

POSCO TITANIUM

POSCO TITANIUM

Titan of the world Gift for human welfare

Discovered in 1790 and put in industrial usage in 1950, titanium has very short history compared to other materials. However, it is becoming one of the most important materials in 21st century. Especially, its superior specific strength and corrosion resistance have been expanding its usage from aircraft to shipbuilding, power plants, medical equipment, and other industrial fields. POSCO, as a total material provider, has entered titanium industry with world-leading technologies and experience accumulated in its steelmaking operations, and delivers better products to our customers with high stability.

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1790년에 발견되어 1950년 공업생산이 시작된 티타늄은 다른 금속에 비해 그 역사는 짧지만 21세기에 주목 받는 신소재로서 비약적인 발전을 하고 있습니다. 특히, 높은 비강도와 뛰어난 내식성으로 인해 과거 우주항공산업에 국한되어 있던 응용분야를 최근 조선, 발전, 의료기기, 생활용품 등 일반 산업분야로 확대하고 있습니다. 포스코는 종합소재메이커로서 철강사업에서 축적한 세계 최고의 기술과 경험을 바탕으로 티타늄판재 사업을 시작하였으며, 스페인 티타늄 제조사인 카자흐스탄의 UKTMP사와 합작사 설립으로 원료부터 제품까지 일관생산체제를 구축함으로써 고객에게 보다 경쟁력 있는 제품을 안정적으로 공급하고 있습니다.

- | | | |
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| 1. 티타늄의 특성 | 5. 주요 Application III | 9. 글로벌 네트워크 |
| 2. 경제성 | 6. 제조 공정 | |
| 3. 주요 Application I | 7. 포스코 티타늄 제품 | |
| 4. 주요 Application II | 8. Technical Data | |



CHARACTERISTICS

Besides its superior quality in weight, strength and corrosion resistance, titanium is a non-toxic, environment-friendly metal.



[Light Weight]

Specific gravity about 60% of steel
일반강 대비 60% 수준의 비중



[High Specific Strength]

Strength similar to steel
일반강 수준의 강도



[Corrosion Resistance]

Excellent corrosion resistance against seawater
해수에 대한 뛰어난 내식성

As a global leading steel company, POSCO is creating another success story in titanium industry.

티타늄은 무게, 강도, 내식성에 있어 우수할 뿐만 아니라 무독성의 환경친화적 금속입니다.

[Low Thermal Expansion]

Thermal expansion similar to glass or concrete
유리, 콘크리트와 유사한 열팽창계수

[Non Magnetic]

Never becomes magnetized
무자성



[High Formability]

Formability similar to 304 stainless steel
304스테인리스 스틸과 비슷한 수준의 성형성

[Non Toxic]

Low leaching out of metallic ions and low incidence of ionic allergy
낮은 수준의 금속이온의 침출 가능성 및 알레르기 발생률

포스코는 선도적인 철강회사로서 티타늄 산업에서 또 다른 성공 신화를 창조하고 있습니다.

COST EFFECTIVENESS



In many applications, titanium offers opportunities for reducing operating costs.

- 1) Better fuel economy through weight savings in engines and other mobile equipment
- 2) Improved energy conservation by efficient heat transfer
- 3) Resistance to aggressive materials such as crude oil with high level of hydrogen sulfide
- 4) Reduction in environmental cost caused by corrosion leakage



Also, titanium provides cost reduction in maintenance and downtime by its superior corrosion resistance especially for plants and equipment designed for a long service life. Welded titanium tube supplied for power plant surface condenser use, has been sold with a 40 year performance guarantee and many of the earlier installations of welded tube have now outlived their original guarantee period.

티타늄 소재는 다양한 적용 분야에서 운전비용의 절감을 제공하고 있습니다.

- 1) 제품의 경량화를 통해 엔진 등의 연료소비 절감
- 2) 효율적인 열전달을 통한 에너지 효율 향상
- 3) 고 황화수소 원유 등과 같은 aggressive 소재에 대한 저항력
- 4) 부식/누수로 인한 오염물질 배출의 방지 등 환경비용 절감

또한, 긴 수명이 요구되는 플랜트 및 장비에 티타늄을 사용하면 탁월한 내식성으로 유지 보수 비용을 절감할 수 있습니다. 발전소 콘덴서에 공급되는 티타늄 용접 튜브는 일반적으로 40년 이상의 품질보증을 하고 있으며 과거 설치된 튜브는 대부분 당초 보증기간 이상으로 사용되고 있습니다.

MAIN APPLICATION I

Due to its superior quality, titanium is used in many fields of industry – nuclear/thermal power plant, petrochemical plant, shipbuilding, ocean plant ,etc.

티타늄은 타 금속 대비 우수한 특성으로 원자력/화력발전소, 석유/화학 플랜트, 조선, 해양플랜트 등 다양한 산업에 사용되고 있습니다.



[Power / Chemical Plant]



Surface Condenser under Assembly

TSM Tech



Heat Exchanger

TSM Tech



Dehydrogen Tower

TSM Tech

[Ocean Plant / Shipbuilding]



Ocean Plant

Samsung Heavy Industries



Plate Heat Exchanger(PHE)



LHE.Co.Ltd



MAIN APPLICATION II

In addition to its wide usage in aerospace and military industry, titanium is also seeing increasing use in construction field.

티타늄은 우주항공, 군사 분야에 광범위한 사용은 물론, 최근 건축분야의 사용도 증가하고 있습니다.

[Aerospace / Military]



F-15k



K-11



S&T Daewoo Space Shuttle

[Construction]



Guggenheim Bilbao, Spain



Benz Museum, Germany



Big Sight, Japan



National Grand Theatre, China

MAIN APPLICATION III

Moreover, titanium is appropriate for the products for sports, leisure, medical equipment, accessories, and the range of applications in industry is being expanded.

또한, 티타늄은 스포츠, 레저, 의료용 제품들과 액세서리에 적합한 소재로서, 그 응용분야가 확대되고 있습니다.



[Sports / Leisure]



Bicycle Frames

Ja Gang Corporation



Golf Driver

Missile Korea



Racket

Dunlop



[Medical Equipment / accessories]



Dental Plate & Spring



Jeil Medical Coporation



Car Muffler

Jun B.L



Titanium Cooker



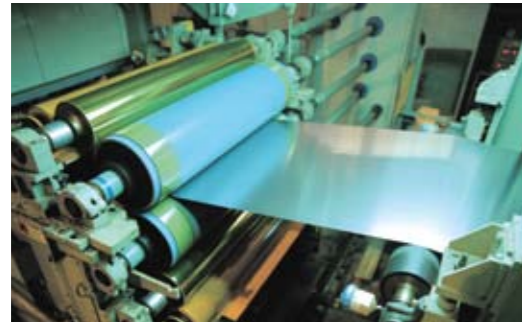
Accessories

Tatias Glasses



Daehan Titanium Optical Co.

MANUFACTURING PROCESS

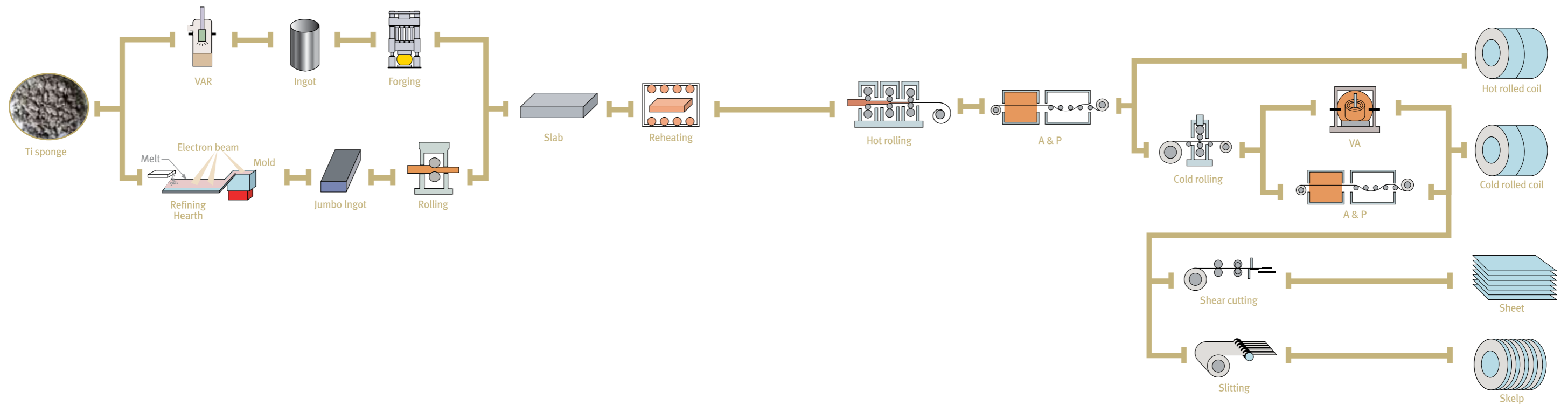


Combining our world-best manufacturing technology in steel & stainless steel, POSCO is now producing titanium products of the best

quality. In addition, POSCO will complete the vertical integration to slab production by 2013, and this will provide our customers with more reliable supply of titanium products.



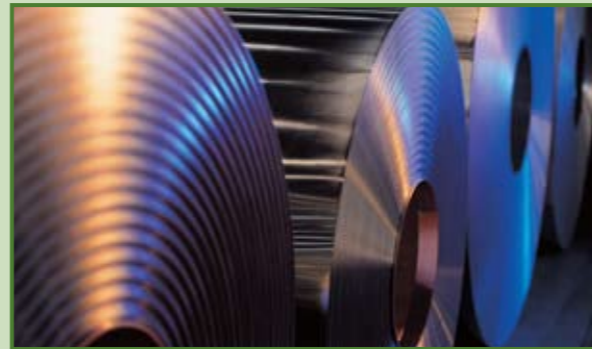
철강과 스테인리스 스틸에서의 세계 최고 제조 기술력을 접목하여, 포스코는 가장 우수한 품질의 티타늄 제품을 생산하고 있습니다. 또한, 2013년까지 완성될 슬라브 생산까지의 수직계열화를 통해 고객에게 보다 안정적으로 티타늄 제품을 공급할 것입니다.



POSCO TITANIUM PRODUCTS

HOT ROLLED/COLD ROLLED SHEET & COIL

HR/CR sheets are produced in high quality and accurate dimensions, mainly used for heat exchanger tubes for nuclear, thermal power plants and plate heat exchangers(PHE).



HR/CR 코일은 우수한 품질과 규격으로 생산되며 주로 원자력, 화력발전 등의 열교환기용 튜브 및 선박용 판형열교환기용 소재로 쓰입니다.

[Acceptable Standards]

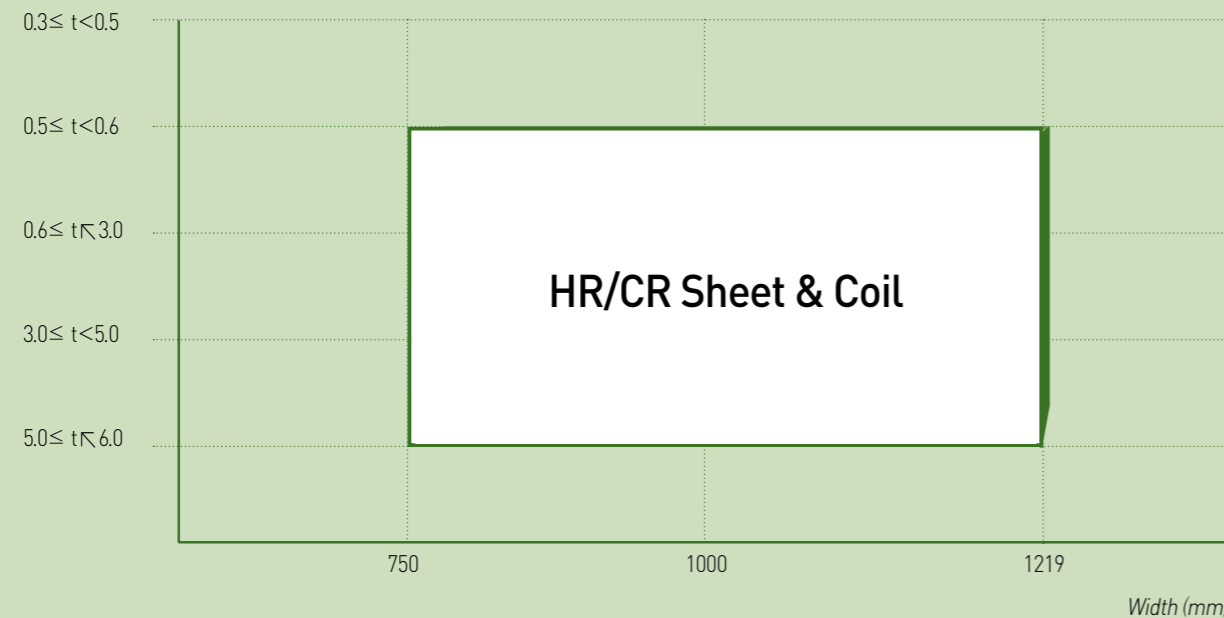
Standard	Grades
ASTM B265	Gr.1, Gr.2
ASME SB265	Gr.1, Gr.2
JIS H 4600	Class1, Class2

[Application]



[Available Sizes]

Thickness(mm)



HOT ROLLED PLATE

[Available from 2011 Q4]

HR plates are mainly used for tube sheets and pressure containers.



후판은 주로 열교환기의 튜브 sheet 와 압력용기 등의 소재로 쓰입니다.

[Acceptable Standards]

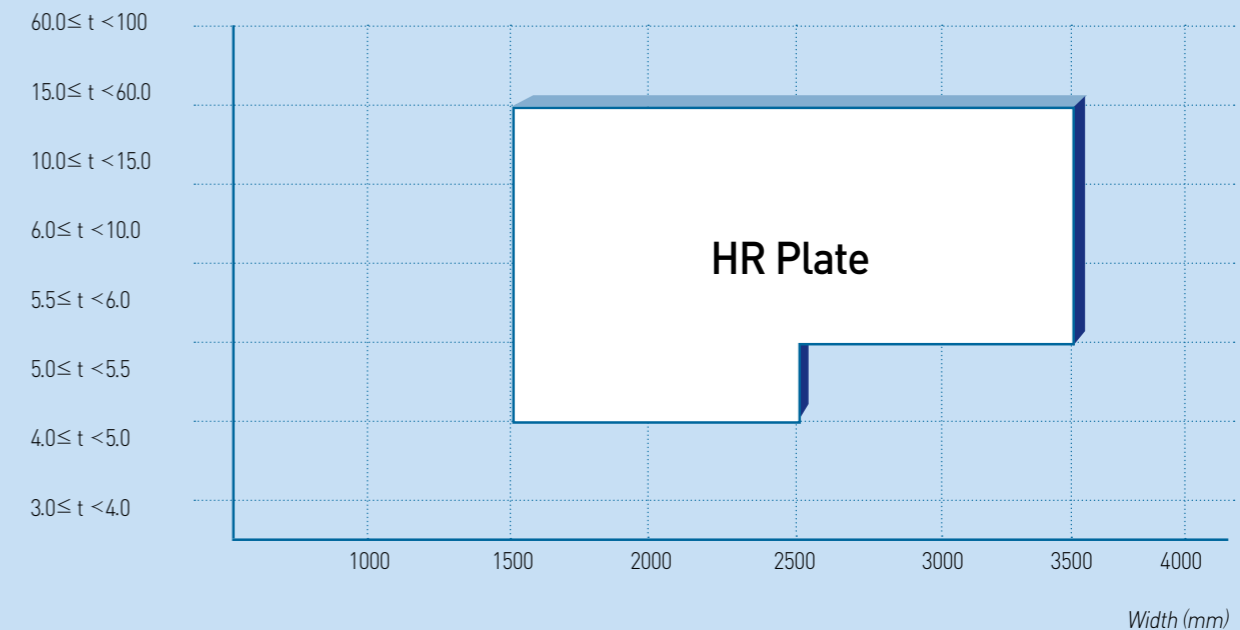
Standard	Grades
ASTM B265	Gr.1, Gr.2
ASME SB265	Gr.1, Gr.2
JIS H 4600	Class1, Class2

[Application]



[Available Sizes]

Thickness (mm)



TECHNICAL DATA

Titanium Standard

Chemical Composition & Mechanical Properties according to ASTM Standards							
DESIGNATION	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5	GRADE 7	GRADE 11
COMPOSITION(%MAX) 화학성분							
Oxygen (O)	0.18	0.25	0.35	0.40	0.20	0.25	0.18
Nitrogen (N)	0.03	0.03	0.05	0.05	0.05	0.03	0.03
Hydrogen (H)	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Carbon (C)	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Iron (Fe)	0.20	0.30	0.30	0.50	0.40	0.30	0.20
Aluminium (Al)	-	-	-	-	5.5~6.75	-	-
Vanadium (V)	-	-	-	-	3.5~4.5	-	-
Palladium (pd)	-	-	-	-	-	0.12~0.25	0.12~0.25
Residual each (total)	0.10 (0.4)	0.10 (0.4)	0.10 (0.4)	0.10 (0.4)	0.10 (0.4)	0.10 (0.4)	0.10 (0.4)
MECHANICAL PROPERTIES 기계적 성질							
Tensile Strength MPa min.	240	345	450	550	895	345	240
인장강도 (ksi)	(35)	(50)	(65)	(80)	(130)	(50)	(35)
Yield Strength MPa	170~310	275~450	380~550	483~655	830	275~450	170~310
항복강도 (ksi)	(25~45)	(40~65)	(55~80)	(70~95)	(120)	(40~65)	(25~45)
Elongation % min.(연신율)	24	20	18	15	10	20	24
Hardness HV typical (경도)	100~150	160~200	180~220	200~280	310~350	160~200	100~150

Physical Properties

Comparison of Physical Properties with those of other Metals											
Item	Atomic no.	Atomic wt.	Density (g/cc)	Melting point(°C)	Linear thermal expansion coefficient (1/°C)	Specific heat (J/g·°C)	Thermal conductivity (W/m·K)	Specific electrical (μΩ-cm)	Electrical conductivity to Cu(%)	Young's modulus (GPa)	Poisson's ratio
Titanium	22	47.90	4.5	1,668	8.4×10 ⁻⁶	0.53	17.0	55	3.1	116	0.34
Iron	26	55.85	7.9	1,530	12×10 ⁻⁶	0.44	76.2	9.7	18	200	0.31
18-8 Stainless steel (SUS 304)	-	-	7.9	1,400 ~ 1,420	17×10 ⁻⁶	0.50	16.2	72	2.4	195	0.3
Aluminum	13	26.97	2.7	660	23×10 ⁻⁶	0.90	210	2.7	64	68	0.33
Aluminum alloy (7075)	-	-	2.8	476 ~ 638	23×10 ⁻⁶	0.96	120	5.8	30	71.7	0.33
Magnesium	12	24.32	1.7	650	25×10 ⁻⁶	1.03	159	4.3	40	44	0.35
Magnesium alloy (AZ-31B)	-	-	1.8	605 ~ 630	26×10 ⁻⁶	1.0	96	9.3	19	45	0.35
Nickel	28	58.69	8.9	1,453	15×10 ⁻⁶	0.46	60.7	9.5	18	207	0.31
Nickel alloy (monel)	-	8.8	8.8	1,300 ~ 1,350	14×10 ⁻⁶	0.43	21.8	48	3.6	170	0.29
Hastelloy C	-	-	8.9	1,305	11.3×10 ⁻⁶	0.43	11.1	130	1.3	205	-
Copper	29	63.57	8.9	1,083	17×10 ⁻⁶	0.39	385	1.7	100	110	0.34

Notes : 18-8 stainless steel : Cr(18%)-Ni(8%)-Fe(R)

Monel : Ni (70%)-Cu (30%) Hastelloy C : 54Ni-17Mo-15Cr-5Fe-4W

AZ-31B : Al (3%)-Zn (1%)-Mn (0.2%) - Mg(R)

7075 : Tempered and quenched ultra-super duraluminum [Cu (1.6%)-Mg (2.5%)-Cr (0.3%)-Zn (5.6%)-Al (R)]

Crystal structure α Titanium (≦885°C) : close-packed hexagonal lattice a=2.9504 Å c/a=1.587

β Titanium (≦885°C) : body-centered cubic lattice a=3.3065 Å

Latent heat of fusion : 14.5 cal/g Permeability : 1.0001

TECHNICAL DATA

Corrosion Resistance

Comparison of corrosion resistance between titanium and other metallic materials

Classification	Corrosion medium	Concentration (%)	Temperature (°C)	Titanium	SUS304	SUS316	Hastelloy C
Inorganic acids	Hydrochloric acid	1	25	A	B	A	A
			Boiling	D	D	D	C
		10	25	B	D	D	D
			Boiling	D	D	D	D
	Sulfuric acid	1	25	A	A	A	A
			Boiling	D	D	C	B
		10	25	B	B	B	A
			Boiling	D	D	D	B
	Nitric acid	10	25	A	A	A	A
			Boiling	A	A	A	B
Organic acids	Acetic acid	10	25	A	A	A	A
			Boiling	A	B	B	A
		60	25	A	C	B	A
			Boiling	D	D	D	A
	Ossalic acid	10	25	A	C	B	A
			Boiling	D	D	D	A
	Formic acid	10	25	B	B	B	B
			60	D	C	B	B
	Lactic acid	10	25	A	B	B	B
			Boiling	A	D	D	B
Alkali	Sodium hydroxide	10	100	A	A	A	A
			Boiling	D	B	B	B
	Potassium carbonate	5	Boiling	A	A	A	A
			20	A	A	A	A
Inorganic chlorides	Sodium chloride	25	25	A*	B*	B*	B
			Boiling	A	B*	B*	B*
	Ammonium chloride	40	25	A*	B*	B*	A
			Boiling	A*	C*	B*	A*
	Zinc chloride	20	Boiling	A*	D	D	D
			50	A	D	D	D
	Magnesium chloride	42	25	A*	A*	A*	A
			Boiling	A	A*	A*	A*
Iron chloride	30	25	A*	D	D	C	
		Boiling	A	D	D	D	
Inorganic salts	Sodium sulphate	20	25	A	A	A	A
			Boiling	A	A	A	A
	Sodium sulfide	10	25	A	A	A	A
			Boiling	A	B	B	A
	Sodium chlorite	5	25	A	C	C	C
			15	A	C	C	C
Sodium carbonate	30	25	A	A	A	A	
		Boiling	A	A	A	A	
Organic compounds	Methyl alcohol	95	25	A	A	A	A
			Boiling	A	B	B	B
	Carbon tetrachloride	100	25	A	A	A	A
			Boiling	A	B	B	B
Phenol	Saturate	25	A	A	A	B	
		Boiling	A	A	A	B	
Gas	Formaldehyde	37	Dry	D	A	A	A
			Humid	A*	D	D	D
	Chlorine	Dry	25	A	C	B	A
			25	A	B	A	B
	Hydrogen sulfide	Humid	25	A	B	A	B
			25	A	A	A	A
Ammonium	100	40	A	A	A	A	
		100	A	A	A	A	
Others	Seawater	-	25	A	A	A	A
			100	A*	B*	B*	A*
	Naptha	-	80	A	A*	A*	A
			180	A	A*	A*	A

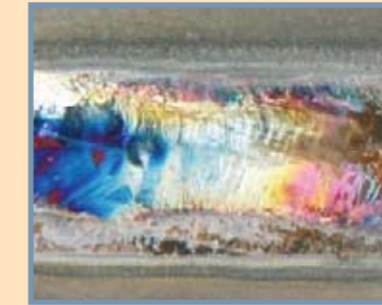
A : <0.125mm / year B : 0.125-0.5mm / year C : 0.5-1.25mm / year D : >1.25mm / year

*Local corrosion such as pitting and crevice corrosion resistance

Appearance of TIG-welded surface



Perfectly shielded condition



Imperfectly shielded condition



Bendability of CP Ti Grade 2

Die Radius	4.0	2.5	1.5	0.5
Result	Good	Good	Good	Good

180° bending, 0.5mm thick

Heat Treatment Conditions

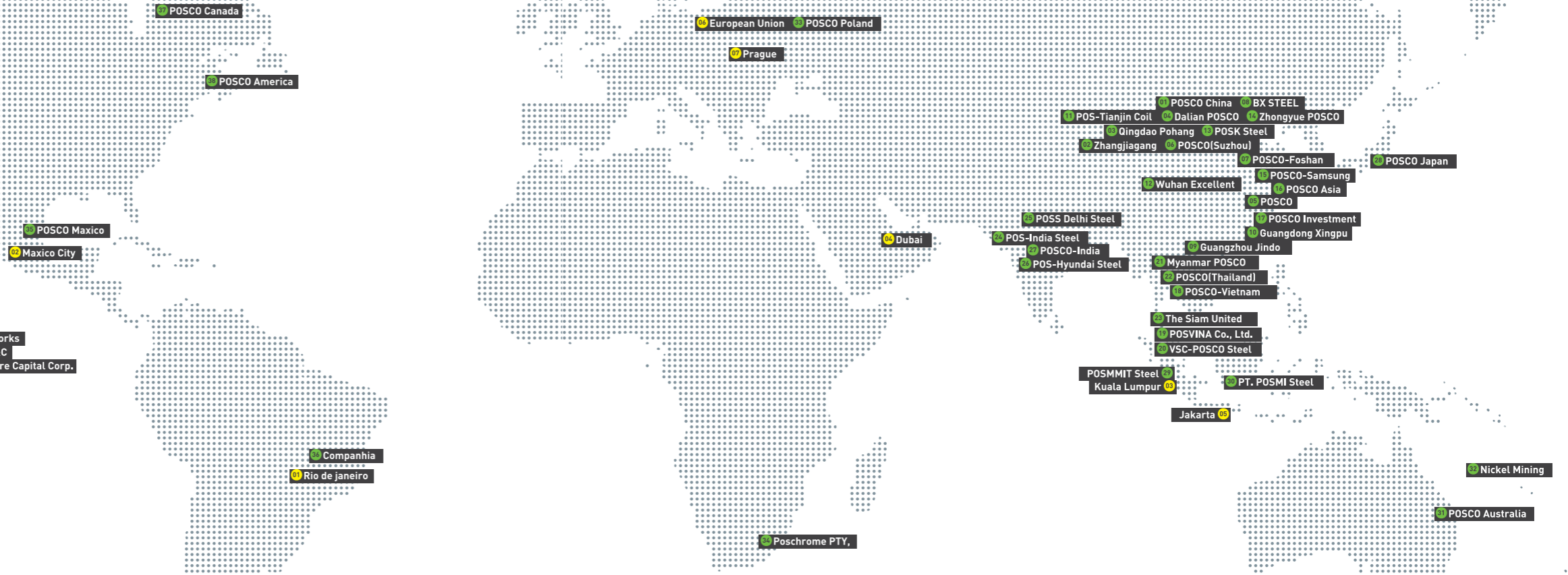
Heat Treatment Method	C.P Titanium	α - β Alloy		β Alloy	
		Ti-3Al-2.5V	Ti-6Al-4V	Ti-15V-3Cr-3Sn-3Al	
Stress relief	Temp.(°C)	480-595	370-595	480-650	790-895
	Time(min)	15-240	15-240	60-240	30-60
Annealing	Temp.(°C)	650-815	650-790	705-870	760-815
	Time(min)	15-120	30-120	15-60	3-30
Solution treatment	Temp.(°C)	-	-	900-970	760-815
	Time(min)	-	-	2-90	2-30
Aging	Temp.(°C)	-	-	480-675	480-675
	Time(hr)	-	-	2-8	2-24

According to AMS-H-81200

GLOBAL NETWORK

SOUTH KOREA

- Posco Center
- POS-AC POSSTEEL POSDATA
- POSRI POSCO Power POSMATE
- Headquarters Pohang Works
- POSREC POSCON POSCO E&C
- POSCOS POSMEC POSTECH Venture Capital Corp.
- Samjung P&A SNNC
- POSCO Specialty Steel
- Gwangyang Works SeungKwang
- POS-M POSCO Terminal



International Subsidiaries

- | | | | | | |
|--|---|---|---|---|--|
| 01. POSCO China Holding Corp. Beijing, China
86-10-5166-6677 86-10-8440-0321 | 07. POSCO-Foshan Steel Processing Center Co.,Ltd. Foshan, China
86-133-2283-8326 86-757-8387-1384 | 12. Wuhan Excellent Steel Center Co., Ltd. Wuhan, China | 19. POSVINA Co., Ltd. Vietnam
84-8-731-3097 84-8-731-3619 | 26. POS-Hyundai Steel Manufacturing India Private Limited. Chennai, India.
91-44-2715-6457 91-4111-256-458 | 33. POSCO Poland Steel Processing Center Poland
48-71-733-7262 48-71-733-7257 |
| 02. Zhangjiagang Pohang Stainless Steel Co., Ltd.(ZPSS) Zhangjiagang, China
86-512-5856-9211 86-512-5855-3680 | 08. BX STEEL POSCO Cold Rolled Sheet Co., Ltd. Benxi, China
84-414-782-3705 86-414-782-2002 | 13. POSK Steel (Pinghu) Processing Center Co., Ltd. Pinghu, China
86-137-5733-5591 86-573-528-1330 | 20. VSC-POSCO Steel Corporation Vietnam
84-95-3344-700 84-31-385-0123 | 27. POSCO-India Pvt. Ltd. Buba, India
91-674-230-3690 91-674-230-0058 | 34. Poschrome PTY, Ltd. South Africa
27-11-245-1081 27-11-905-1281 |
| 03. Qingdao Pohang Stainless Steel Co., Ltd.(QPSS) Qingdao, China
86-532-8683-7020 86-532-8683-7011 | 09. Guangzhou Jindo Container Manufacturing Co., Ltd. Guangzhou, China
86-20-3877-1900 86-20-3877-1905 | 14. Zhongyue POSCO (Qinhuangdao) Tinsplate Industrial Co., Ltd. Qinhuangdao, China
86-335-535-1888 86-335-535-1993 | 21. Myanmar POSCO Steel Co., Ltd. Myanmar
95-1-638-304 95-1-365-418 | 28. POSCO Japan Co., Ltd. Tokyo, Japan
81-3-3546-0924 81-3-3546-6519 | 35. POSCO Maxico S.A. de C.V. Mexico
52-833-217-5903 52-833-217-5904 |
| 04. Dalian POSCO-CFM Coated Steel Co., Ltd.(PCCS) Dalian, China
86-411-8751-5003 86-411-8751-4710 | 10. Guangdong Xingpu Steel Center Co., Ltd.
86-133-0283-1851 86-7572-666-1109 | 15. POSCO-Samsung Suzhou Processing Center Co., Ltd. Suzhou, China | 22. POSCO(Thailand) Co., Ltd. Thailand
66-38-65-0463 66-38-45-4207 | 29. POSMMIT Steel Centre Sdn., Bhd. Malaysia
60-3-6092-5200 60-3-6092-0382 | 36. Companhia Coreano-Brasileira de Pelotizac(KOBRASCO)Brazil
55-27-3333-4864 55-27-3333-4762 |
| 05. POSCO(Guangdong) Coated Steel Co., Ltd. (POS-GCS) Guangdong, China
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