

S2205 钢 (英)

Background

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 standard 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. 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.

Key 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

Typical compositional ranges for grade 2205 stainless steels are given in table 1.

Table 1. Composition ranges for 2205 grade stainless steels.

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 Properties

Typical mechanical properties for grade 2205 stainless steels are given in table 2.

Table 2. Mechanical properties of 2205 grade stainless steels

Grade	Tensile Str (MPa) min	Yield Strength 0.2% Proof (MPa) min	Elongation (% in 50mm) min	Hardness	
				Rockwell C (HR C)	Brinell (HB)
2205	620	450	25	31 max	293 max
Note: Mechanical property requirements for S31803 and S32205 are identical.					

Physical Properties

Typical physical properties for grade 2205 stainless steels are given in table 3.

Table 3. Typical annealed condition physical properties for 2205 grade stainless steels

Grade	Density (kg/m ³)	Elastic Modulus (GPa)	Mean Co-eff of Thermal Expansion (μm/m/°C)			Thermal Conductivity (W/m.K)		Specific Heat 0-100°C (J/kg.K)	Electrical Resistivity (nΩ.m)
			0-100°C	0-315°C	0-538°C	at 100°C	at 500°C		
2205	7805	200	13.7	14.7	-	19	-	450	850
Note: Physical properties of S31803 and S32205 are identical.									

Grade Specification Comparison

Approximate grade comparisons for 2205 stainless steels are given in table 4.

Table 4. Grade specification comparisons for 2205 grade stainless steels

Grade	UNS No	Old British		Euronorm		Swedish SS	Japanese JIS
		BS	En	No	Name		
2205	S31803 / S32205	318S13	-	1.4462	X2CrNiMoN22-5-3	2377	SUS 329J3L

Note: 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.

Possible Alternative Grades

Possible alternative grades to grade 2205 stainless steels are given in table 5.

Table 5. Grade specification comparisons for 2205 grade stainless steels

Grade	Why it might be chosen instead of 2205
904L	Better formability is needed, with similar corrosion resistance and lower strength.
UR52N+	High resistance to corrosion is required, eg resistance to higher temperature seawater.
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 lower cost.

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.

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 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, 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.