Grade Data Sheet

2205

2205 is the most widely used duplex (ferritic/austenitic) stainless steel grade. It finds applications due to both excellent corrosion resistance and high strength.

The original S31803 composition has over the years been refined by many steel suppliers, and the resulting restricted composition range was endorsed as UNS S32205 in 1996. S32205 gives better guaranteed corrosion resistance, but much of the S31803 currently produced also complies with S32205. It is recommended that grade 2205 always be clarified as S31803 or S32205, but note that ASTM A240 defines 2205 as S32205.

2205 is not generally suitable for use at temperatures above 300°C as it suffers from precipitation of brittle micro-constituents, nor below -50°C because of its ductile-to-brittle-transition.

Corrosion Resistance

Excellent general corrosion resistance; superior to Grade 316 in most environments. Excellent resistance to localised corrosion including intergranular, pitting and crevice corrosion; the CPT of 2205 is generally at least 35°C. The grade is also resistant to chloride stress corrosion cracking (SCC) at temperatures of up to about 150°C. Grade 2205 will often perform well in environments which cause premature failure of austenitic grades. It has better resistance to sea water than grade 316. Consult Atlas Technical Assistance for specific environmental recommendations.

Heat Resistance

Although 2205 has good high temperature oxidation resistance this grade, like other duplex stainless steels, suffers from embrittlement if held for even short times at temperatures above 300°C. If embrittled this can only be rectified by a full solution annealing treatment. Duplex stainless steels are almost never used above 300°C.

Heat Treatment

Solution treatment (annealing)

Heat to 1020-1100°C and cool rapidly. This grade cannot be hardened by thermal treatment, but does work harden.

Welding

Weldable by all standard methods, but should not generally be welded without filler metal as this may result in excessive ferrite. AS 1554.6 pre-qualifies welding of 2205 with 2209 rods or electrodes to ensure that deposited metal has the correctly balanced duplex structure. Nitrogen added to the shielding gas will also assist in ensuring adequate austenite in the structure. Heat input must be kept low and no pre- or post-heat should be used. The lower co-efficient of thermal expansion of all duplex stainless steels compared with austenitic grades reduces distortion and associated stresses.

Machining

The high strength that makes 2205 useful in many applications also reduces its machinability. Cutting speeds are approximately 20% slower than for grade 304. There is as yet no "Ugima" Improved Machinability version of 2205.

Fabrication

The high strength of 2205 also makes bending and forming more difficult; these operations will require larger capacity equipment than would be required for austenitic stainless steels. The ductility of 2205 is less than that of an austenitic grade (but is not low when compared to most other structural materials), so severe forming operations, such as cold heading, are not generally possible. If severe cold working is required it is recommended that intermediate annealing be carried out.

Typical Applications

Chemical processing, transport and storage. Oil and gas exploration and processing equipment. Marine and other high chloride environments. Pulp & Paper digesters, liquor tanks and paper machines.

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Specified Properties

These properties are specified for flat rolled product (plate, sheet and coil) in ASTM A240/A240M. Similar but not necessarily identical properties are specified for other products such as pipe and bar in their respective specifications.

Composition Specification (%)

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
2205 (S31803)	min.	-	-	-	-	-	21.0	2.5	4.5	0.08
	max.	0.030	2.00	1.00	0.030	0.020	23.0	3.5	6.5	0.20
2205 (S32205)	min.	-	-	-	-	-	22.0	3.0	4.5	0.14
	max.	0.030	2.00	1.00	0.030	0.020	23.0	3.5	6.5	0.20

Mechanical Property Specification

Grade	Tensile Strength (MPa) min	Yield Strength 0.2% Proof (MPa) min	Elongation (% in 50mm) min	Hardness	
				Rockwell C (HR C)	Brinell (HB)
S31803	620	450	25	31 max	293 max
S32205	655	450	25	31 max	293 max

Physical Properties

(typical values in the annealed condition)

Grade	Density (kg/m^3)	Elastic Modulus (GPa)	Mean Coefficient of Thermal Expansion			Thermal Conductivity		Specific Heat	Electrical Resistivity
			0-100°C (μm/m/°C)	0-315°C (μm/m/°C)	0-538°C (μm/m/°C)	at 100°C (W/m.K)	at 500°C (W/m.K)	0-100°C (J/kg.K)	(nΩ.m)
2205	7800	200	13.7	14.7	-	19.0	-	450	850
Physical properties of S31803 and S32205 are identical.									

Grade Specification Comparison

Grade	UNS No	Euronorm		Swedish SS	Japanese JIS
		No	Name		
2205	S31803 / S32205	1.4462	X2CrNiMoN22-5-3	2377	SUS 329J3L
These comparisons are approximate only. The list is intended as a comparison of functionally similar materials **not** as a schedule of contractual equivalents. If exact equivalents are needed original specifications must be consulted. ASTM grade S31803 is a closer equivalent to most other specifications than is S32205.					

Possible Alternative Grades

Grade	Why it might be chosen instead of 2205
904L	Better formability is needed, with similar corrosion resistance and lower strength.
UR52N+ 2507	Higher resistance to corrosion is required, eg resistance to higher temperature seawater. These super duplex grades also have higher strength than 2205.
6%Mo	Higher corrosion resistance is required, but with lower strength and better formability.
316L	The high corrosion resistance and strength of 2205 are not needed … 316L is more available and may be lower cost.