Duplex stainless steel offer

grade **DX2202**

Chemical composition

Elements	C	Mn	Cr	Ni	Mo	N
%	0.02	1.30	23.00	2.50	0.30	0.21

Typical values - PREN = 26

ArcelorMittal Industeel - Ugitech patent EP2038445B1

European designation [(1)]	American designation [(2)]
X2CrNiN22-2 / 1.4062	UNS 32202 / Type 2202

[(1)] According to NF EN 10088   [(2)] According to ASTM A240

This grade complies with:

- Stainless Europe Material Safety Data Sheet n°1 (European Directive 2001/58/EC).
- European Directive 2000/53/EC on end-of-life vehicles and later modifications.
- Standard NFA36 711 "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)".
- French Decree No.92-631 dated 8 July 1992 and Regulation No. 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food (and repealing Directives 80/590/EECand 89/109/EEC).
- French regulatory paper dated 13 January 1976 relating to materials and articles made of stainless steel in contact with foodstuffs.

General characteristics

The principal features of DX2202 are:

- Good general resistance to corrosion, comparable to 304L (18-9L) at elevated temperature and to 316L (18-11ML) at room temperature
- Improved mechanical strength
- Service temperature range: -50°C to 300°C
- Improved stress corrosion resistance compared to 304 (18-9E)

Applications

- Construction: crash barriers & foot bridges
- Drinking water systems
- Desalination
- Pulp and paper industry (tanks, cladding of paper machines)
- Oil tanks
- Juice tanks
- Automotive structures

Product range

Forms: sheets, blanks, strips

Thicknesses: from 0.8 up to 10 mm

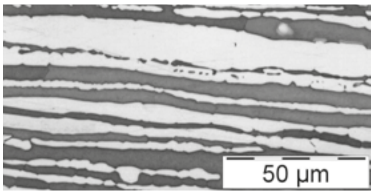
Width: up to 2000 mm according to thickness

Finishes: hot rolled, cold rolled

Metallurgical properties

The grade DX2202 is a stainless steel of the austeno-ferritic group, whose structure is composed of a mix of ferritic (α) and austenitic (γ) phases. The two-phase structure of the alloy makes it possible to obtain elevated yield strength values whilst still maintaining sufficient ductility. The hardening is provided by the ferritic phase, whereas the austenitic lattice enables to preserve both ductility and toughness.

The mixed structure gives our DX2202 a good resistance to stress corrosion cracking and makes it insensitive to intergranular corrosion.



Microstructure of the DX2202 (dark areas represent the ferritic phase)

Continuous use of our DX2202 at temperatures above 300°C is not recommended for the following reason: between 350 and 550°C there is a loss of ductility by embrittlement of the ferritic phase due to the formation of the so-called α' phase, possibly accompanied by other embrittling phases; this is a classical phenomenon encountered with ferritic structure, more commonly referred to as "475°C embrittlement".

made for life

Physical properties

Cold rolled and annealed sheet.

Density	d	kg/dm³	20 °C	7.8
Melting temperature	-	°C	-	1470
Specific heat	c	J/kg.K	20 °C	490
Thermal conductivity	k	W/m.K	20 °C	15
Mean thermal expansion coefficient	α	10^{-6}/K	20-200 °C 20-400 °C	13.5 14
Electric resistivity	ρ	Ω mm²/m	-	0.7
Magnetic	-	-	-	yes
Young's Modulus	E	10^3.MPa	20 °C	200

Mechanical properties

In annealed condition at 20°C

According to ISO 6892-1, transverse direction

Gauge length: 50 mm

Grade	European designation	UNS designation	Rm [1] (MPa)	$Rp_{0.2}$ [2] (MPa)	A [3] %
DX2202	1.4062	S32202	710	530	30
DX2304	1.4362	S32304	730	550	30
DX2205	1.4462	S32205	800	620	30
316L	1.4401/4404	316/316L	620	300	52
K45	1.4509	445 [a]	510	360	29
304	1.4301	304	650	300	54

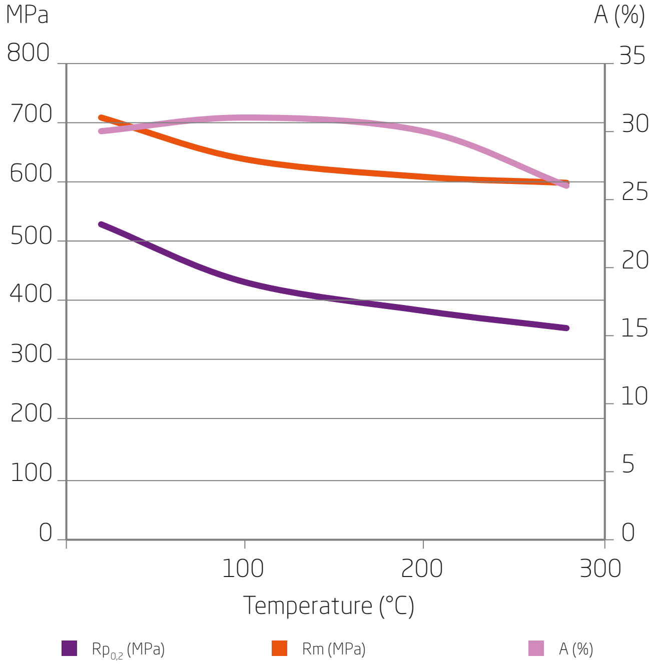
1 MPa= 1 N/mm² / *Typical values / [1] Ultimate Tensile Strength (UTS) / [2] Yield Strength (YS)
[3] Elongation (A) [a] Common designation

Typical impact toughness

Temperature (°C)	Kv min.* (J/cm²)
20	150
-40	100

*Kv_2 transversal, HRAP 5mm

At high temperatures



Corrosion resistance

General corrosion resistance

DX2202 has been designed to replace 304 (18-9E) and 304L (18-9L) in most applications that are critical for the 304 (18-9E) and 304L (18-9L). Pure sulfuric acid is an example where its resistance is better than that of 18-9L but lower than that of DX2304 (1.4362, Type 2304) and 316L (18-11ML).

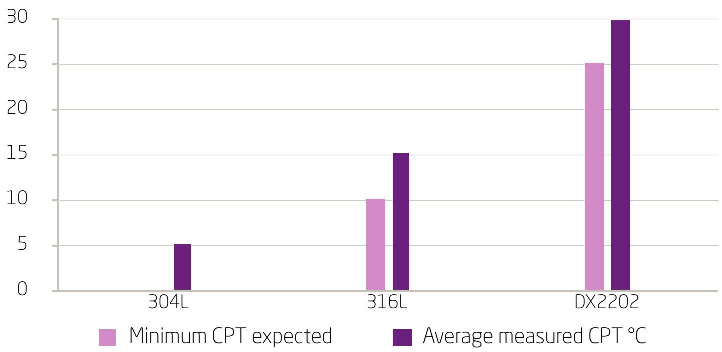
DX2202 can also be used in combination with nitric acid.

Pitting corrosion resistance

Generally speaking, the DX2202 has at least the same level of pitting corrosion resistance as the 304L (18-9L). Depending on the environment, the pitting corrosion resistance of the DX2202 can be compared with the resistance of the 316L (18-11ML). This is the case in drinking water where the pitting potential is even slightly higher than the 304L (18-9L) and the 316L (18-11ML).

In other environments though, for example environments rich in sodium chloride at different temperatures, the DX2202 corrosion resistance is at least at the same level as that of 304L (18-9L) but slightly inferior to that of 316L (18-11ML).

Critical Pitting Temperature (°C)



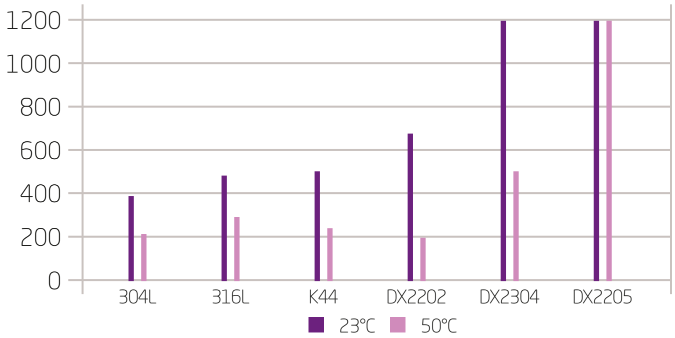
Intergranular corrosion resistance

The DX2202 is resistant to intergranular corrosion like other duplex stainless steels and is conform to the requirements of following standards:

- Strauss test according to ASTM A262E
- HUEY test according to ASTM A262C

More information about corrosion test results is available from our technical customer support department.

Pitting potential (mV/SCE)

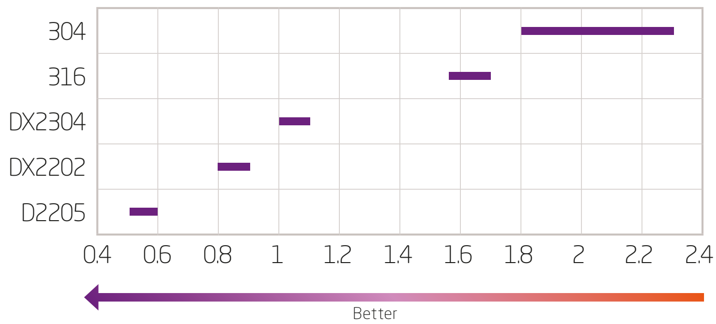


Crevice Corrosion

Crevice corrosion is a type of corrosion that can be divided in two stages. During the first stage, the initiation, an incubation period is needed before sufficient chloride accumulation and acidification lead to depassivation within the crevice region. A depassivation pH can be defined as the critical condition for passivity breakdown.

The propagation is the second stage and is involved in the dissolution of metal. To slow down this stage, molybdenum and nickel containing grades are to be preferred since both these elements have a positive effect on decreasing the speed of propagation.

Depassivation pH, 2M NaCl, 23°C



Atmospheric corrosion resistance

Tests are in progress at various locations to check the atmospheric corrosion resistance of our DX2202.

The initial results situate this grade between 304L (18-9L) and 316L (18-11ML) and show that the use of this grade in marine atmospheres is not recommended.

Forming

Cold forming

Our grade DX2202 is suited to be cold formed as well.

When the cold working deformation exceeds 20%, an intermediate full annealing heat treatment (1040/1080°C) must be applied. Such heat treatment is also recommended after the last cold forming pass, if cold deformation exceeds 10%, in order to restore the mechanical properties.

Bending

Compared to the 304L (18-9L) a minimum bending radius must be applied due to the higher mechanical properties and lower elongation to rupture. The minimum bending radius must be at least 3 times the thickness of the base material and 4 times the thickness of the welded assembly.

Grade	Stretching: Erichsen height* (mm)	Limiting Drawing Ratio* (LDR)
DX2202	10.5	1.9 - 1.95
DX2205	9.5	1.9 - 1.95
DX2304	9.5	1.95 - 2.0
K41	9.4	2.29
304L	11.4	1.9

* Typical values - LDR: cylindrical punch (diam. 33 mm), Erichsen test: hemispherical punch (diam. 20 mm)

Welding

The chemical composition of DX2202 has been balanced to limit microstructural changes in the heat affected zone. In the case of welding without filler material, solidification is fully ferritic followed by austenite formation during further cooling. Too rapid cooling can lead to excess of ferrite. It is important, though, to select welding parameters, i.e. energy, filler metal, shielding gas, to obtain a controlled ferrite fraction both in the fusion zone and in the heat affected zone. The welding conditions depend on the thickness and on the welding equipment, please don't hesitate to consult our specialists.

Recommendations

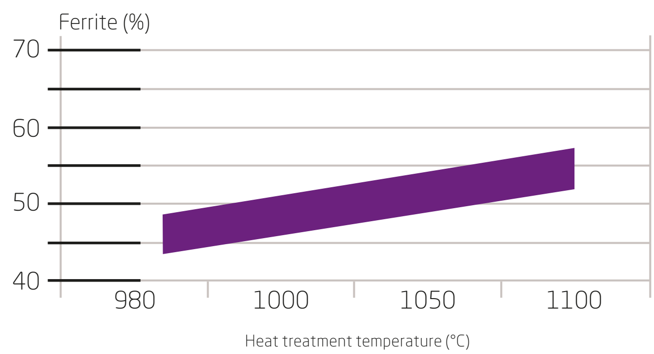
The use of a top/bottom shielding gas is recommended. Nitrogen must be added in the case of welding without filler metal or adapted to the filler metal in the other case. The austeno-ferritic structure of DX2202 eliminates the risk of hot cracking. If welded under with improper conditions, this grade can become sensitive to cold-cracking. To avoid any risks, non hydrogenated gas must be used for the purpose of welding and all filler materials must be correctly dried (temperature above 250°C in most cases). Pre or post-welding heat treatment is not recommended, as improper conditions can lead to intermetallic phase precipitation. In case of multipass welding, maximal interpass temperature of 150°C is advised to prevent precipitation of deleterious phases. Better corrosion resistance is achieved with weld pickling and passivation.

Welding process	No filler material	With filler metal			Shielding gas
	Typical thicknesses	Typical thicknesses	Filler material		
			Rod	Wire	
Resistance: spot, seam	≤ 2 mm				
TIG	≤ 1.5 mm	> 0.5 mm	W 23 7 N L or W 22 9 3 N L [1] ER2209 [2]	G 23 7 N L or G 22 9 3 N L [1] ER2209 [2]	Ar + 2-3% N_2 Ar, Ar+ He
PLASMA	≤ 1.5 mm	> 0.5 mm			Ar + 2-3% N_2 Ar, Ar+ He
MIG		> 0.8 mm		G 23 7 N L or G 22 9 3 N L [1] ER2209 [2]	Ar + 2-3 % N_2 + 2% CO_2 or O_2
S.A.W.		> 5 mm		S 23 7 N L or S 22 9 3 N L [1] ER2209 [2]	
S.M.A.W		Repairs	E 22 9 3 N L R [1] ER2209 [2]		
Laser	≤ 5 mm				N_2 (Ar or He possible)

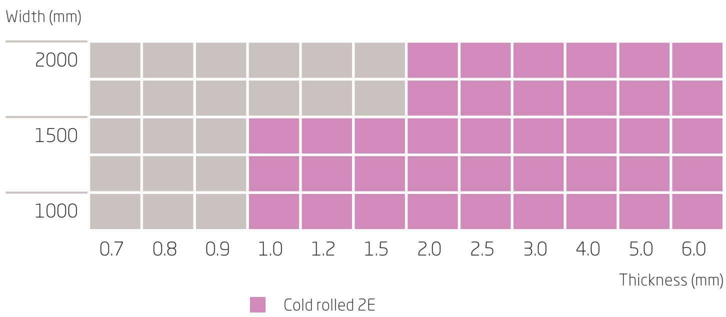
[1] EN ISO 14343 [2] AWS 5.9

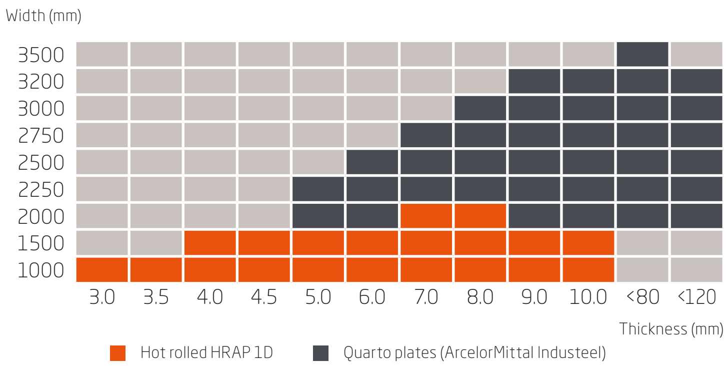
Heat treatment

After cold forming, an annealing treatment of a couple of minutes at 1040 +/- 60°C, followed by water quenching or rapid air cooling restores the structure and eliminates internal stresses.



General size range for Duplex





Please consult us for sizes outside this range.

Aperam Stainless Europe
Le Cézanne - 30, Avenue des Fruitiers
FR-93212 La Plaine Saint Denis Cedex

Information
www.aperam.com/stainlesseurope
stainless.europe@aperam.com