



高強度高韌性低溫用低合金鋼 銲接材料

廣泰金屬工業股份有限公司
研發部 張家銘
2016.11.04

www.kuangtai.com

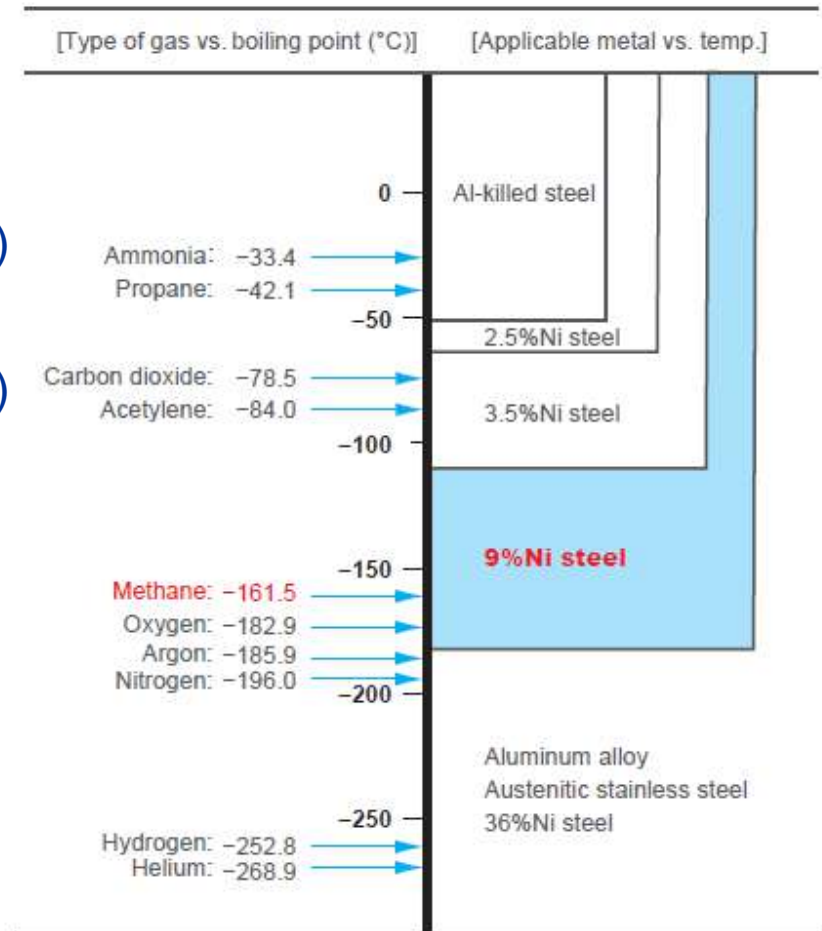


低合金鋼種類

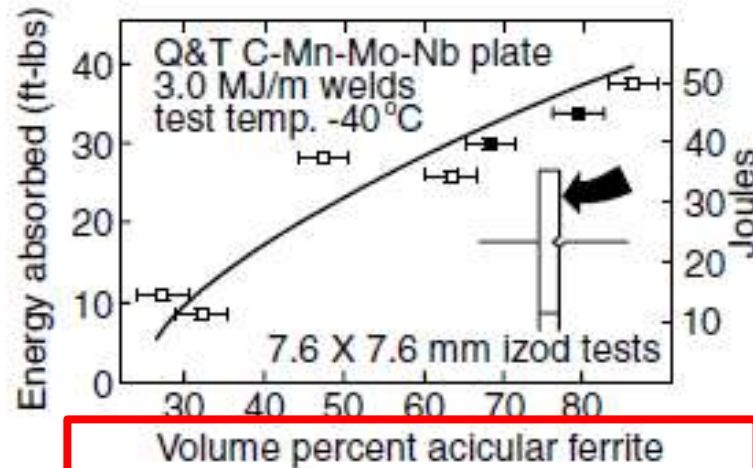
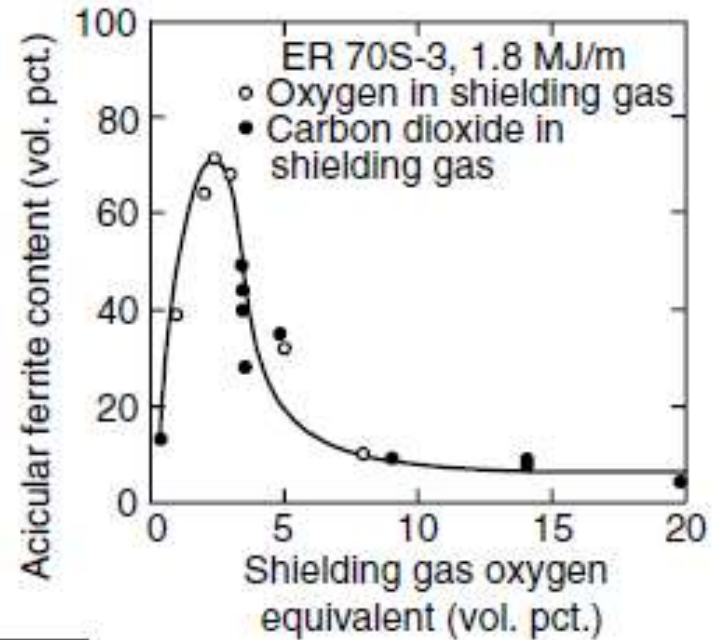
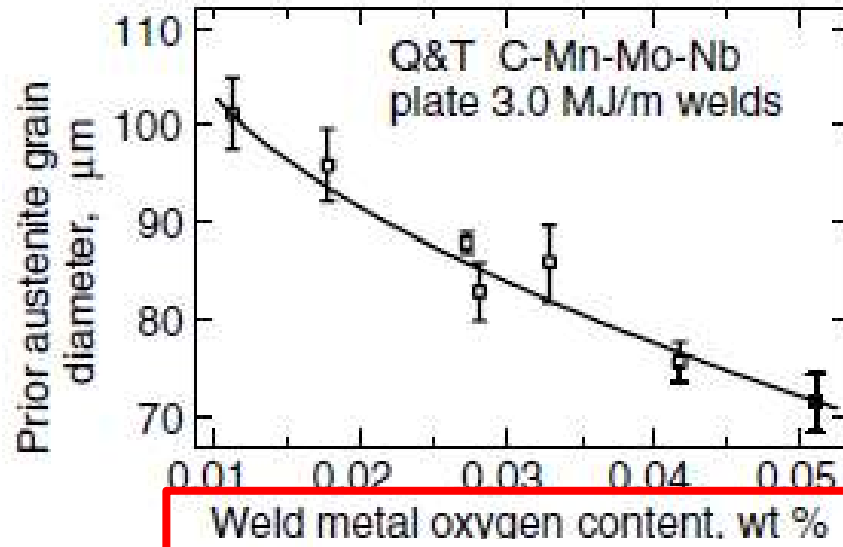
- 耐熱鋼
 - 含0.5%~9% Cr 及0.5~1% Mo
- 低溫鋼
 - 含1.5%~3.5% Ni
- 耐候鋼
 - 含少量Cu、Cr、Ni使鋼材表面形成緻密氧化層保護，防止再向內腐蝕
- 高強鋼
 - 控制Mn、Cr、Ni、Mo達到高抗拉強度與降伏強度

低溫鋼定義

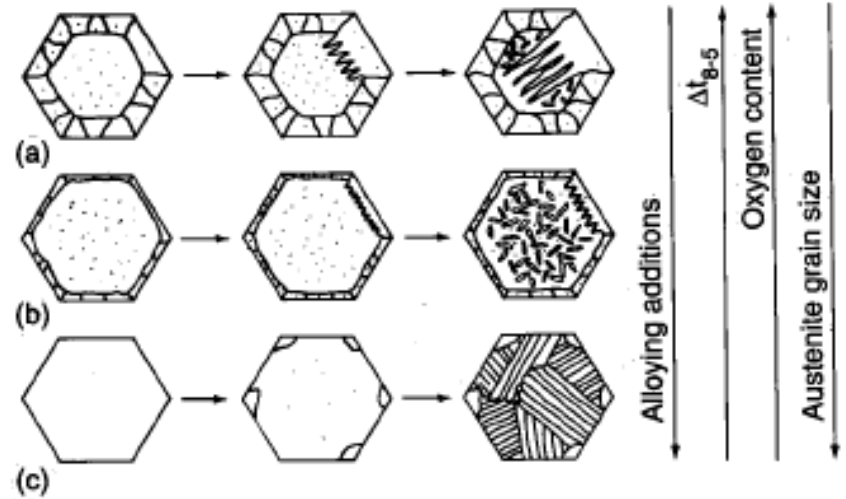
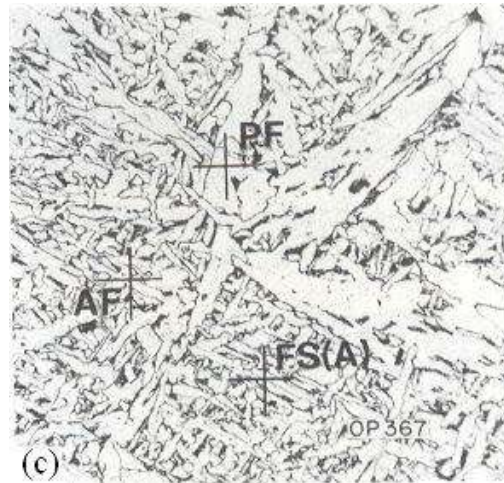
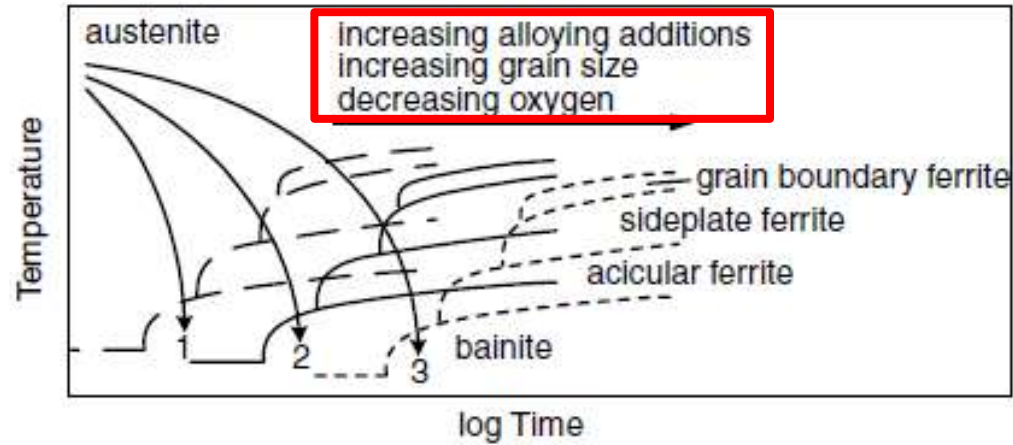
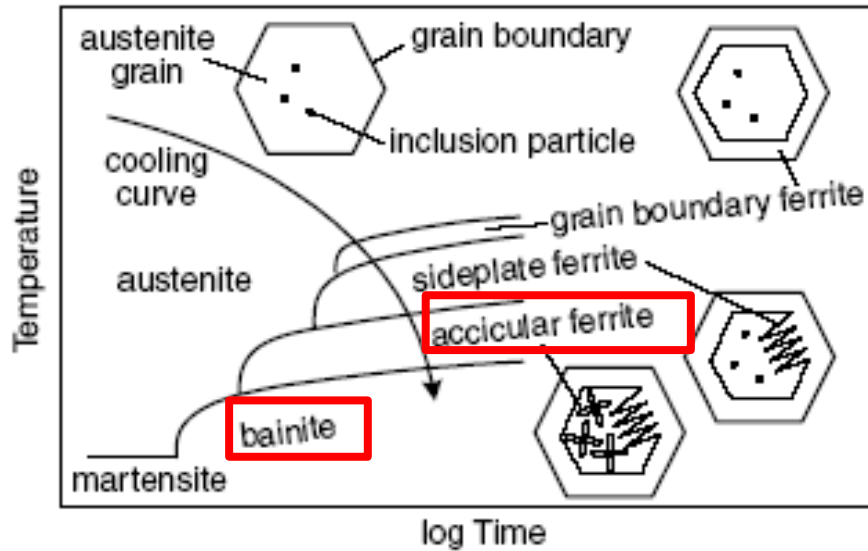
- 低溫鋼的工作溫度介於 **-20~-296°C** 之間的工程結構用鋼
- 肥粒鐵型
 - 1.5%Ni鋼 (工作溫度: -20~-50°C)
 - 2.5%Ni鋼 (工作溫度: -50~-70°C)
 - 3.5%Ni鋼 (工作溫度: -70~-100°C)
- 低碳麻田散鐵型
 - 9%Ni 鋼 (工作溫度: -100~-196°C)



低溫衝擊韌性



低溫鋼組織細化





民生用低合金高強度鋼

- 日本

- HT-50 (C-Mn)
- HT-60 (Ni-Cr-Mo)
- HT-80 (Ni-Cr-Mo)
- HT-100 (Ni-Cr-Mo)

製程: 1.軋制
2.正火
3.調質
4.TMCP
5.淬火+時效
6.淬火+低溫回火



- 歐美高強度管線用鋼

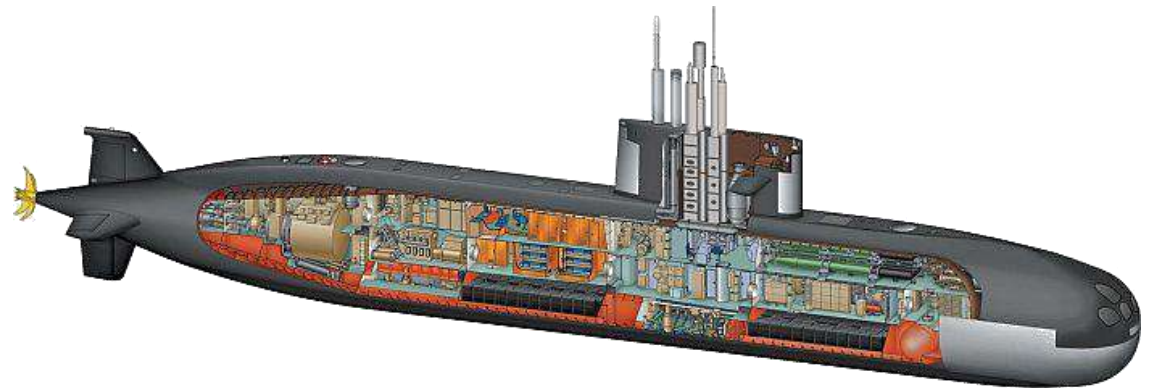
- X70 (C-Mn or Cu)
- X80 (Ni-Cr-Mo or Ti-B)
- X100 (Mo)

製程: 1.TMCP
2.CR+時效
3.調質



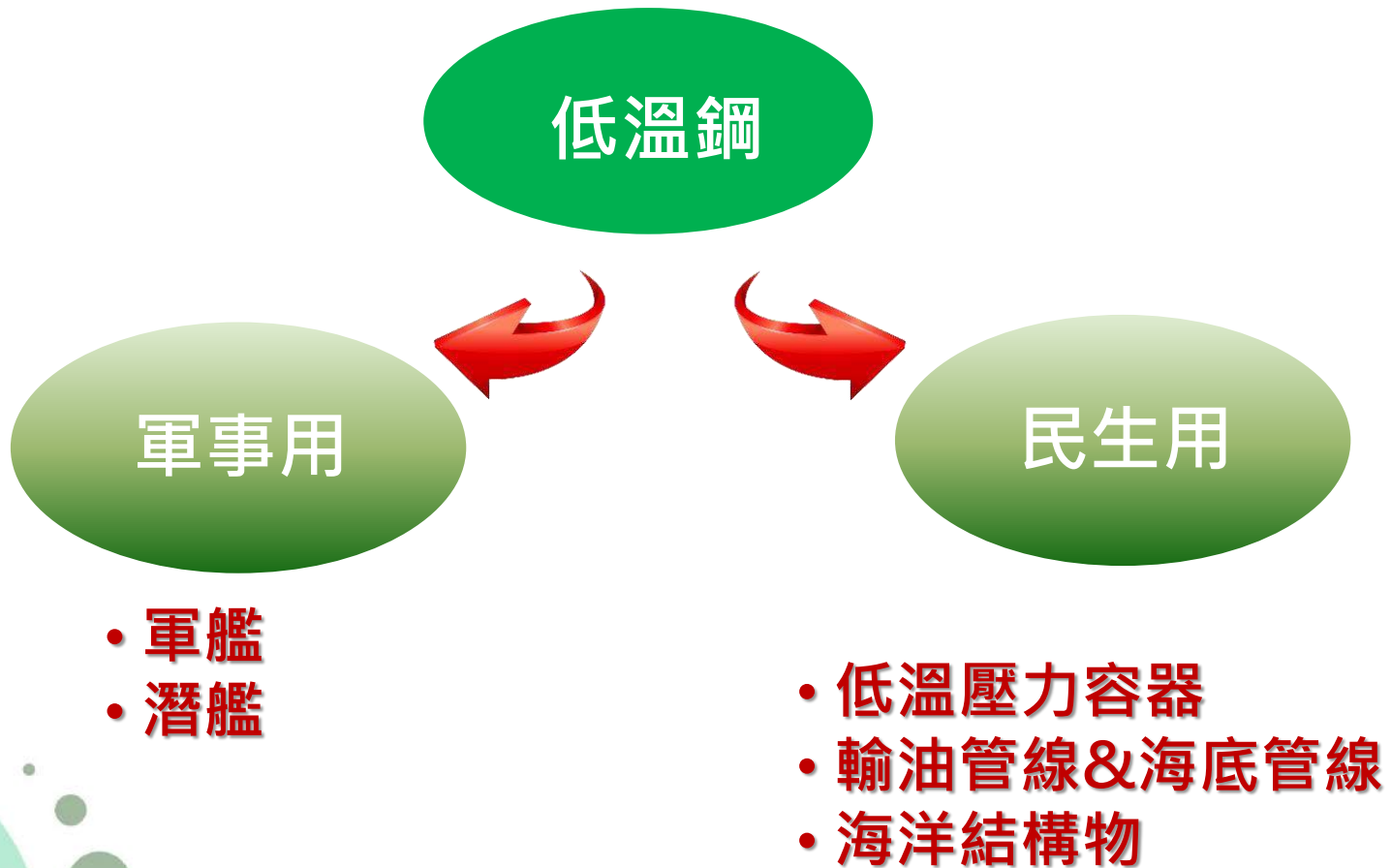
潛艦用低合金高強度高韌性鋼

- 美國
 - HY-80 & HSLA-80
 - HY-100 & HSLA-100
 - HY-130
- 日本
 - NS 46
 - NS 63
 - NS 80
 - NS 90
 - NS 110





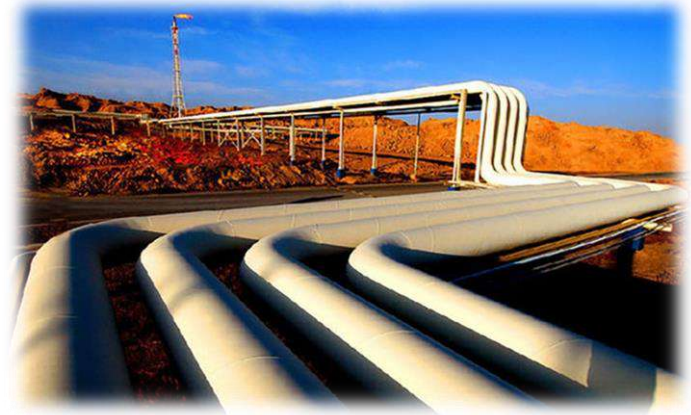
低溫鋼應用





民生應用- 低溫壓力容器、輸送管線及設備

- LNG
- LPG
- 液態氧(-183°C)
- 液態氮(-196°C)
- 液態氫(-253°C)
- 液態氦(-269°C)

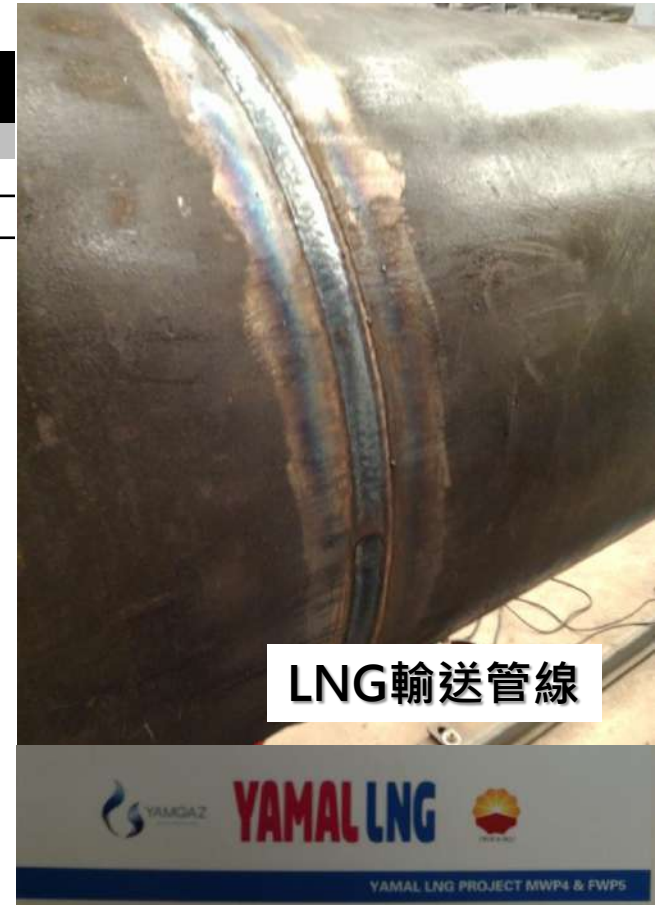
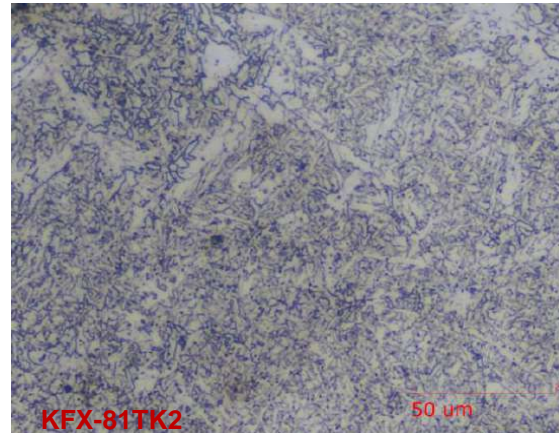
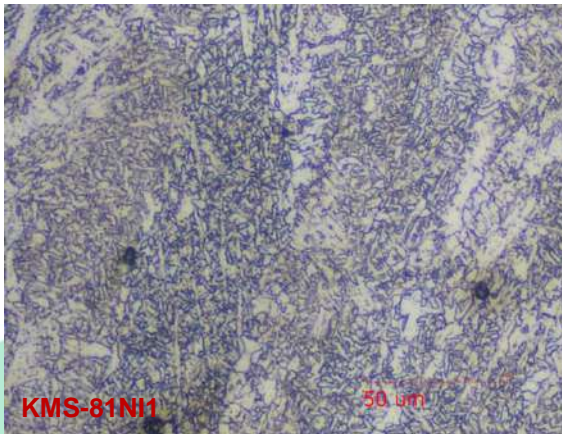




民生應用-LNG輸送管線

Brand Name	Tensile Test Results			Charpy V-Notch Impact Value (Joules)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-29°C	-45°C	-60°C
KMS-80SNi1	509	598	29	87	69	42
ER80S-Ni1	470 min	550 min.	24 min	-	27 min	-

Brand Name	Tensile Test Results			Charpy V-Notch Impact Value (Joules)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-30°C	-40°C	-60°C
KFX-81TK2	592	635	24	140	100	80
E81T1-K2C	470 min.	550-690	19min	27 min	-	-



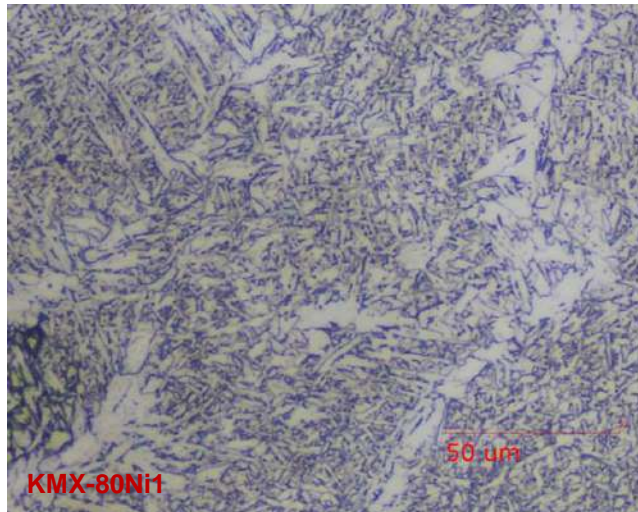
Root pass: **KM-80Ni1 (ER80S-Ni1)**
Hot/Cap pass: **KFX-81TK2 (E81T1-K2C)**

2016 銲接年會產品發表會 @高雄應用科技大學

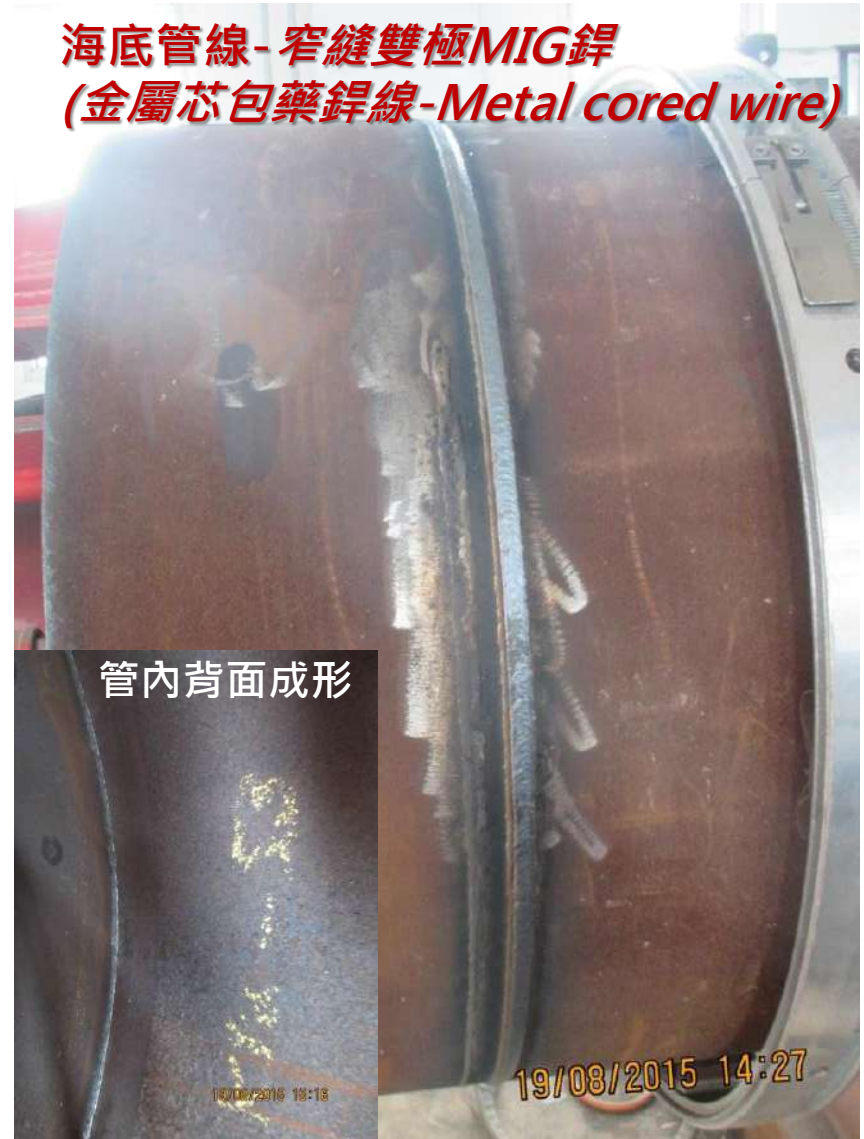


民生應用-海底管線

Root pass: *KMX-80Ni1* (E80C-Ni1)
Hot pass: *KMX-80Ni1* (E80C-Ni1)
Cap pass: *KMX-80Ni1* (E80C-Ni1)

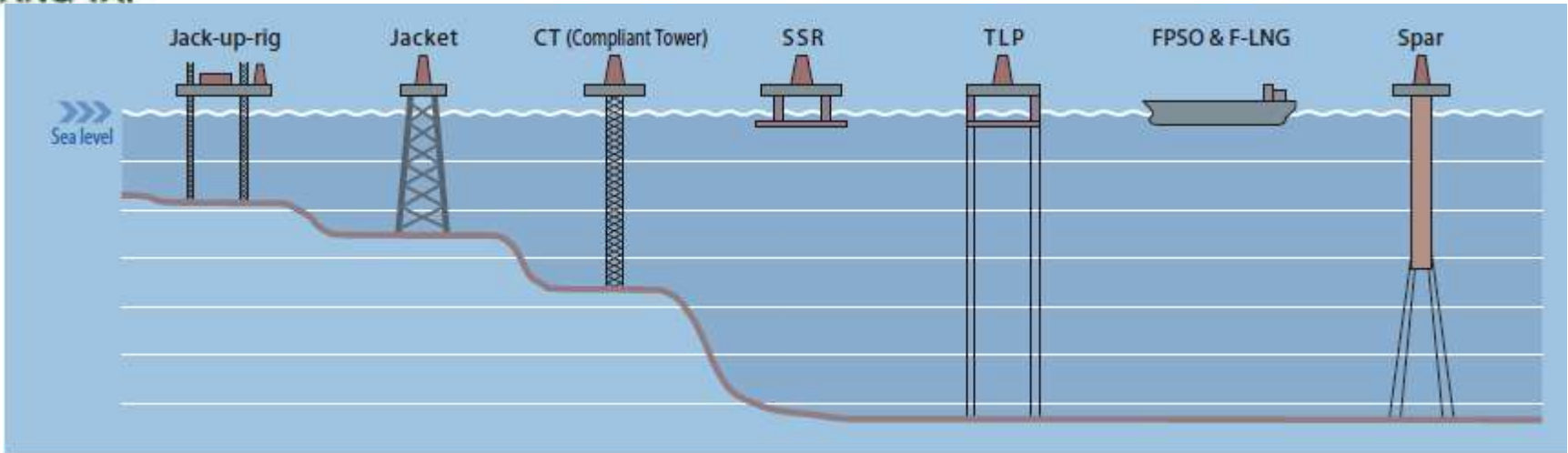


海底管線-窄縫雙極MIG銲
(金屬芯包藥銲線-Metal cored wire)





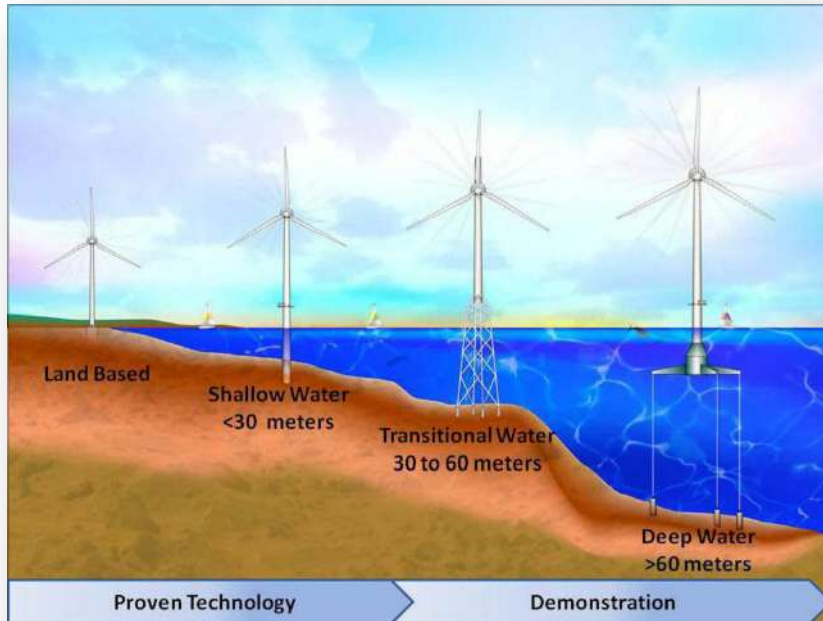
民生應用-海洋平台



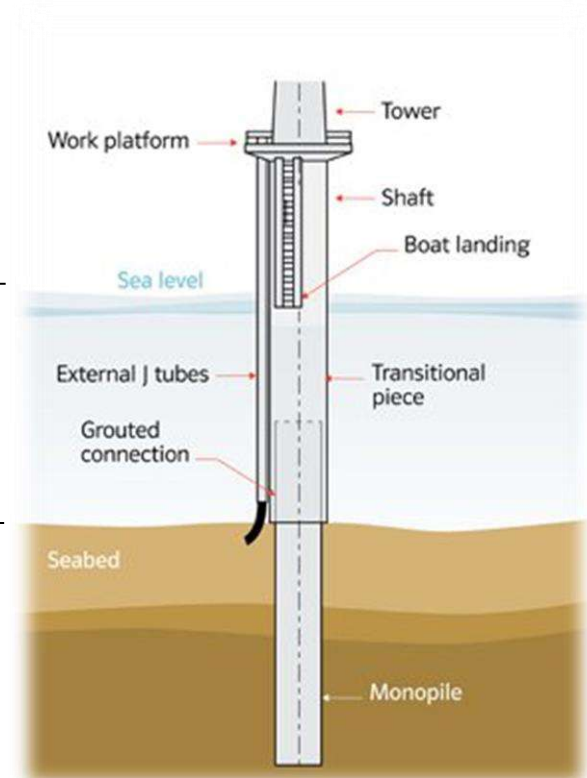
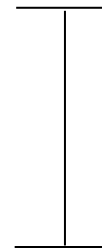
Basic requirement:
-40°C or -60°C impact toughness

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民生應用-離岸風力發電



水下支撐結構



EN 10025-3/4 S355NL & S460ML
中鋼: S690Q

Basic requirement:
-40°C or -60°C impact toughness

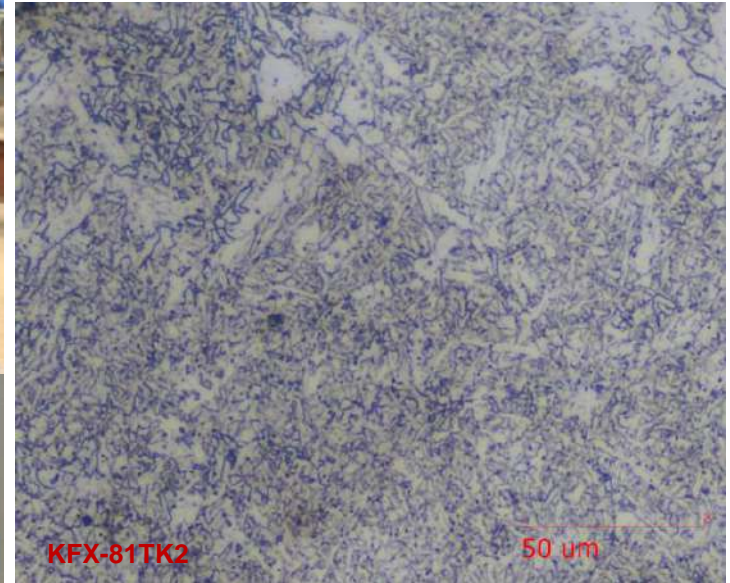




民生應用-海洋平台



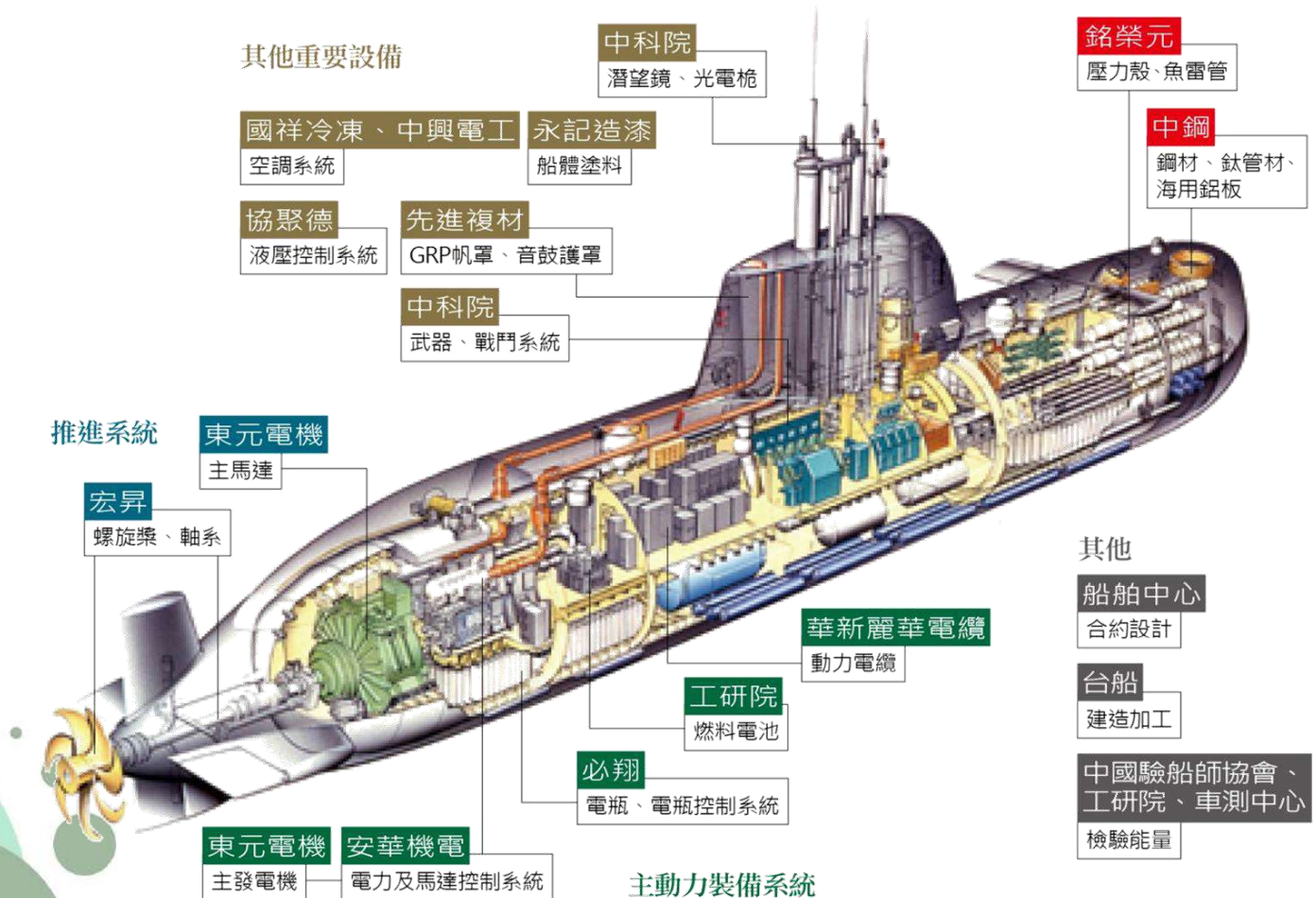
KFX-81TK2 (E81T1-K2C)



Brand Name	Tensile Test Results			Charpy V-Notch Impact Value (Joules)			Diffusible hydrogen (ml/100g)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-30°C	-40°C	-60°C	1	2	3
KFX-81TK2	592	635	24	140	100	80	4.1	4.2	3.9
E81T1-K2C	470 min.	550-690	19min	27 min	-	-	5 max		

軍事用-潛艦

一艘台製潛艦 看見18個潛在贏家
——造船供應鏈大公開





HY & HSLA比較

	C	Si	Mn	Ni	Cr	Mo	Cu
HY-80	0.18	0.15-0.35	0.1-0.4	2.0-3.25	1.0-1.8	0.2-0.6	-
HSLA-80	0.06	0.4	0.4~0.7	0.7~1.0	0.6~0.9	0.15~0.25	1.0~1.3


銲接性提升


製造成本下降

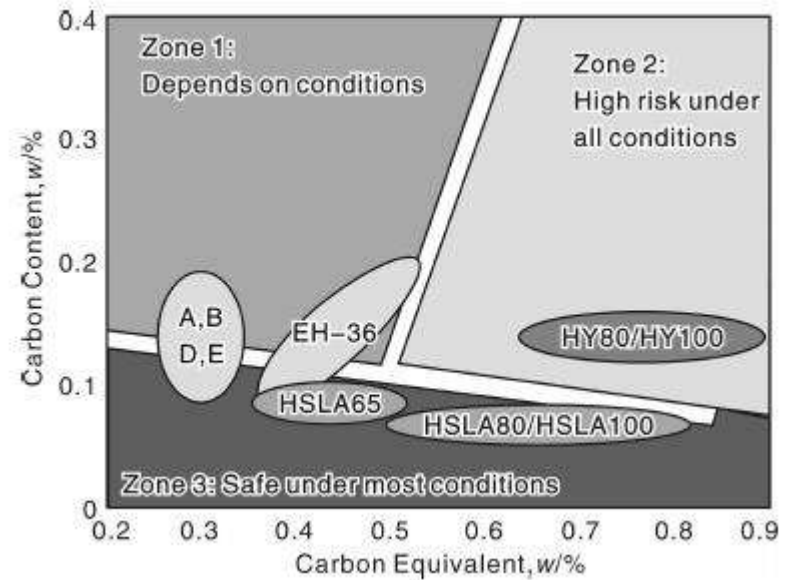
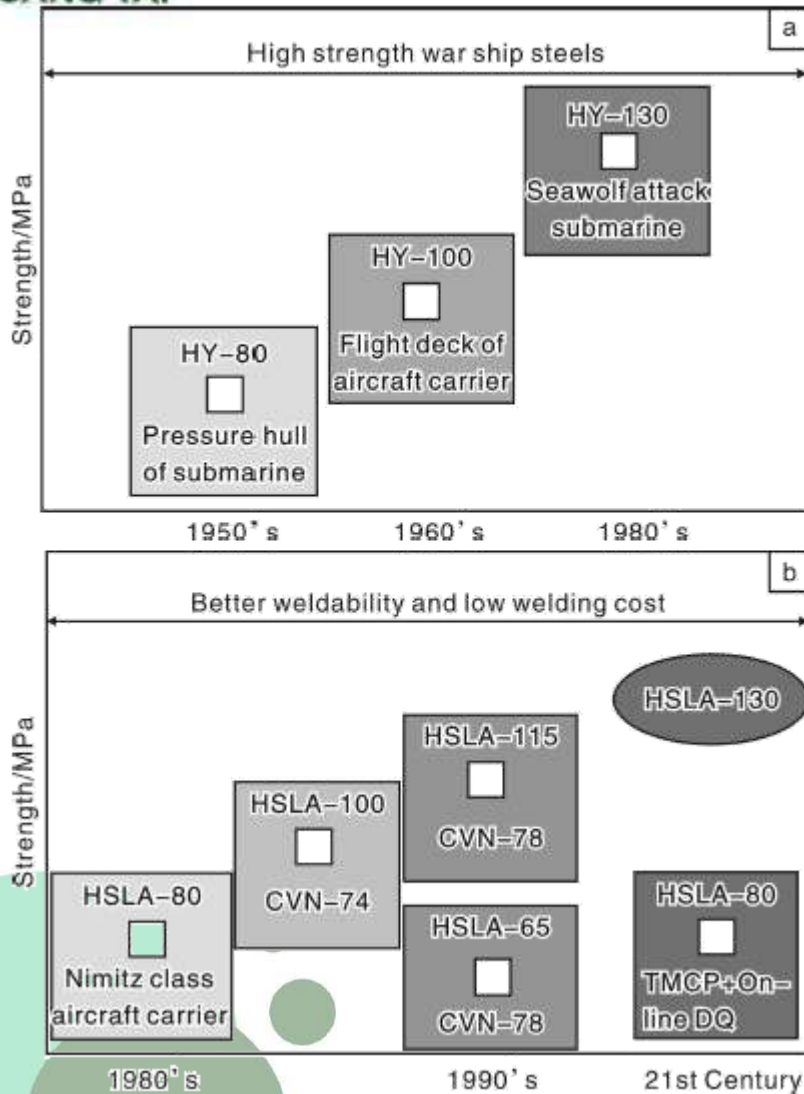

銅析出硬化提高強度


**HY-80 需預熱90~150度
 HSLA-80不需預熱**

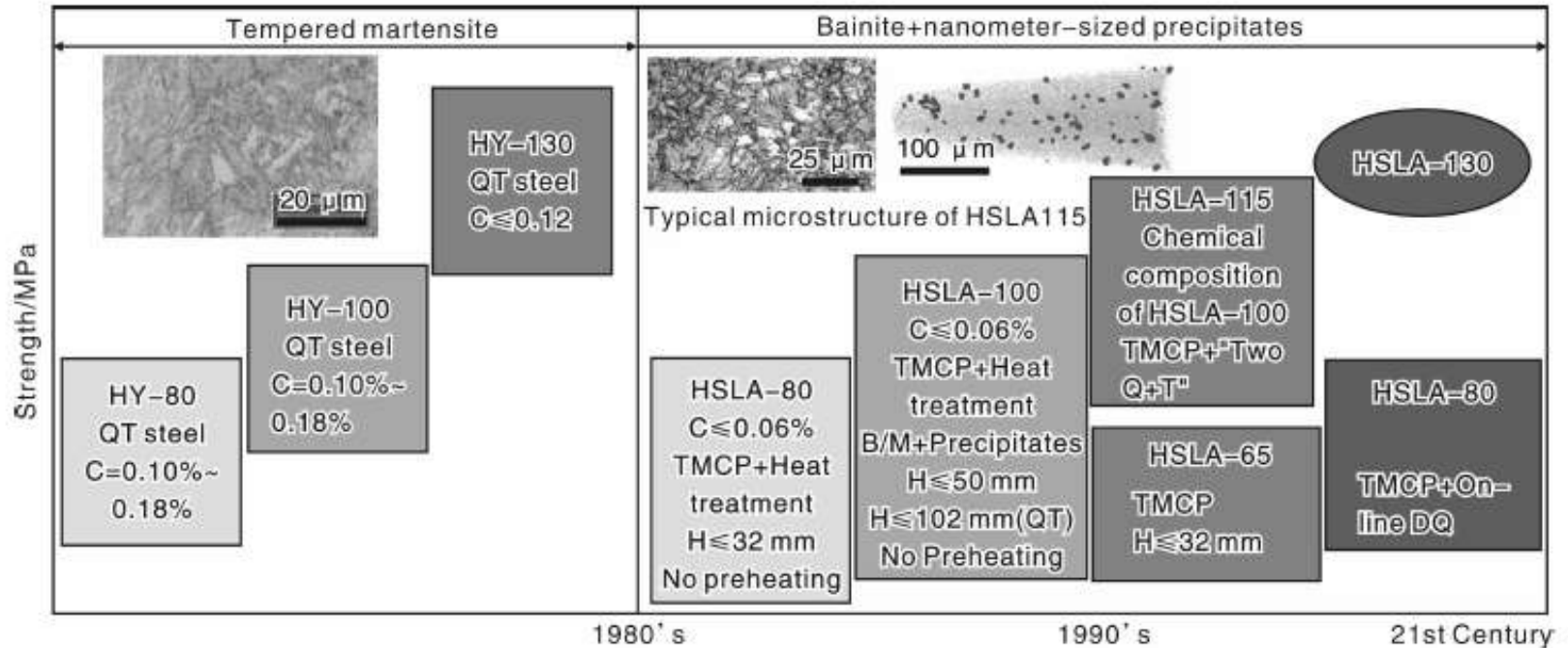
**中鋼開發
 HSLA-80**

鋼板	厚度 (mm)	機性表現			
		YS (MPa)	TS (MPa)	EL (%)	CVN _{-84°C} (J)
HSLA-80	13	606	681	28	194.2
	15	581	628	30	310.0
	20	559	617	26	245.3
	32	594	666	26	217.0
美軍規格	--	552-690	--	≥20	≥142

HY & HSLA-銲接性比較



HY&HSLA比較-組織比較



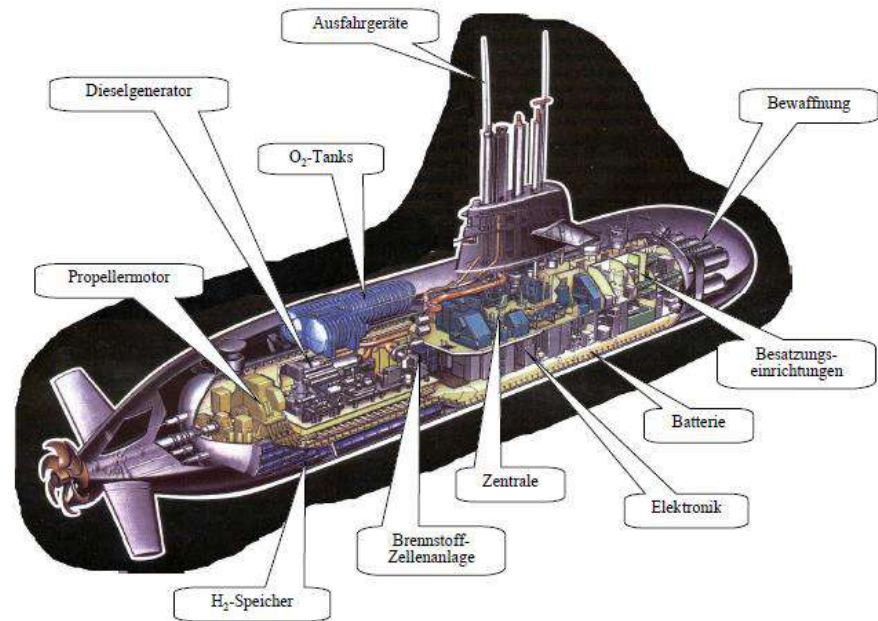


軍事用-潛艦用鐸材

Welding Consumable specification:

T9074-BC-GIB-010/0200

**FILLER MATERIALS FOR CRITICAL APPLICATIONS:
REQUIREMENTS FOR FLUX-CORED WELDING ELECTRODES, BARE WELDING
ELECTRODES AND FLUXES, AND COVERED WELDING ELECTRODES FOR
LOW-ALLOY STEEL APPLICATIONS**





潛艦用鐸材

- SMAW-Chemical Composition*

Element	MIL-10018-M1	MIL-10718-M	MIL-12018-M2
Carbon	0.06	0.07	0.07
Manganese	0.80 - 1.85	0.80 - 1.85	0.80 - 1.85
Silicon	0.65	0.60	0.65
Phosphorus	0.025	0.025	0.025
Sulfur	0.017	0.017	0.012
Chromium	0.40 <u>4/</u>	0.40 <u>4/</u>	0.65
Nickel	1.25 - 3.00	1.25 - 2.50	1.50 - 4.00
Molybdenum	0.50	0.25 - 0.50	0.90
Vanadium	0.05	0.05	0.05
Copper	<u>2/</u>	<u>2/</u> , <u>3/</u>	<u>2/</u> , <u>3/</u>
Boron	---	<u>3/</u>	<u>3/</u>



KL-108M



KL-118M



潛艦用鐸材

- SMAW-Mechanical Properties*

Property	Condition	MIL-10018-M1	MIL-10718-M	MIL-12018-M2
Yield strength (ksi)	As-welded	82 - 110 <u>2/</u>	88 - 122 <u>2/</u> , <u>12/</u>	102 - 123 <u>2/</u> , <u>3/</u>
	Stress relieved	80	86	---
Ultimate tensile strength (ksi)		<u>4/</u>	<u>4/</u>	<u>4/</u>
Elongation in 2 inches (percent)	As-welded	20 <u>5/</u>	20 <u>5/</u>	18 <u>5/</u>
	Stress relieved	20	20	---
Transverse side bend		<u>6/</u>	<u>6/</u>	<u>6/</u>
Charpy V-notch <u>g/</u> Energy ft-lb average @ Temperature (F)	As-welded	35@(-60F) 60@(0F)	35@(-60F) 60@(0F)	45@(-60F) <u>8/</u> 60@(0F)
	Stress relieved	20@(-60F) 50@(0F)	20@(-60F) 50@(0F)	---
Dynamic tear, Energy ft-lb average @ Temperature (F) <u>9/</u> , <u>10/</u>	As-welded	300@(-20F) 450@(30F)	300@(-20F) 450@(30F)	400@(-20F) 575@(30F)
Explosion test series		<u>11/</u>	<u>11/</u>	<u>11/</u>



KL-118M-Data sheet

Mechanic Properties

	Tensile Test Results			Charpy V-Notch Impact Value (Joules)			Diffusible Hydrogen (ml/100g)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-18°C	-40°C	-51°C	1	2	3
KL-118M	690	783	22	133	106	85	2.7	2.9	2.5
MIL-11018-M	616~854	-	20 min	81 min	-	47 min	3.2 max for 3.2mm 3.5 max for 4.0mm ↑		

Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Mo	V
KL-118M	0.06	0.48	1.54	0.017	0.007	2.297	0.023	0.397	0.007
MIL-10718-M	≤0.07	≤0.65	0.85~1.85	≤0.025	≤0.017	1.25-2.50	≤0.40	0.25~0.50	≤0.05

潛艦用鐳材

- GMAW & SAW-Chemical Composition**

Welding process	ALL	GMAW SAW	ALL	GMAW SAW
Type <u>2/</u>	100S-1 100S-2	100S-1C 100S-2C	120S-1 120S-2	120S-1C 120S-2C
Chemical composition (weight percent) <u>1/</u>				
Carbon	0.07 <u>3/</u>	0.07 <u>3/</u>	0.070 <u>3/, 4/</u>	0.070 <u>3/, 4/</u>
Manganese	1.25-1.8	1.25-2.5	0.90-2.35	1.4-3.8
Silicon	0.20-0.55	0.20-0.55	0.60	0.20-0.55
Phosphorus	0.012	0.012	0.012	0.012
Sulfur	0.008	0.010	0.008	0.010
Nickel	1.40-2.10	1.40-2.10	1.00-3.0	1.00-3.5
Molybdenum	0.25-0.55	0.25-0.55	0.30-1.00	0.30-1.10
Chromium	0.30 <u>8/</u>	0.30 <u>8/</u>	0.80	0.60
Vanadium	0.05	0.04	0.03	0.04
Aluminum	0.10	0.05	0.10	0.05
Titanium	0.10	0.10	0.10	0.10
Zirconium	0.10	0.10	0.10	0.10
Copper	<u>5/, 6/, 7/</u>	<u>5/, 6/, 7/</u>	<u>5/, 6/, 7/</u>	<u>5/, 6/, 7/</u>
Boron	<u>7/</u>	<u>7/</u>	<u>7/</u>	<u>7/</u>





潛艦用鐸材

- GMAW & SAW-Mechanic Properties*

Type <u>2</u> /	100S-1 100S-1F 100S-2 100S-2F	120S-1 120S-1F 120S-2 120S-2F
Yield Strength (1000 pounds per square inch) (ksi)	82 to 120 <u>3</u> / <u>12</u> /	102 to 123 <u>3</u> / <u>4</u> / <u>12</u> /
Elongation in 2 inches min. (percent)	16	15
Transverse side bend	<u>5</u> /	<u>5</u> /
Charpy V-notch. Energy ft-lb min. average @ Temperature (degrees Fahrenheit) (F)	35@(-60F) <u>6</u> / 60@(0F) <u>6</u> /	45@(-60F) <u>6</u> / <u>7</u> / 60@(0F) <u>6</u> /
Dynamic tear. Energy ft-lb minimum average @ Temperature (degrees Fahrenheit) (F)	300@(-20F) <u>8</u> / <u>9</u> / 450@(+30F) <u>9</u> / <u>10</u> /	400@(-20F) <u>8</u> / <u>9</u> / 575@(+30F) <u>9</u> / <u>10</u> /
Explosion test series	<u>11</u> /	<u>11</u> /



KM-100S1-Data sheet

Mechanic Properties

	Tensile Test Results			Charpy V-Notch Impact Value (Joules)			Diffusible Hydrogen (ml/100g)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-18°C	-40°C	-51°C	1	2	3
KM-100S1	651	730	18	155	112	82	2.1	2.2	2.2
MIL-100S-1	575-840	-	16 min	81 min	-	47 min	4.0 max		

Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Mo	V
KM-100S1	0.075	0.44	1.32	0.008	0.007	1.78	0.045	0.41	0.01
MIL-100S-1	≤0.07	0.2~0.55	1.25~1.8	≤0.012	≤0.008	1.2-2.1	≤0.30	0.25~0.55	≤0.05



潛艦用鐳材

- FCAW-Chemical Composition & Mechanical Properties*

MIL-type <u>1/</u>	Chemical composition (wt. percent) <u>2/</u> <u>3/</u>									
	Carbon	Manganese	Silicon	Phosphorus	Sulfur	Nickel	Chromium	Molybdenum	Vanadium	Copper
MIL-101TC MIL-101TM	0.07	0.50 to 1.50	0.60	0.015	0.015	1.30 to 3.75	0.20	0.50	0.05	0.06

MIL-type	101TC 101TM
Yield strength (1000 pounds per square inch) (ksi) <u>2/</u>	82 to 110
Elongation in 2 inches min. (percent)	18
Transverse side bend	<u>3/</u>
Charpy V-notch. Energy ft-lb minimum average @ Temperature (degrees Fahrenheit) (F) <u>4/</u>	35@(-60F) 60@(0F)
Dynamic tear. Energy ft-lb minimum average @ Temperature (degrees Fahrenheit) (F)	300@(-20F) <u>5/</u> 450 @(+30F) <u>6/</u>
Explosion crack starter test	<u>7/</u>



KFX-101K3





KFX-101K3-Data sheet

Mechanic Properties

	Tensile Test Results			Charpy V-Notch Impact Value (Joules)			Diffusible Hydrogen (ml/100g)		
	Y.S. (MPa)	T.S. (MPa)	EL. (%)	-18°C	-40°C	-51°C	1	2	3
KFX-101K3	674	719	22	112	76	58	3.8	3.7	3.5
MIL-101TC	575-770	-	18 min	81 min	-	47 min	4.0 max		

Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Mo	V
KFX-101K3	0.04	0.28	1.278	0.013	0.006	2.14	0.04	0.30	0.015
MIL-101TC	≤0.07	≤0.6	0.5~1.5	≤0.015	≤0.015	1.3-3.75	≤0.20	≤0.5	≤0.05



廣泰全系列低溫鋼用產品

SMAW

Welding consumable	Min. applicable strength (MPa)		Applicable temperature(°C)	Chemical compositions of weld metal (mass %)						
	YP	TS	vE \geq 47J	C	Si	Mn	Ni	Mo	Ti	B
KL-718-1	400	520	-40	0.06	0.4	1.5	-	-	0.03	0.004
KN-718G	400	520	-45	0.08	0.2	1.2	1.6	-	0.02	0.003
KN-818C1	460	550	-60	0.08	0.4	1.0	2.5	-	0.02	0.002
KN-916G	530	620	-60	0.07	0.3	1.3	2.6	-	0.01	0.002
KL-108M	610	690	-51	0.05	0.4	1.3	2.0	0.3	0.02	-
KL-118M	680	760	-51	0.06	0.5	1.6	2.3	0.3	0.02	-

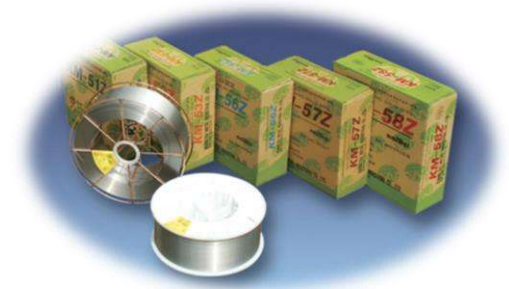




廣泰全系列低溫鋼用產品

GMAW

Welding Consumable	Min. applicable strength (MPa)		Applicable temperature(°C)	Chemical compositions of weld metal (mass %)						
	YP	TS	vE \geq 47J	C	Si	Mn	Ni	Mo	Ti	B
KM-80Ni1	470	550	-45	0.08	0.4	1.0	1.0	-	-	-
KM-80Ni2	470	550	-60	0.08	0.5	1.1	2.2	-	-	-
KM-90D2	540	620	-30	0.08	0.4	1.6	-	0.4	-	-
KM-100S1	690	610	-51	0.07	0.4	1.3	1.8	0.4	-	-





KUANG TAI

FCAW

廣泰全系列低溫鋼用產品

Welding Consumable	Min. applicable strength (MPa)		Applicable temperature(°C)	Chemical compositions of weld metal (mass %)						
	YP	TS		vE \geq 47J	C	Si	Mn	Ni	Mo	Ti
KFX-719	400	520	-40	0.06	0.4	1.6	0.4	-	0.02	0.004
KFX-81TNi1	470	550	-30	0.04	0.3	1.3	0.9	-	0.02	0.004
KFX-81TNi2	470	550	-40	0.03	0.4	1.2	1.9	-	0.02	0.004
KFX-81TK2	470	550	-40	0.06	0.4	1.4	1.4	-	0.02	0.004
KFX-91TK2	540	620	-50	0.05	0.4	1.6	1.6	-	0.02	0.004
KFX-101K3	610	690	-40	0.04	0.3	1.4	2.1	0.3	0.01	0.002
KFX-111K3	680	760	-40	0.06	0.4	1.8	2.3	0.3	0.02	0.004





廣泰全系列低溫鋼用產品

MCAW

Welding Consumable	Min. applicable strength (MPa)		Applicable temperature(°C)	Chemical compositions of weld metal (mass %)						
	YP	TS	vE \geq 47J	C	Si	Mn	Ni	Mo	Ti	B
KMX-70M	400	480	-30	0.05	0.4	1.5	-	-	0.02	0.004
KMX-80Ni1	470	550	-45	0.06	0.3	1.3	0.9	-	0.02	0.004





Thanks for your attention!

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