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

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.
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.

Fume data

Fume composition, wt % typical:

Fe	Mn	Cr	Ni	Mo	Cu	F *	OES (mg/m^3)
7	6	6	1	0.2	<0.2	16	0.8

* F = 28% for basic coated 2205XKS but this does not affect OES.

SUPERMET 2205

Overalloyed rutile electrode for 22%Cr duplex

Product description

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.

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.

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.

Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

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)

ø mm	2.5	3.2	4.0	5.0
min A	50	65	100	130
max A	90	120	160	190

Packaging data

ø 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

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.

Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.4 E2209-16
BS EN 1600 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).

ø mm	2.5	3.2	4.0	5.0
min A	60	75	100	130
max A	90	120	155	190

Packaging data

ø 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

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.

Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.4 E2209-17
BS EN 1600 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).

ø mm	2.5	3.2	4.0
min A	60	75	100
max A	90	120	155

Packaging data

ø 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

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.

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.

Specifications

AWS A5.4 E2209-15
BS EN 1600 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	+ 20°C	J	--	> 85	--
	- 50°C	J	47	> 60	> 75
	- 75°C	J	--	> 30	--
Hardness		HV	--	260-290	240

Operating parameters

DC +ve only.

ø mm	2.5	3.2	4.0	5.0
min A	50	70	100	130
max A	75	95	155	190

Packaging data

ø 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	typical TIG	typical MIG	typical 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	- 30°C	J	--	180 (> 140)	> 70	75 (>55)
	- 50°C	J	--	180 (> 120)	> 60	55 (>35)
	- 75°C	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

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).

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%CO_2 or 100% CO_2 shielding gas.

Metal recovery about 90% with respect to the wire.

Specifications

	Supercore 2205	Supercore 2205P
AWS A5.22	E2209T0-1/4	E2209T1-1/4
BS EN ISO 17633-A	T 22 9 3 N L R C/M 3	T 22 9 3 N L P C/M 2
BS EN ISO 17633-B	TS2209-FB0	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

Shielding gas: Either 80%Ar-20%CO_2 or 100% CO_2 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.
Current: DC+ve ranges as below for Ar-20%CO_2. Welding with 100%CO_2 requires approx 3V higher:

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

Spools vacuum-sealed in barrier foil with cardboard carton: 15kg
The as-packed shelf life is virtually indefinite.
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.
Where possible, preferred storage conditions are 60% RH max, 18°C min.

Fume data

Fume composition (wt %)

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:

ø 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.