PREMIARC™ DW-329A
AWS A5.22 E2209T0-1/-4

PREMIARC™ DW-329AP
AWS A5.22 E2209T1-1/-4

Such technologically demanding welding applications as chemical tankers, pulp mills, and offshore structures are the typical fields where DW-329A and DW-329AP shine in flux-cored arc welding of duplex stainless steel.

What is duplex stainless steel?

Duplex stainless steel is known for combining the superior stress-corrosion crack resistance of ferritic stainless steel with the excellent ductility, toughness and weldability of austenitic stainless steel. To establish this sophisticated characteristic, duplex stainless steel features a binary microstructure consisting of approx. 50% ferrite and 50% austenite as shown in Figure 1 and a compositional balance of Cr, Ni, Mo and N. It also features yield strength that is two times higher than the 300-series austenitic stainless steels. Because duplex stainless steel has good weldability in terms of hot and cold crack resistance, users can follow almost the same welding procedure as that for austenitic stainless steels. Chemical plant machinery, oil and natural gas drilling pipes and pipelines, chemical tankers, and water gates are typical applications for duplex stainless steels.

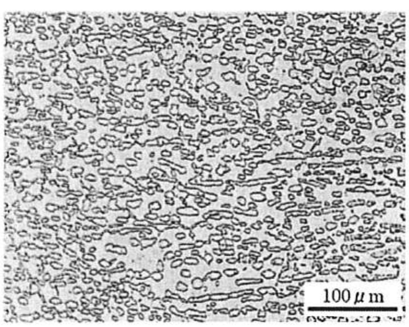


Figure 1: An example of duplex stainless steel microstructure which exhibits distributed austenite (brighter areas) in the ferrite matrix (darker areas).

The unsurpassed performance of KOBELCO duplex stainless flux-cored wires

Among several KOBELCO filler metals for duplex stainless steel, DW-329A and DW-329AP enjoy higher reputations worldwide due to excellent performance in usability, mechanical properties and corrosion resistibility. Both brands resemble each other in terms of type of flux (rutile-based flux), suitable shielding gases (CO_2 and Ar/CO_2 mixtures), mechanical properties and chemical composition. However, their applicable welding positions are different: DW-329A is suitable for flat and horizontal fillet welding only, while DW-329AP is excellent in out-of-position welding. DW-329AP features the chemical composition and mechanical properties listed in Table 1 and the microstructure in Figure 2.

Table 1: Typical chemical and mechanical properties of DW-329AP (1.2 mmØ) all-weld metal and AWS requirements(1)

Trade designation and AWS properties	DW-329AP	Requirements of AWS A5.22 E2209T1-4
C (%)	0.024	0.04 max
Si (%)	0.55	1.0 max
Mn (%)	0.89	0.5-2.0
P (%)	0.018	0.04 max
S (%)	0.005	0.03 max
Cu (%)	0.06	0.5 max
Ni (%)	9.68	7.5-10.0
Cr (%)	22.96	21.0-24.0
Mo (%)	3.28	2.5-4.0
N (%)	0.14	0.08-0.20
PRE(2)	36.0	-
FNW(3)	40.5	-
0.2% PS (MPa)	617	-
TS (MPa)	808	690 min
El. (%)	31	20 min
RA (%)	48	-

Note (1) Shielding gas: 80%Ar-20%CO_2.
(2) PRE = Cr% + 3.3Mo% + 16N%.
(3) FNW: Ferrite Number per WRC Diagram-1992.

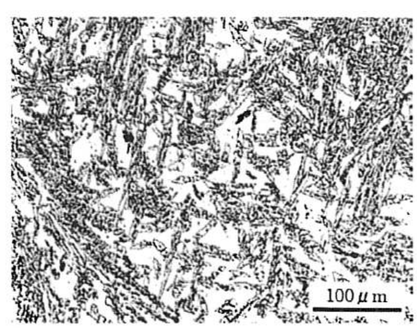


Figure 2: A typical austenite-ferrite binary microstructure of DW-329AP weld metal: the brighter areas show ferrite, and the darker areas show austenite.

PRE (Table 1) or Pitting Resistance Equivalent is used as the pitting index to evaluate the resistance to pitting corrosion. With a higher PRE value, the pitting corrosion resistance can be improved. The WRC chemistry-phase diagram (Figure 3) is commonly used for estimating the ferrite number related to the ferrite content of duplex stainless steel weld metals.

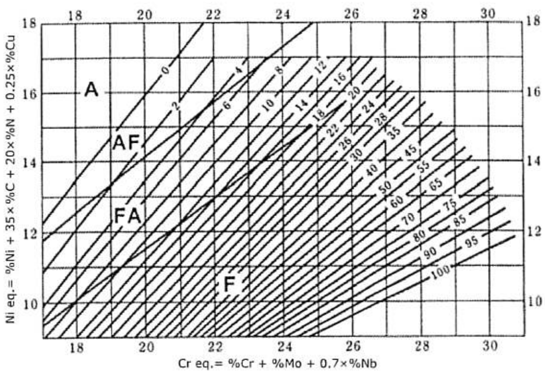


Figure 3: WRC chemistry-phase diagram (Solidification mode: A: austenite, γ ; F: ferrite, δ ; AF: γ + δ ; FA: δ + γ).

DW-329AP weld metal possesses sufficient notch toughness or absorbed energies as shown in Figure 4. However, as the testing temperature decreases, the absorbed energy decreases. This is a noticeable disadvantage when compared with austenitic stainless steel weld metals. Therefore, duplex stainless steel weld metals are not suitable for cryogenic temperature applications.

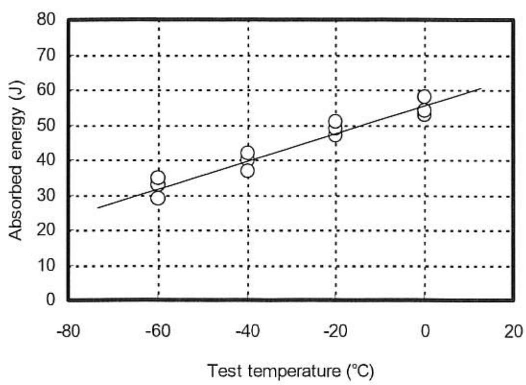


Figure 4: Charpy impact absorbed energies of DW-329AP (1.2 mmØ) weld metal at low temperatures with 80%Ar-20%CO_2 shielding.

Duplex stainless steel is superior in the resistance to pitting corrosion (defined as extremely localized corrosion, resulting in holes in the metal) in chloride-involved applications. DW-329AP weld metal features, as shown in Table 2, excellent resistance to pitting corrosion due to its elaborate chemistry design.

Table 2: Results of pitting corrosion testing of DW-329AP (1.2 mmØ) weld metal with 80%Ar-20%CO_2 shielding(1)

Testing condition	Corrosion loss (g/m^2-hr)	Judgement
20°C-24hr	0.005	No pitting
25°C-24hr	0.032	No pitting

Note (1) Testing method: ASTM G48 Practice A.
Specimen size: 10T x 15W x 35L (mm).

Figure 5 and Table 3 show the weld joint properties of DW-329AP with sound macrostructure, sufficient tensile strength and ductility. These test results were obtained in joint welding testing with a 20-mm thick duplex stainless steel base metal of UNS S31803 (0.025%C, 0.47%Si, 1.43%Mn, 5.51%Ni, 21.98%Cr, 2.96%Mo, 0.16%N).

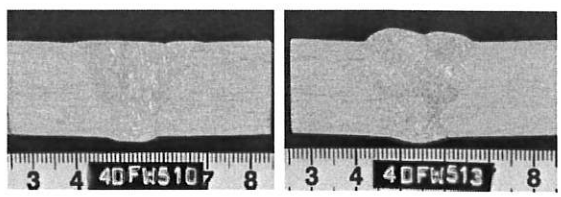
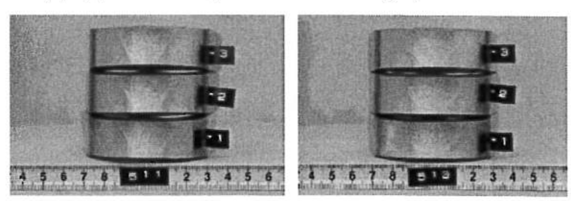


Figure 5: Macrostructure of DW-329AP one-sided weld joints in flat welding (left) and vertical-up welding (right) with ceramic backing and 80%Ar-20%CO_2 shielding.

Table 3: Results of tensile and bend testing of DW-329AP (1.2 mmØ weld joints with 80%Ar-20%CO_2 shielding

	Welding position	1G	3G
Tensile	Specimen size (mm)	20T x 25W	20T x 25W
	Tensile strength (MPa)	735	723
	Fracture location	Base metal	Base metal
Bend	Specimen size (mm)	9.5T x 20W	9.5T x 20W
	Bending radius	2TR-180 deg.	2TR-180 deg.
	Appearance(1)	Left below	Right below
	Judgement	Acceptable	Acceptable

Note (1) Appearance of specimens after testing by 2TR-180°.



1G position 3G position