

Stainless Steels

DATA SHEET

B-60

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22%Cr DUPLEX STAINLESS STEELS

Alloy type

22%Cr standard duplex ferritic-austenitic stainless steels.

Materials to be welded

ASTM	BS EN & DIN
A182 Gr F51	1.4462
A890 Gr 4A (cast)	X2CrNiMoN22-5-3
BS	UNS
318S13	S31803, S32205 J92205 (cast)

Proprietary alloys include:

Sandvik	SAF2205
Avesta Polarit	2205
Creusot Ind	UR 45N
Böhler	A903
VDM	Cronifer 2205LCN
S+C	Maresist F51 (cast)
Sumitomo	SM22Cr

Lean and Mo-free duplex including:

(UNS S32304 / DIN 1.4362 / X2CrNiN23L)	
Sandvik	SAF 2304
Creusot Ind	UR35N
LDX 2101	Avesta Polarit

Applications

Duplex stainless steel pipe, plate, fittings and forgings have an approximate 50:50 microstructure of austenite with a ferrite matrix. This, coupled with general alloying level, confers:

- high strength compared with standard austenitic steels, eg type 316L.
- good general corrosion resistance in a range of environments.
- high resistance to chloride induced stress corrosion cracking (CSCC).
- high resistance to pitting attack in chloride environments, eg seawater.

These alloys are finding widening application in the **offshore oil/gas, chemical and petrochemical** process industries, eg **pipework systems, flowlines, risers, manifolds** etc.

Microstructure

Multipass welds in the as-welded condition contain about 25–50% ferrite depending on dilution and heat input/cooling rate conditions.

Welding guidelines

Preheat not generally required. Interpass temperature 150°C max. Heat input in the range 1.0–2.5 kJ/mm (depending on material thickness) should be acceptable but some codes restrict the max to 1.75 or 2.0kJ/mm.

PWHT

Although welds in wrought duplex stainless steels are almost always left in the as-welded condition, major repairs to castings are generally specified in the solution treated condition. Experience has indicated good properties following 1120°C/3-6h + water quench with or without a cooling step to 1060°C before quenching.

Additional information

A Technical Profile covering duplex and superduplex stainless steels is available.

Related alloy groups

Lean duplex (data sheet B-59), superduplex (data sheets B-61, B-62 and B-63) and duplex matching consumables for casting repairs.

Products available


Process	Product	Specification
MMA	Supermet 2205	-
	Ultramet 2205	AWS E2209-16
	Supermet 2205AR	AWS E2209-17
	2205XKS	AWS E2209-15
TIG/SAW	ER329N	AWS ER2209
MIG	ER329N	AWS ER2209
SAW flux	SSB	BS EN SA AF2 DC
FCW	Supercore 2205	AWS E2209T0-1/4
	Supercore 2205P	AWS E2209T1-1/4

General Data for all 22%Cr Duplex MMA Electrodes

Storage	<p>3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin is satisfactory for longer than a working shift of 8h. Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.</p> <p>For electrodes that have been exposed: Redry 200 – 300°C/1-2h to restore to as-packed condition. Maximum 380° C, 3 cycles, 10h total. Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.</p>																
Fume data	<p>Fume composition, wt % typical:</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">Fe</td> <td style="padding: 2px 10px;">Mn</td> <td style="padding: 2px 10px;">Cr</td> <td style="padding: 2px 10px;">Ni</td> <td style="padding: 2px 10px;">Mo</td> <td style="padding: 2px 10px;">Cu</td> <td style="padding: 2px 10px;">F *</td> <td style="border-left: 1px solid black; padding: 2px 10px;">OES (mg/m³)</td> </tr> <tr> <td style="border-right: 1px solid black; text-align: center;">7</td> <td style="text-align: center;">6</td> <td style="text-align: center;">6</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0.2</td> <td style="text-align: center;"><0.2</td> <td style="text-align: center;">16</td> <td style="border-left: 1px solid black; text-align: center;">0.8</td> </tr> </table> <p>* F = 28% for basic coated 2205XKS but this does not affect OES.</p>	Fe	Mn	Cr	Ni	Mo	Cu	F *	OES (mg/m ³)	7	6	6	1	0.2	<0.2	16	0.8
Fe	Mn	Cr	Ni	Mo	Cu	F *	OES (mg/m ³)										
7	6	6	1	0.2	<0.2	16	0.8										






SUPERMET 2205

Overalloyed rutile electrode for 22%Cr duplex

Product description	<p>MMA electrode with enhanced Cr, Mo and N levels, giving higher weld pitting resistance than the nearest AWS specification A5.4 E2209-16. See Ultramet 2205 for rutile type conforming to AWS.</p> <p>Supermet 2205 is made on high quality stainless steel core wire with a rutile flux system designed to give minimum carbon content coupled with optimum operating characteristics.</p> <p>Supermet 2205 is designed for welding wrought, forged or cast "standard" duplex stainless steels for service in the as-welded condition. Good properties are also obtained when solution treated, as frequently required for casting repairs. The electrode has a rutile flux system and is used primarily for downhand and H-V welding applications. Smaller sizes offer excellent all-positional operability.</p> <p>Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.</p>											
Specifications	NONE Nearest is AWS A5.4 E2209-16.											
ASME IX Qualification	QW432 F-No -, QW442 A-No 8											
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	PRE _N
	min	--	0.5	0.3	--	--	24.0	8.5	3.0	--	0.14	36
	max	0.03	2.0	1.0	0.02	0.03	26.0	10.0	4.0	0.5	0.25	43
	typ	0.02	1	0.7	0.01	0.02	25	9.5	3.4	0.1	0.17	38
	PRE _N = Cr + 3.3Mo + 16N											
All-weld mechanical properties	As welded						min	typical	Pipe butt weld	1120°C/3h + WQ		
	Tensile strength		MPa				690	850	867	800		
	0.2% Proof stress		MPa				480	650	752	480		
	Elongation on 4d		%				20	30	25	32		
	Reduction of area		%				--	40	35	--		
	Impact energy		+20°C		J	--	60-73	--	--	--		
			- 20°C		J	--	45-55	45-50	--	--		
			- 30°C		J	--	40-52	42-46	--	> 90		
			- 40°C		J	--	35-47	38-43	--	> 70		
			- 50°C		J	--	30-40	35-40	--	> 35		
Operating parameters	DC +ve or AC (OCV 55V min)											
	∅ mm	2.5		3.2		4.0		5.0				
	min A	50		65		100		130				
	max A	90		120		160		190				
Packaging data	∅ mm	2.5		3.2		4.0		5.0				
	length mm	300		350		350		450				
	kg/carton	12.0		13.2		13.8		18.6				
	pieces/carton	630		354		255		165				


ULTRAMET 2205

Rutile all-positional electrode for 22%Cr duplex

Product description	<p>MMA electrode made on duplex stainless steel core wire with a rutile flux system designed to give minimum carbon content coupled with optimum operating characteristics. The electrode has a rutile flux system optimised for all welding positions except vertical down and provides excellent operability.</p> <p>Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.</p>												
Specifications	AWS A5.4 BS EN 1600		E2209-16 E 22 9 3 N L R 3 2										
ASME IX Qualification	QW432 F-No 5, QW442 A-No 8												
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	PRE _N	
	min	--	0.5	0.3	--	--	22.0	8.5	2.8	--	0.14	34	
	max	0.03	2.0	0.90	0.02	0.03	23.5	10.0	3.5	0.5	0.2	38	
	typ	0.02	1	0.7	0.01	0.02	23.2	9	3.2	0.1	0.17	36	
All-weld mechanical properties	As welded						min	typical					
	Tensile strength						MPa	690	850				
	0.2% Proof stress						MPa	480	675				
	Elongation on 4d						%	20	27				
	Elongation on 5d						%	20	25				
	Reduction of area						%	--	40				
	Hardness						HV10 (HRC)	--	< 305 (< 28)				
	Impact energy						+ 20°C J (mm)	--	> 54 (> 0.8)				
						- 20°C J (mm)	--	43-48 (> 0.5)					
						- 50°C J (mm)	--	32-41 (>0.38)					
Operating parameters	DC +ve or AC (OCV: 50V min).											    	
	∅ mm	2.5		3.2		4.0		5.0					
	min A	60		75		100		130					
	max A	90		120		155		190					
Packaging data	∅ mm	2.5		3.2		4.0		5.0					
	length mm	300		350		350		350					
	kg/carton	12.0		13.5		13.5		13.5					
	pieces/carton	654		372		243		174					

SUPERMET 2205AR

Rutile downhand electrode for 22%Cr duplex

Product description	<p>MMA electrode made on high quality stainless steel core wire with a rutile flux system designed to give minimum carbon content coupled with optimum operating characteristics. The electrode has a rutile flux system optimised for operability.</p> <p>Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.</p>											
Specifications	AWS A5.4 BS EN 1600		E2209-17 E 22 9 3 N L R 3 3									
ASME IX Qualification	QW432 F-No 5, QW442 A-No 8											
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	PRE N
min	--	0.5	--	--	--	--	21.5	8.5	2.5	--	0.14	35
max	0.04	2.0	1.00	0.025	0.030	23.5	10.5	3.5	0.5	0.2	38	
typ	0.04	0.8	0.7	0.01	0.02	23	9	3.2	0.1	0.17	36	
All-weld mechanical properties	As welded						min	typical				
Tensile strength							MPa	690	830			
0.2% Proof stress							MPa	450	680			
Elongation on 4d							%	20	28			
Elongation on 5d							%	20	26			
Hardness							HV10 (HRC)	--	< 310 (< 28)			
Impact energy							+ 20°C	J	45			
							- 20°C	J	40			
							- 50°C	J	35			
Operating parameters	DC +ve or AC (OCV: 50V min). <div style="float: right;">  </div>											
	∅ mm	2.5		3.2		4.0						
	min A	60		75		100						
	max A	90		120		155						
Packaging data	∅ mm	2.5		3.2		4.0						
	length mm	300		350		450						
	kg/carton	12.0		13.5		18.0						
	pieces/carton	630		363		249						

2205XKS

Basic pipe-welding electrode for 22%Cr duplex

Product description	<p>MMA electrode made on duplex stainless core wire with a special basic flux to give optimum all-positional operability. Recovery is about 105% with respect to core wire, 65% with respect to whole electrode.</p> <p>The electrode has a basic flux system and is recommended where the highest sub-zero toughness is required, and for the most demanding positional welding applications such as fixed pipework in the ASME 6G position.</p>											
Specifications	AWS A5.4 BS EN 1600		E2209-15 E 22 9 3 N L B 4 2									
ASME IX Qualification	QW432 F-No 5, QW442 A-No 8											
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	PRE _N
	min	--	0.5	--	--	--	22.0	8.5	3.0	--	0.15	35
	max	0.04	2.0	0.90	0.02	0.03	23.5	10.0	3.5	0.75	0.20	38
	typ	0.03	1	0.6	0.01	0.02	23	9	3.2	0.1	0.17	36
All-weld mechanical properties	As welded						min	typical		1120 – 1135°C +WQ		
	Tensile strength						MPa	690	750-870		790	
	0.2% Proof stress						MPa	450	630-700		480	
	Elongation on 4d						%	20	28		41	
	Elongation on 5d						%	20	26		37	
	Reduction of area						%	--	45		64	
	Impact energy											
	Hardness						HV	--	260-290		240	
Operating parameters	DC +ve only. <div style="float: right;"> </div>											
	∅ mm	2.5		3.2		4.0		5.0				
	min A	50		70		100		130				
	max A	75		95		155		190				
Packaging data	∅ mm	2.5		3.2		4.0		5.0				
	length mm	300		350		350		350				
	kg/carton	12.0		13.5		13.5		12.6				
	pieces/carton	720		402		273		156				

ER329N

Solid welding wire for 22%Cr duplex

Product description	Solid duplex stainless wire for welding 2205 type duplex stainless steels.										
Specifications	AWS A5.9		ER2209								
	BS EN ISO 14343-A		22 9 3 N L								
	BS EN ISO 14343-B		SS2209								
	BS 2901: Pt2		22.8.3S92								
ASME IX Qualification	QW432 F-No 6, QW442 A-No 8										
Composition (wire wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N
	min	--	1.0	0.25	--	--	22.5	8.0	3.0	--	0.14
	max	0.03	2.0	0.65	0.020	0.030	23.5	9.5	3.5	0.3	0.20
	typ	0.015	1.6	0.5	0.001	0.015	23	8.2	3.2	0.1	0.17*
Duplex weld metal microstructure with austenite + 30-50% ferrite. Pitting resistance equivalent $PRE_N = Cr + 3.3Mo + 16N$ is > 35. * ER329N MIG spooled wire is selected for suitability for both MIG and auto-TIG, with typically 0.15%N to control porosity.											
All-weld mechanical properties	Typical values as welded					min	TIG	typical MIG	SAW + SSB		
	Tensile strength					MPa	690	790	800-835		790
	0.2% Proof stress					MPa	450	620	560-620		630
	Elongation on 4d					%	20	36	28-35		30
	Elongation on 5d					%	20	33	30		27
	Hardness					HV	--	270 (< 310)	270 (< 310)		275 (< 320)
						HRC	--	23 (< 28)	23 (< 28)		23 (< 28)
	Impact energy					J	--	180 (> 140)	> 70		75 (>55)
					J	--	180 (> 120)	> 60		55 (>35)	
					J	--	125 (>70)	--		--	
Typical operating parameters		TIG			MIG		SAW				
	Shielding	Argon			Ar / He / CO ₂		SSB flux *				
	Current	DC -			pulsed		DC +				
	Diameter	1.6 / 2.4mm			1.2mm		2.4mm				
	Parameters	100A, 12V			180A, 28V		350A, 30V				
* LA491 flux also suitable.											
Packaging data	ø mm	TIG			MIG		SAW				
	0.8	--			15kg spool		--				
	1.0	--			15kg spool		--				
	1.2	2.5kg tube			15kg spool		--				
	1.6	2.5kg tube			--		25kg coil				
	2.0	2.5kg tube			--		to order				
	2.4	2.5kg tube			--		25kg coil				
	3.2	2.5kg tube			--		25kg coil				
Fume data	MIG fume composition (wt %) (TIG and SAW fume negligible)										
		Fe	Mn	Cr ³	Ni	Mo	Cu	OES (mg/m ³)			
		28	10	20	8	1.5	< 0.5	2.5			

SUPERCORE 2205, 2205P

Flat and positional FCAW for 22%Cr duplex

Product description	<p>High performance rutile flux cored wires produced in the most versatile size of 1.2mm. Supercore 2205 is suited to welding in the flat and horizontal-vertical positions (material > 6mm). Supercore 2205P is optimised for positional welding, both vertical up and for fixed pipework qualified in the ASME 5G or 6G welding positions (pipe typically > 150mm diameter, > 15mm wall).</p> <p>Made with an austenitic stainless steel sheath and rutile flux system. Weld metal carbon content is typically <0.03% when using either 80%Ar-20%CO₂ or 100% CO₂ shielding gas.</p> <p>Metal recovery about 90% with respect to the wire.</p>																											
Specifications	AWS A5.22 BS EN ISO 17633-A BS EN ISO 17633-B			Supercore 2205 E2209T0-1/4 T 22 9 3 N L R C/M 3 TS2209-FB0				Supercore 2205P E2209T1-1/4 T 22 9 3 N L P C/M 2 TS2209-FB1																				
ASME IX Qualification	QW432 F-No 6, QW442 A-No 8																											
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	PRE*																
min	--	0.5	--	--	--	--	21.5	8.5	2.8	--	0.08	34																
max	0.04	2.0	1.00	0.02	0.030	24.0	10.0	4.0	0.3	0.20	38																	
typ	0.03	1.2	0.7	<0.01	0.02	23	9.2	3.1	0.1	0.12	35																	
	* PRE (pitting resistance equivalent) = Cr + 3.3Mo + 16N																											
All-weld mechanical properties	As welded				min	typical																						
Tensile strength					MPa	690	800																					
0.2% Proof stress					MPa	480	630																					
Elongation on 4d					%	20	32																					
Elongation on 5d					%	20	29																					
Reduction of area					%	--	45																					
Impact energy	- 20°C				J	--	65 *																					
	- 50°C				J	--	55 *																					
	- 75°C				J	--	30 *																					
Hardness					HV	--	270																					
	* These values are for Supercore 2205P . Impact energy values for Supercore 2205 are typically 40J at – 20°C, 30J at –50°C.																											
Operating parameters	<p>Shielding gas: Either 80%Ar-20%CO₂ or 100% CO₂ shielding gas at 20-25l/min. Proprietary gases may be used but argon should not exceed 85%. Gas mixtures without oxygen additions can be helpful for optimum weld metal toughness.</p> <p>Current: DC+ve ranges as below for Ar-20%CO₂. Welding with 100%CO₂ requires approx 3V higher:</p> <table border="1"> <thead> <tr> <th>ø mm</th> <th>amp-volt range</th> <th>typical</th> <th>stickout</th> </tr> </thead> <tbody> <tr> <td>1.2</td> <td>150A-25V to 280A-34V</td> <td>200A-30V</td> <td>15-20mm</td> </tr> <tr> <td>1.6</td> <td>200A-28V to 330A-34V</td> <td>230A-30V</td> <td>15-25mm</td> </tr> <tr> <td>1.2 P</td> <td>120A-22V to 250A-34V</td> <td>150A-25V</td> <td>15-20mm</td> </tr> </tbody> </table>												ø mm	amp-volt range	typical	stickout	1.2	150A-25V to 280A-34V	200A-30V	15-20mm	1.6	200A-28V to 330A-34V	230A-30V	15-25mm	1.2 P	120A-22V to 250A-34V	150A-25V	15-20mm
ø mm	amp-volt range	typical	stickout																									
1.2	150A-25V to 280A-34V	200A-30V	15-20mm																									
1.6	200A-28V to 330A-34V	230A-30V	15-25mm																									
1.2 P	120A-22V to 250A-34V	150A-25V	15-20mm																									
Packaging data	<p>Spools vacuum-sealed in barrier foil with cardboard carton: 15kg</p> <p>The as-packed shelf life is virtually indefinite.</p> <p>Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers.</p> <p>Where possible, preferred storage conditions are 60% RH max, 18°C min.</p>																											
Fume data	<p>Fume composition (wt %)</p> <table border="1"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cr³</th> <th>Cr⁶</th> <th>Cu</th> <th>F</th> <th>OES (mg/m³)</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>12</td> <td>2</td> <td>4</td> <td>5.5</td> <td><0.5</td> <td>9</td> <td>0.9</td> </tr> </tbody> </table>												Fe	Mn	Ni	Cr ³	Cr ⁶	Cu	F	OES (mg/m ³)	10	12	2	4	5.5	<0.5	9	0.9
Fe	Mn	Ni	Cr ³	Cr ⁶	Cu	F	OES (mg/m ³)																					
10	12	2	4	5.5	<0.5	9	0.9																					

SSB FLUX

Sub-arc flux

Product description	Agglomerated basic non-alloying flux for submerged arc welding.											
Specifications	DIN 32522		BFB6 63353 DC8M									
	BS EN 760		SA AF2 DC									
ASME IX Qualification	QW432 F-No -, QW442 A-No -											
Composition (typical)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	N	
	ER329N wire	0.015	1.6	0.5	0.001	0.015	23	8.5	3.2	0.1	0.17	
	deposit	0.02	1.3	0.5	--	--	22.5	8.5	3.1	0.1	0.15	
All-weld mechanical properties with ER329N wire	As welded											
	Tensile strength				MPa	790						
	0.2% Proof stress				MPa	630						
	Elongation on 4d				%	30						
	Hardness				HV	275 (< 320)						
					HRC	23 (< 28)						
Impact energy	- 30°C				J	75 (>55)						
	- 50°C				J	55 (>35)						
Operating parameters	Current: DC +ve ranges as below:											
	∅ mm	amp-volt range				typical			stickout			
	1.6	200-350A, 27-31V				300A, 28V			20-25mm			
	2.4	250-450A, 28-32V				350A, 29V			20-25mm			
Packaging data	Metrode SSB Flux is supplied in sealed moisture resistant 20kg metal drums. Preferred storage conditions for opened drums: < 60%RH, > 18°C. If the flux has become damp or has been stored for a long period, it should be redried in the range 250-400°C/1-3h.											