DAIDO STEEL

G-coat

Titanium and Titanium Alloy Welding Wire for Gas Metal Arc Welding

G-coat - Titanium and Titanium Alloy Welding Wire for GMAW*

Introduction

The use of lightweight titanium parts in automobile and motorcycle exhaust systems is rapidly expanding in order to meet the growing demand for improved fuel efficiency and design flexibility.

Welding of titanium and titanium alloy parts usually employs TIG (Tungsten Inert Gas) welding although low throughput of TIG welding results in higher costs of such assemblies. A more desirable option is higher efficiency MIG (Metal Inert Gas) welding. However, the addition of a small amount of oxygen into argon gas is necessary in order to stabilize the welding arc and the oxygen reacts with the titanium to form hard and brittle oxides that deteriorate the welded joint integrity.

Daido Steel has solved this problem with the development of a new class of welding wires, “G-coat”, which enables high efficiency MIG welding of titanium and titanium alloy parts using inert gas only (Ar or He), without the addition of oxygen.

“G-coat” titanium and titanium alloy welding wire, with its special coating , exhibits many positive qualities. Some of these qualities are outlines below.

(1) The most suitable for GMAW
(2) Excellent arc stability in inert shielding gas (Pure Ar or He)
(3) Good wire feedability
(4) Smooth and uniform surface weld bead
(5) Low spatter
(6) Provides good mechanical properties in the Welded joints comparable with the base metal

Table 1 SPECIFICATION OF PRODUCTS

Trade Name	Chemical Composition (mass%)								Equivalent Standards	
	O	H	N	C	Fe	Al	V	Ti	AWS	JIS
WT1G	≦ 0.10	≦ 0.008	≦ 0.02	≦ 0.02	≦ 0.20	---	---	Bal.	ERTi-1	YTW270
WT2G	≦ 0.15	≦ 0.008	≦ 0.02	≦ 0.02	≦ 0.20	---	---	Bal.	ERTi-2	YTW340
WT3G	≦ 0.25	≦ 0.008	≦ 0.02	≦ 0.02	≦ 0.30	---	---	Bal.	ERTi-3	YTW480
WAT5G	≦ 0.20	≦ 0.0125	≦ 0.05	≦ 0.10	≦ 0.30	5.50~ 6.75	3.50~ 4.50	Bal.	ERTi-5	YTAW6400
WAT5EG	≦ 0.13	≦ 0.0125	≦ 0.05	≦ 0.08	≦ 0.25	5.50~ 6.50	3.50~ 4.50	Bal.	ERTi-23	YTAW6400E

* GMAW: Gas Metal Arc Welding also known as MIG (Metal Inert Gas) Welding

1. Weld Bead (Bead on Plate)

Smooth and uniform surface weld beads can be obtained using G-coat.

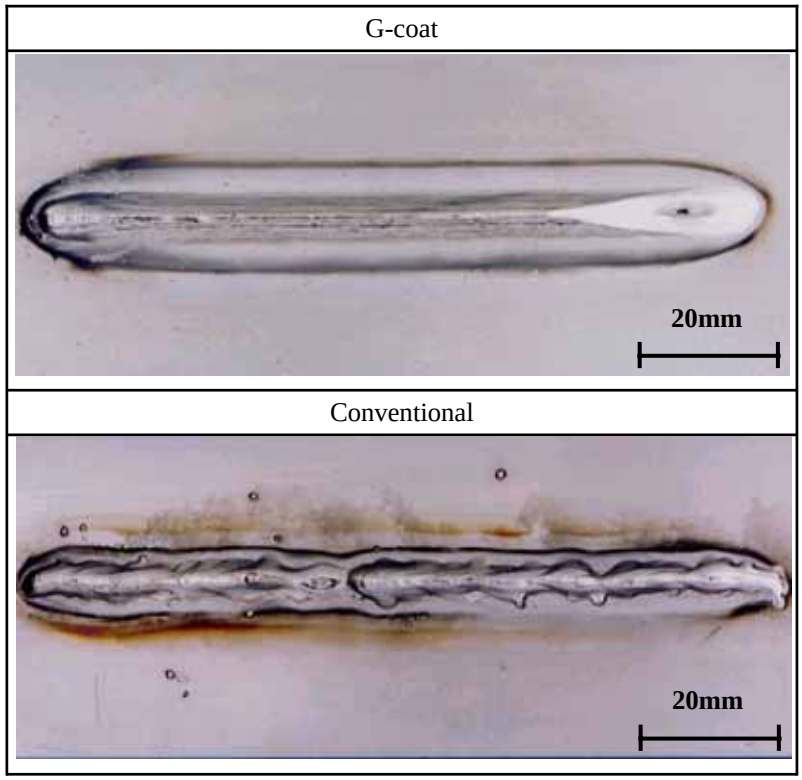


Fig.1 Weld Beads

Table 2 Welding Conditions

Wire			Welding Current	Arc Voltage	Welding Speed	Shielding Gas	Base metal		
Diameter	AWS	JIS					ASTM	JIS	Thickness
1.0mm	ERTi-2 equiv.	YTW340 equiv.	100A	20V	60cm/min	Pure Ar	B265 Grade2 equiv.	TP340	1.5mm

2. Wire Feedability

Required feeding load of G-coat is extremely low and stable even with metal conduits.

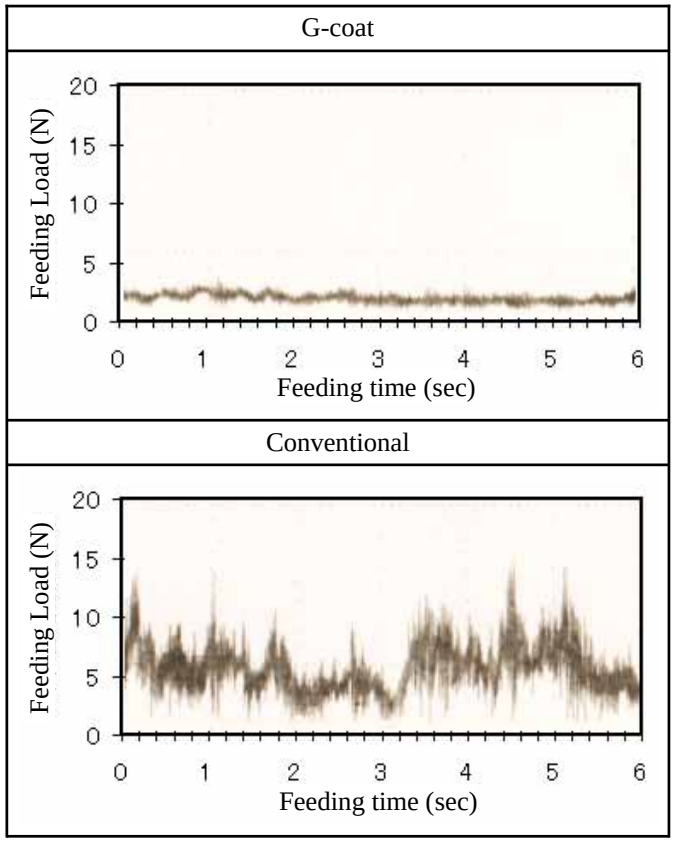


Fig.2 Wire Feeding Load

Table 3 Test Conditions

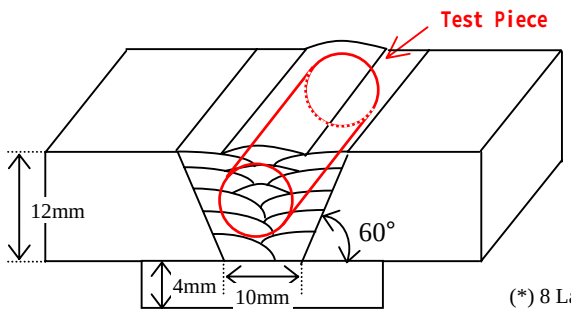
Wire			Wire Feeding Rate	Arc	Metal Conduit
Diameter	AWS	JIS			
1.0mm	ERTi-2 equiv.	YTW340 equiv.	4.5m/min	None	2.0m Length (for steel wire)

3. Tensile Properties of Deposited Metal

Deposited metal with G-coat wire has the same tensile strength as that with conventional MIG wire or TIG welding, as does the base metal.

Table 4 Welding Conditions

Wire				Welding Current	Arc Voltage	Welding Speed	Shielding Gas	Base Metal		
Sample	Diameter	AWS	JIS					ASTM	JIS	Thickness
G-coat	1.0mm	ERTi-1 equiv.	YTW270 equiv.	150A	22-23V	40cm/min	Pure Ar	B265 Grade1 equiv.	TP270	12mm
		ERTi-5 equiv.	YTAW6400 equiv.					B265 Grade5 equiv.	TAP6400	
Conventional	1.0mm	ERTi-1 equiv.	YTW270 equiv.	150A	22-23V	40cm/min	Pure Ar	B265 Grade1 equiv.	TP270	12mm
		ERTi-5 equiv.	YTAW6400 equiv.					B265 Grade5 equiv.	TAP6400	



(*) 8 Layer 21 Pass Welded

Fig.3 Position of Tensile Test Piece sampled from Deposited Metal

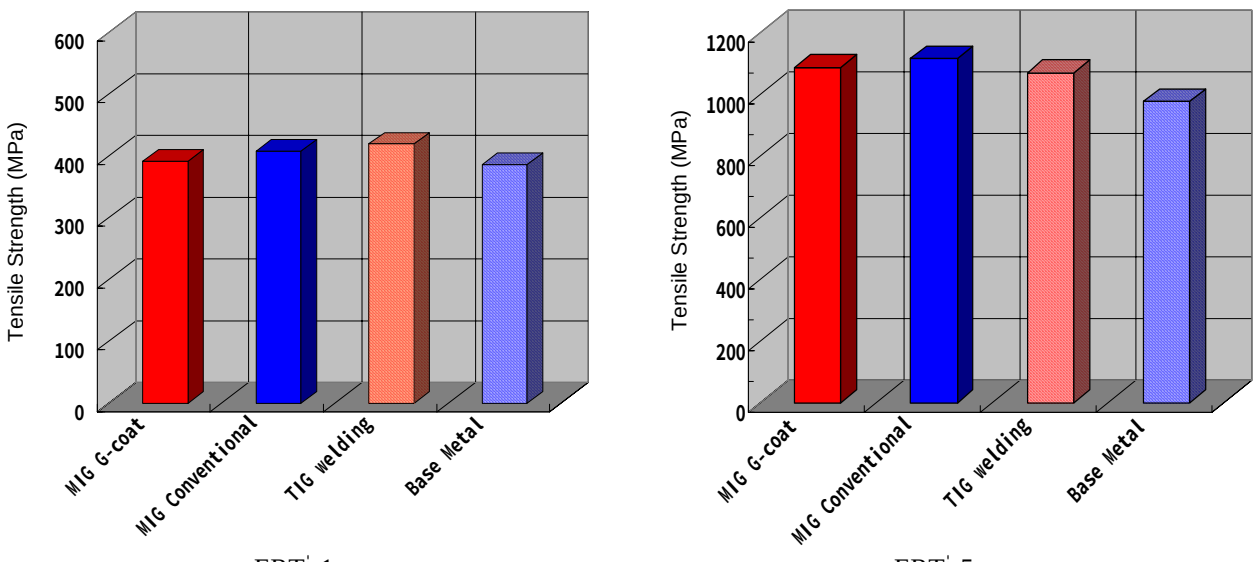


Fig.4 Tensile Strength of Deposited Metal

4. Mechanical Properties of Butt Joint in Thin Plates

Butt joint with G-coat has good mechanical properties comparable to the base metal.

Table 6 Welding Conditions

Wire			Welding Current	Arc Voltage	Welding Speed	Shielding Gas	Base Metal		
Diameter	AWS	JIS					ASTM	JIS	Thickness
1.0mm	ERTi-1 equiv.	YTW280 equiv.	100A	20V	60cm/min	Pure Ar	B265 Grade1 equiv.	TP270	1.5mm
	ERTi-5 equiv.	YTAW6400e quiv.					B265 Grade5 equiv.	TAP6400	

Table 7 Results of Tensile Test and Face Bend Test of Welded Joint

Sample	Tensile Test		Face Bend Test
	Tensile Strength	Fractured Portion	R=2t (3mm), 180°Bend
ERTi-1	406MPa	Base Metal	No Cracks Observed
B265 Grade1	390MPa	-	No Cracks Observed
ERTi-5	1074MPa	Heat Affected Zone	-
B265 Grade5	1071MPa	-	-

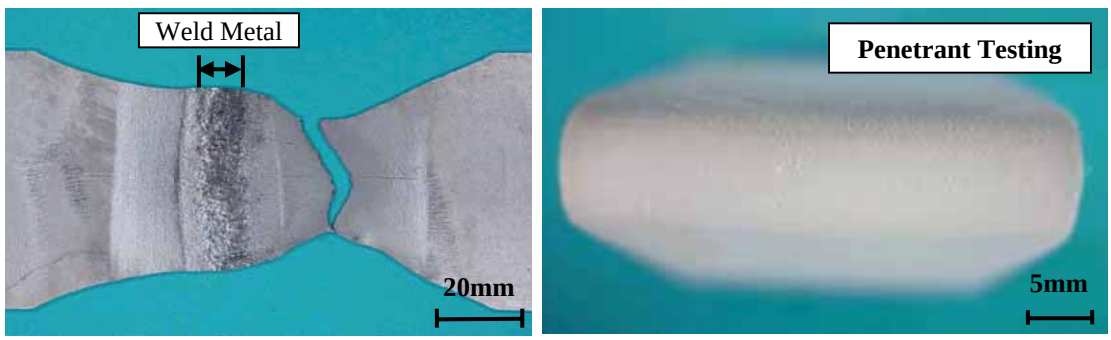


Fig.5 Appearances of Tensile Test Piece and Face Bend Test Piece of Welded Joint (ERTi-1)

(Note: Excess weld metal removed by grinding)

5. Microstructure of Weld Metal

Microstructures of weld metal with G-coat show close similarities to those with conventional wire.

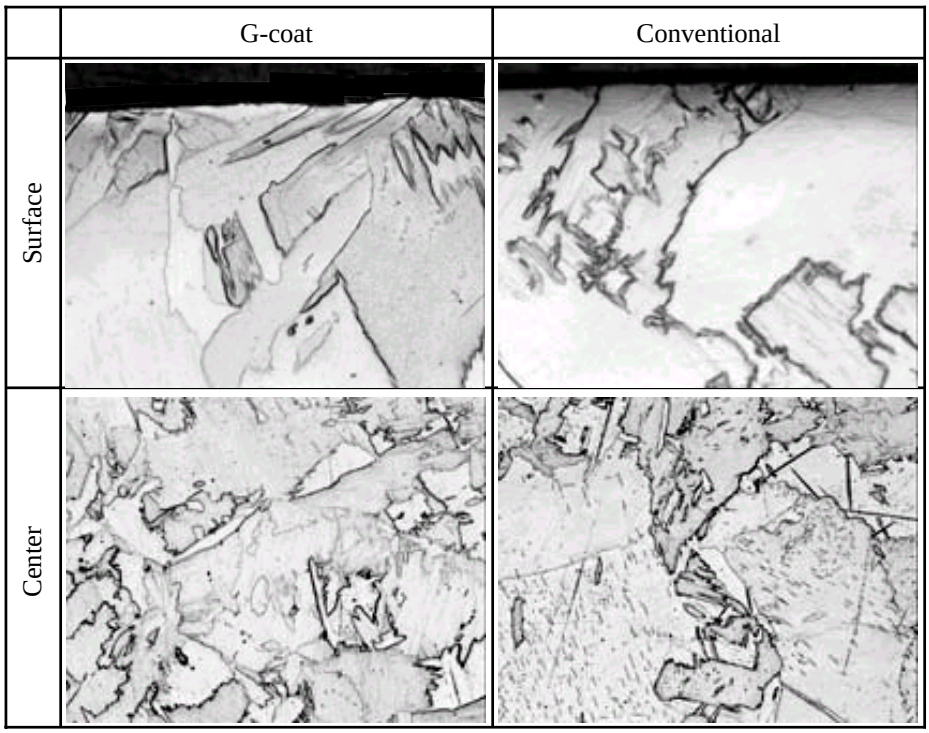


Fig.6 Microstructures of Weld Metal (ERTi-1)

6. Hardness of Weld Metal

Hardness of weld metal is no difference when comparing G-coat and conventional wire.

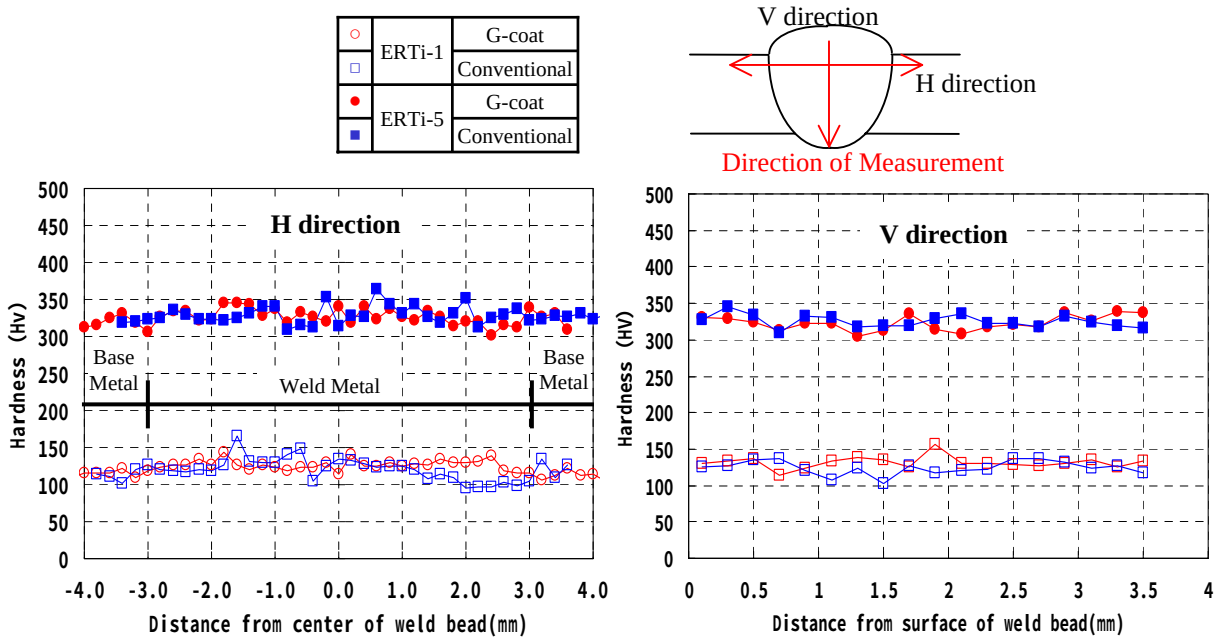


Fig.7 Hardness Distribution of Weld Metal

7. Application Examples

Sound and deep-penetrated weld bead is possible when using G-coat.

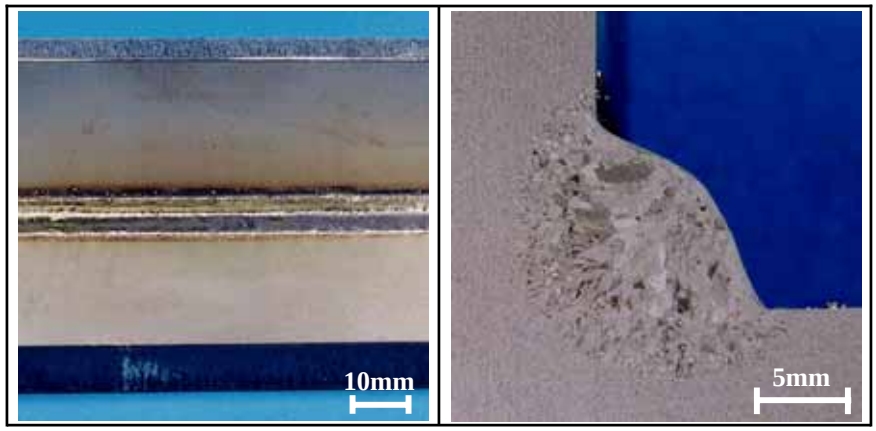


Fig.8 Fillet Welded Joint of Thick Plates

Table 8 Welding Conditions

Wire			Welding Current	Arc Voltage	Welding Speed	Base Metal		
Diameter	AWS	JIS				ASTM	JIS	Thickness
1.2mm	ERTi-2 equiv.	YTW340 equiv.	230A	21V	30cm/min	B265 Grade2 equiv.	TP340	16mm

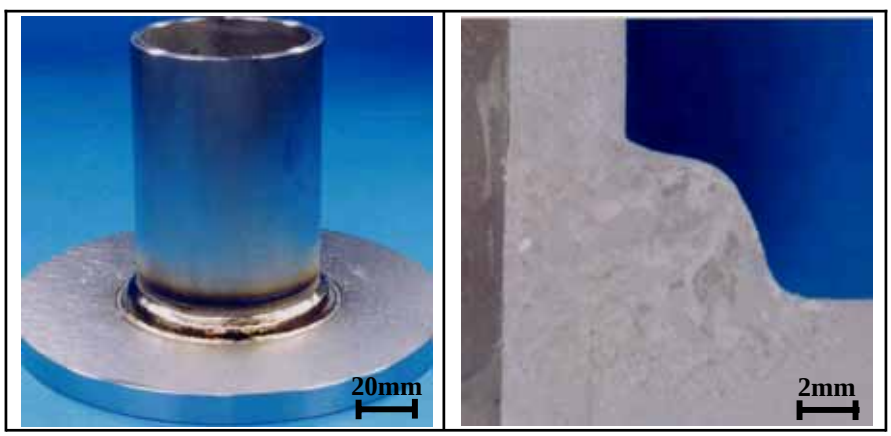


Fig.9 Weld Joint of Tube and Flange

Table 9 Welding Conditions

Wire			Welding Current	Arc Voltage	Welding Speed	Base Metal		
Diameter	AWS	JIS				ASTM	JIS	Thickness
1.2mm	ERTi-2 equiv.	YTW340 equiv.	150A	22V	30cm/min	B265 Grade2 equiv.	TP340	Tube: 4mm Flange: 10mm

8. Patent

Patents pending (JPN,Others)