05 - 0.07 (0.0020 - 0.0027)	16 - 21 (52 - 69)
			Drill Ø mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Drilling	High speed steel	Cutting oil	1.5 (0.06)	0.02 - 0.03 (0.0008 - 0.0012)	9 - 13 (29 - 42)
			3 (0.11)	0.05 - 0.06 (0.0020 - 0.0024)	11 - 15 (36 - 49)
			6 (0.23)	0.08 - 0.09 (0.0031 - 0.0035)	11 - 15 (36 - 49)
			12 (0.48)	0.09 - 0.10 (0.0035 - 0.0039)	11 - 15 (36 - 49)
				Feed mm/t (inch/t)	Speed m/min (feet/min)
Milling profiling	High speed steel	Cutting oil		0.05 - 0.10 (0.002 - 0.004)	9 - 19 (29 - 62)

APPLICATIONS

- > Rail and road containers and tanks
- > Chemical industry
- > Petrochemical industry



YOUR CONTACTS

Didier Paul
 Tel. +33 6 19 28 29 31
 didier.r.paul@arcelormittal.com

<http://industeel.arcelormittal.com>

Industeel Belgium
 266 rue de Châtelet
 B - 6030 Marchienne-au-Pont

Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.