Industeel

ArcelorMittal

URANUS 2205+

A 22%Cr duplex stainless steel with PREN ≥ 36

URANUS 2205+ (UR 2205+) is a nitrogen alloyed austenitic-ferritic duplex stainless steel (2205), with a minimum PREN value guaranteed of 36 due to over-alloying in Molybdenum and Chromium. This alloy presents higher mechanical and corrosion resistance properties than duplex 22 Cr stainless steels.

Its yield strength is about twice that of standard austenitic grades and well in excess of that of nitrogen alloyed austenitics.

The operating temperature of UR 2205+ is generally limited from -50°C to 280°C (*-58°F to 536°F*). Lower temperature used particularly for welded structures may also be considered for certain operating conditions.

Standard

EURONORM : 1.4462 - X2 Cr Ni Mo N 22-5-3
ASTM : UNS S 31803/S 32205

Chemical analysis

Typical values (wt%)

C	Cr	Ni	Mo	N
0.020	22.6	6	3.4	0.18

PREN = [Cr %] + 3.3 [Mo %] + 16 [N %] ≥ 36

Mechanical properties

Tensile properties - Minimum guaranteed values

°C	$R_{p\ 0.2}$ MPa	$R_{p\ 1.0}$ MPa	R_m MPa	*°F*	*YS 0.2% KSI*	*YS 1.0% KSI*	*UTS KSI*	A/El%
20	510	540	720	*68*	*74*	*78*	*104*	25
Plates th ≤ 50mm (2 inches)								
50	460	500	670	*122*	*67*	*72*	*97*	
100	420	450	640	*212*	*61*	*65*	*93*	25
150	380	420	620	*302*	*55*	*61*	*90*	
200	350	390	600	*392*	*51*	*56*	*87*	20
250	320	350	600	*482*	*46*	*51*	*87*	
300	310	340	600	*572*	*45*	*49*	*87*	20

°C	$R_{p\ 0.2}$ MPa	$R_{p\ 1.0}$ MPa	R_m MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	A/El%
50	440	480	650	122	64	70	94	
100	400	430	620	212	58	62	90	
150	360	400	600	302	52	58	87	
200	330	370	580	392	48	64	84	
250	300	330	580	482	44	48	84	
300	290	320	580	572	42	46	84	

UR 2205+ should not be used over 280°C (536°F) for long periods.

Impact values

KCV +20°C	+68°F	120J/cm² average 90J/cm² mini	87 Ft.lbs 65 Ft.lbs
KCV -50°C	-58°F	90/cm² average 75J/cm² mini	65 Ft.lbs 54 Ft.lbs

Density : 7.85 kg/dm³

Temperature interval (°C) (°F)	Thermal expansion x10⁻⁶ 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 (68 - 212)	12	20 (68)	80	17	450	200	75
20 - 200 (68/392)	12.5	100 (212)		18	450	194	73
20 - 300 (68/572)	13	200 (392)		19	500	186	70
		300 (572)		20	550	180	67

Structure

The UR 2205+ alloy has a two-phase microstructure containing, 50% α, 50% γ

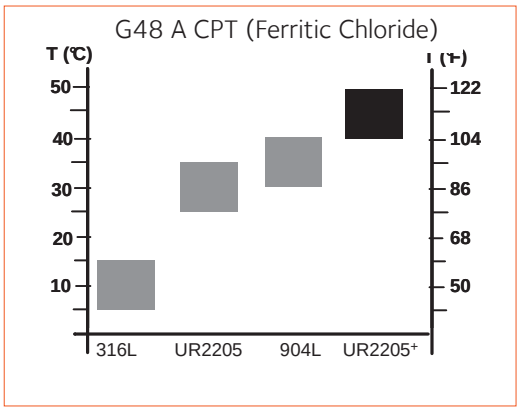
Corrosion resistance

General corrosion

UR 2205+ has a general corrosion resistance better than a 316L steel (Z3 CND 17.12.03) and equivalent or better than a 904L alloy (UR 904).

Pitting corrosion

	PREN value
316L	≥ 23
URANUS 2205	≥ 33
URANUS 2005+	≥ 36
URANUS 904 (20Cr/25 Ni/4.5 Mo/Cu)	≥ 32



Crevice corrosion

Better than 316L ; equivalent to UR 904 / 904L.

Stress corrosion cracking

Duplex structure gives to UR 2205+ a definite advantage over austenitic steels (chloride containing media at temperatures up to 280°C (536°F).

Intergranular corrosion

UR 2205+ is resistant to Strauss test (A262E) in the delivered and as welded conditions.

Fabrication

Heat treatment

The heat treatment for delivery is 1050-1100°C (1922/2012°F).
Air cooling for thicknesses < 8 mm is agreed, but water quenching is advised. For thicknesses of 8 mm and above, water quenching is necessary. Special precautions must be taken during heat treatment to avoid deformation.

Cold forming

Due to its higher mechanical properties, UR 2205^{+} requires more strength than a classical austenitic stainless steel. Deformation higher than 20% requires an intermediate heat treatment.

Hot forming

Recommended between 1150°C and 1000°C *(2102 and 1832°F)*.
After forming, a new heat treatment is necessary to obtain optimal mechanical properties and microstructure stability.

Pickling

A pickling solution acceptable for 316L may be used, but the pickling time required is at least twice that of 316L.

Machining

Machining is yet another example of a fabrication process in which the employed techniques (eg. tools and lubricants) are very similar to those used for conventional stainless steels).

Machining characteristics of UR 2205^{+} are better than those of 316L and 904L.

Operation	Tool	Lubrication	CONDITIONS			
			Depth of cut (mm) *(inch)*	**Feed (mm)** *(inch)*	**SPEED (m/min)** *SPEED (feet/min)*	
					UR 904	**UR 2205^{+}**
Turning	High speed steel	Cutting oil	6 *0.23*	0.5 *0.019*	6-11 *19.7-36.1*	15-20 *49.2-65.6*
			3 *0.11*	0.4 *0.016*	9-14 *29.5-45.9*	23-28 *75.5-91.9*
			1 *0.04*	0.2 *0.008*	15-20 *49.2-65.6*	30-35 *98.4-114.8*
	Carbide	Dry or cutting oil	6 *0.23*	0.5 *0.019*	25-35 *82-114.8*	75-85 *246.1-278.9*
			3 *0.11*	0.4 *0.016*	45-55 *147.6-180.4*	90-100 *295.3-328.1*
			1 *0.04*	0.2 *0.008*	65-70 *213.3-229.7*	110-120 *360.9-393.7*
Parting off	High speed steel	Cutting oil	Blade width	Feed	SPEED (m/min (feet/min)	
			1.5 *0.06*	0.03 *0.0012*	10-13 *32.8-42.7*	23-28 *75.5-91.9*
			3 *0.11*	0.04 *0.0016*	11-14 *36.1-45.9*	24-29 *78.7-95.1*
			6 *0.23*	0.05 *0.0020*	12-15 *39.4-49.2*	25-30 *82-98.4*
Drilling	High speed steel	Cutting oil	Drill dia.	Feed	SPEED (m/min) (feet/min)	
			1.5 *0.06*	0.25 *0.0010*	6-10 *19.7-32.8*	10-14 *32.8-45.9*
			3 *0.11*	0.06 *0.0024*	7-11 *23-26.1*	11-15 *36.1-49.2*
			6 *0.23*	0.08 *0.0031*	7-11 *23-26.1*	11-15 *36.1-49.2*
			12 *0.48*	0.10 *0.0039*	7-11 *23-26.1*	11-15 *36.1-49.2*
Milling profiling	High speed steel	Cutting oil		Feed	SPEED (m/min) (feet/min)	
				0.05-0.10 *0.002-0.0039*	10-20 *32.8-65.6*	12-22 *39.4-72.2*

Welding

UR 2205^{+} is an austenitic-ferritic duplex grade, and the ferrite/austenite ratio is controlled by:
- its chemical composition, designed to obtain between 45 and 55 % of ferrite and the complement austenite after heat treatment at 1050/1100°C (*1922/2012°F*),
- the thermal cycle undergone by the alloy, a higher heat treatment temperature (*>1100°C is 2012°F*) resulting in a higher amount of ferrite.

After thermal cycle (heat at high temperature and rapid cooling), the HAZ structure is enriched by ferrite compared to the heat treated structure. Nevertheless, the high nitrogen level of UR 2205^{+} allows an excellent control of the structure in HAZ. The chemical composition of UR 2205^{+} has been calculated so that ferrite does not exceed 75 % to guarantee a good corrosion resistance and a good ductility. Austeno-ferritic structure of UR 2205^{+} steel (primary solidificatIon) excludes all risk of hot cracking.

UR 2205+ is easily welded by the following processes:

- TIG welding, both manual and automatic	- MIG welding
- Plasma welding	- Manual arc welding with covered electrodes
- Flux cored Arc Welding (FCAW)	- Submerged Arc Welding (SAW)

Special care must be taken in controlling the ferrite content of the weld deposit, which is usually between 20 and 60 %, and, depending on the application, a low ferrite content will be recommended (20-40 % of α) i.e. for SMAW, SAW and FCAW
The chemical composition has to be adapted to stabilise austenite (generally, nickel or nitrogen overalloying compared to the base metal). Using of a Cr and Mo overalloyed filler metals is recommended.
Welding in several passes helps to limit ferrite content.
As for austenitic grades :
- No preheat is necessary prior to welding
- The heat input must be controlled (10 to 25 kJ/cm is generally recommended)
- Interpass temperature must be limited to 150°C (*302°F*)
- No post weld heat treatment is necessary, except if, in particular cases, or for a particular welding, a lower ferrite content is necessary. Treatment will be realised at a sufficient temperature to avoid any transformation in phase. A higher temperature can be required when using overalloyed welding products 1080/1100°C (*1976/2012°F*).
- Usual precautions including cleaning and degreasing of weld area, protection against weld spatters must be taken to ensure corrosion resistance of finished product.
- Careful final descaling and/or cleaning of the weld is highly recommended.

1. Plasma + TIG welding
- Typically used for thicknesses 5 to 12 mm.
- Normal 22.09 wire, or overalloyed wire (25.10.4 type) will be used for plasma pass.
- If no filler metal is used for the plasma arc, Ar + (2-3)% N_2 will be used as shielding gas.
- Ferrite content will be between 30 and 60 %. Complementary TIG welding will also be realised with normal 22.09 wire or overalloyed wire. The ferrite content will also be between 30 and 60 %.
- Nitrogen addition (2-3%) to the shielding gas can be recommended to stabilize the microstructure and improve the corrosion behaviour. In each case, contamination of shielding gas by hydrogen must be avoided.

2. Manual Metal Arc Welding
A standard 22.09 wire or 25-10-4 grade allowing overalloy of deposit metal will be used. The ferrite content is between 20 and 40%. For more information, please contact us.

3. Submerged Arc Welding
This process can be used for single pass or multipass welds for high thicknesses (≥10mm) or to complete a plasma pass. The filler metal is a duplex wire and basic fluxes should be preferred. Ferrite content will be controlled between 20 and 40% in order to avoid cold cracking risks ; use only well dryed fluxes to avoid hydrogen pick-up.

Applications

Gas transportation on- offshore	Other uses	
- tubes for platforms - tubes for transportation of acid gas to refining stations - wet carbonic gases collecting unit	- Bulk tankers for transportation of chemical products - acid areas (H_2SO_4 diluted, phosphoric acid, production and storage of phosphates)	- urea production - trucks, lorries - pollution control industry - pulp and paper industry - plastic industry - food industry - chloride areas

Size range

	Plates
Thickness	5 to 150mm *3/16" to 6"*
Width	Up to 3300mm *Up to 130"*
Length	Up to 12000mm *Up to 472"*

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