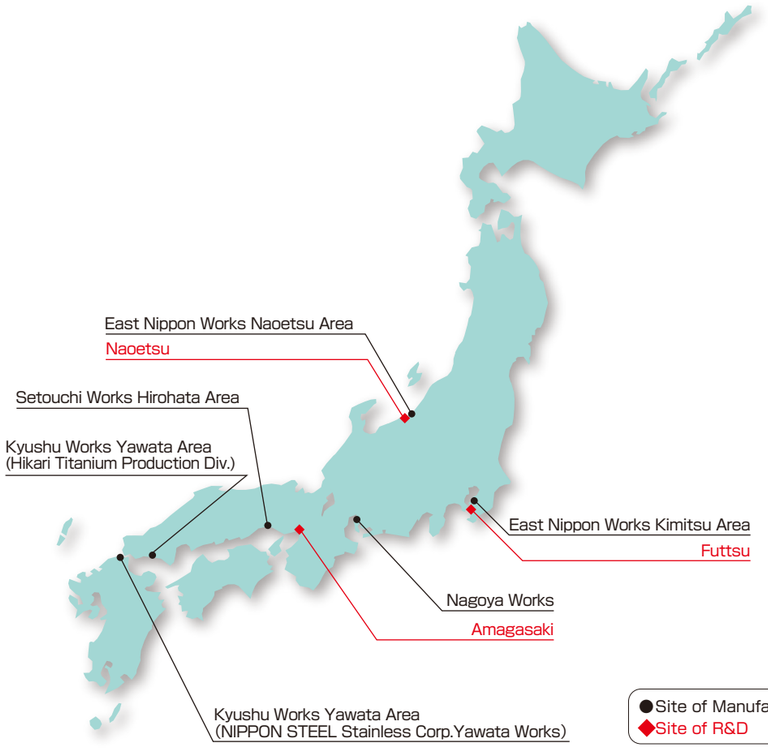
NIPPON STEEL

www.nipponsteel.com

Sites of Manufacturing and Researching



NIPPON STEEL CORPORATION
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Titanium Products
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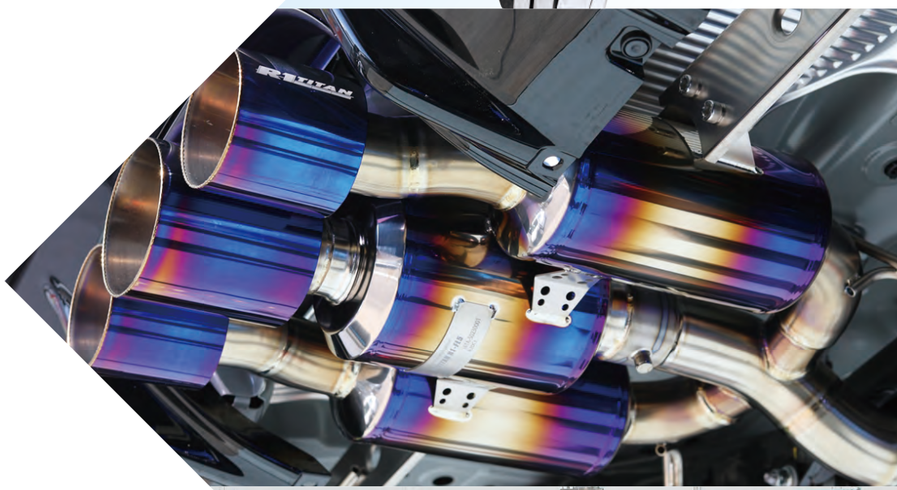
NIPPON STEEL

Titanium

Titanium Products



NET ZERO
NIPPON STEEL
Green Transformation
initiative

NIPPON STEEL CORPORATION

Introduction

Titanium, which was found in the 1790s, is the 4th most abundant practical metal existing in the upper crust of the earth. It has taken a long time before an industrial refining process for titanium was reached to completion, and not until 1946 did industrial production of this new metal, titanium begin. The metal was adopted for aerospace applications for the beginning, owing to its specific strength. And then, the demand for titanium, which also has outstanding corrosion resistance, began to increase markedly for such applications as Chemical industries and Electric power generation. Today, titanium is a well-known material for its character from aesthetic and for environmental and biological conformity. Titanium, which has excellent physical properties and is friendly to the environment, meets contemporary needs from the world and has a great potential for an expected growth in the future.

NIPPON STEEL, as a world top-class comprehensive producer of titanium mill products, supplies its high-function, high-quality products and services to the customers.

Based on the results of basic studies of titanium which has been obtained for many decades, with its more strengthened organization and staffs of research and development, we continue R&D for various fields of titanium application, such as Chemical industries, Electric power generation, Seawater desalination, Civil engineering, Architecture, Automotive, Consumer appliances, and Aerospace industries, etc. We are also developing new applications of titanium actively aiming to customers' needs.

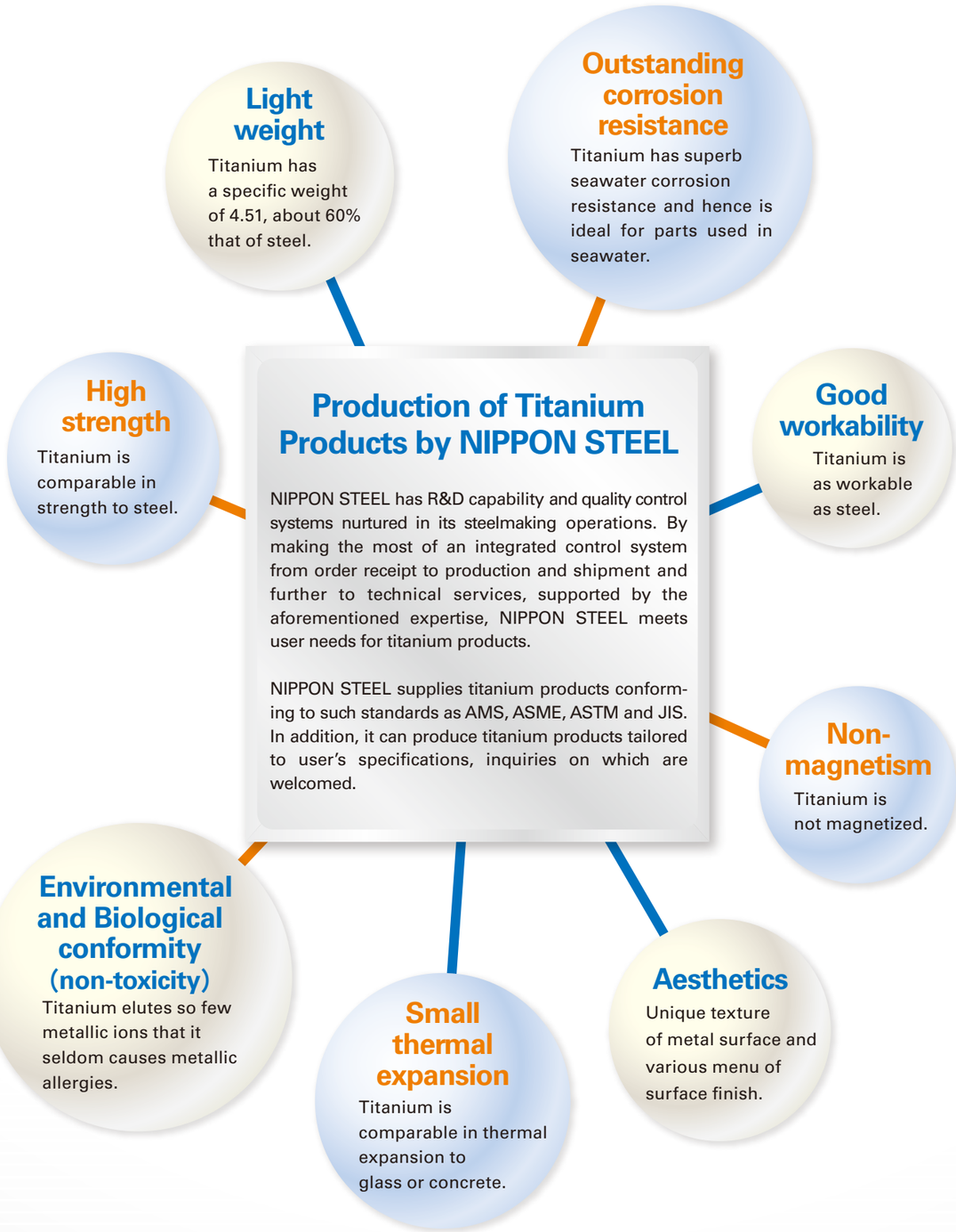
NIPPON STEEL is to pursue the infinite potential of the contemporary metal, "Titanium".

CONTENTS

Our titanium products have passed third-party verification under the SuMPO Environmental Label Program, managed by the Sustainable Management Promotion Organization (SuMPO), and have obtained the SuMPO Environmental Product Declaration (EPD). The SuMPO EPD we have acquired quantitatively evaluates the environmental impact from the raw material procurement to the manufacturing process, as well as the recycling effects.

JR-BZ-24002E	Titanium Plates TranTixxii-Eco	https://ecoleaf-label.jp/epd/1641
JR-BZ-24001E	Titanium Plates	https://ecoleaf-label.jp/epd/1640
JR-BZ-23002E	Titanium Coils/Sheets TranTixxii-Eco	https://ecoleaf-label.jp/epd/1090
JR-BZ-23001E	Titanium Coils/Sheets	https://ecoleaf-label.jp/epd/1089

Characteristics of Titanium



Titanium Mill Production Flow

Processes dedicated to Titanium (Refining, Melting)

*1
Chlorination
Distillation
Reduction
Vacuum Separation
Crushing
Compact Pressing
EB melting
Ti scrap
VAR melting
Ingot
Slabbing Billeting
Slab
Billet

Equipment shared with Steel Manufacturing

Plate rolling
Finish Plate rolling
Plates
Hot rolling
Hot rolled coil
Hot rolled coils/sheets
Cold rolling
Cold rolled Coils
Cold rolled sheets

*2
Bar forging/rolling(outsourced to partnered companies)
Bars
Rolling
Wires, Rods

*1) Purchasing titanium sponge from TOHO TITANIUM CO., LTD. or other sources.
*2) xxxxxxxxx

Hot and Cold Rolled Coils / Sheets

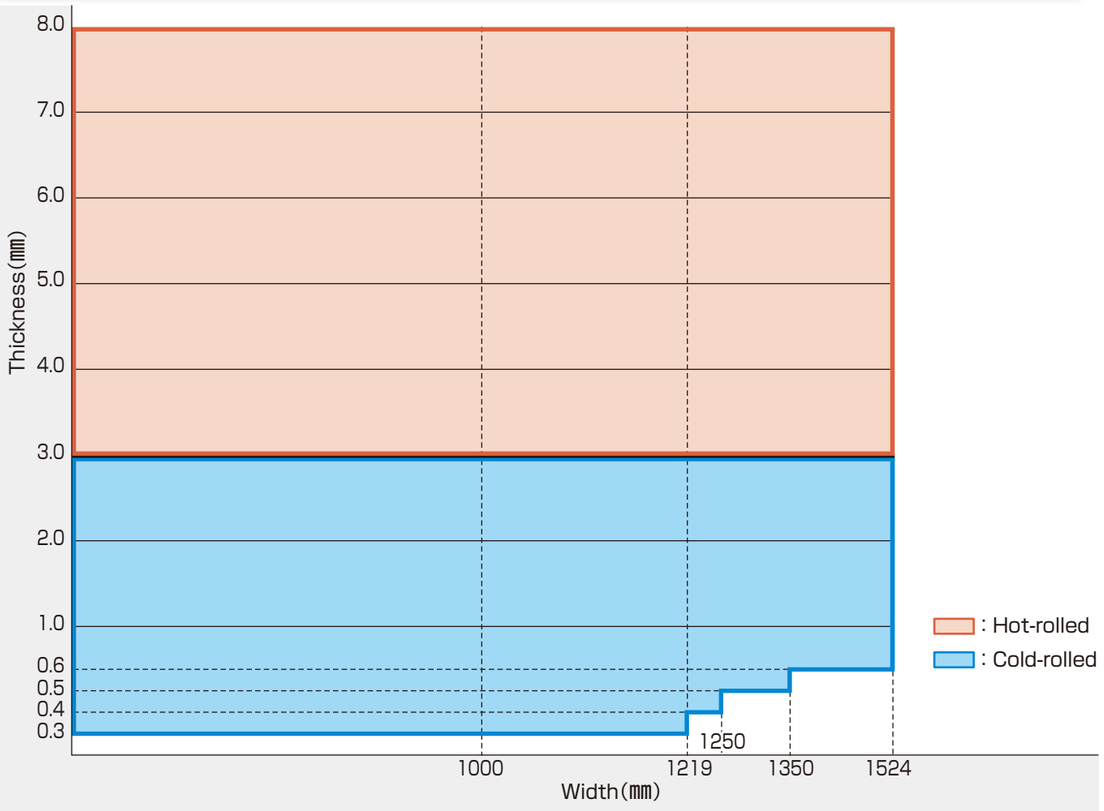
Applicable standards

Standard	Grade
AMS	AMS4900, AMS4901, AMS4902, AMS4914, AMS4940, AMS4947
ASME SB 265	Gr.1, Gr.2, Gr.3, Gr.4, Gr.7, Gr.11, Gr.13, Gr.14, Gr.16, Gr.17, Gr.30, Gr.31
ASTM B265	Gr.1, Gr.2, Gr.3, Gr.4, Gr.7, Gr.11, Gr.13, Gr.14, Gr.16, Gr.17, Gr.30, Gr.31
JIS H 4600	Class 1, Class 2, Class 3, Class 4, Class 11, Class 12, Class 13, Class 17, Class 19, Class 20, Class 21, Class 22
Company specifications	Ti-20V-4Al-1Sn (β alloy), Super-TIX™10CSSN-1,Super-TIX™10CU Super-TIX™10CUNB, Super-TIX™800, Super-TIX™51AF, Super-TIX™52AFS
Others	Ti-15V-3Cr-3Sn-3Al

Surface finish

Bright annealing / Annealing & pickling ※ Please consult us for any other surface finish.

Available sizes



(Note 1) For ASTM Gr.3 (JIS Class 3) or higher grades, please consult us when placing an order.
(Note 2) For ASTM Gr.1 (JIS Class 1), 0.20mm thick x 1219mm wide coils are available.

Titanium Coils / Sheets for Architecture & Design Use

Designing Titanium TranTixxii™

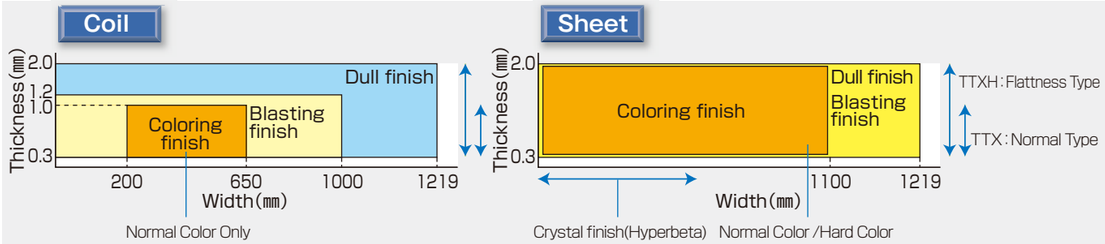
Applicable standard

Standard	Grade
ASME SB 265	Gr 1 or Gr 1 or Gr 1 equivalent (TTX:Normal Type, TTXH:Flattness Type)
ASTM B265	Gr 1 or Gr 1 equivalent (TTX:Normal Type, TTXH:Flattness Type)
JIS H 4600	Class 1 or Class 1 equivalent (TTX:Normal Type, TTXH:Flattness Type)

Surface finish

Texture × Color	Dull finish, Blasting finish, Bright finish, Hairline finish, Crystal finish(Hyperbeta)
	Coloring finish (Normal Color / Hard Color), IP Coloring finish [*UV Proof/VOC free]
Stable Color	Special Treatment (Less-Subject to Discoloration Technology)

Available sizes



Please consult us for other sizes.

Please refer to our website for our standard size range.

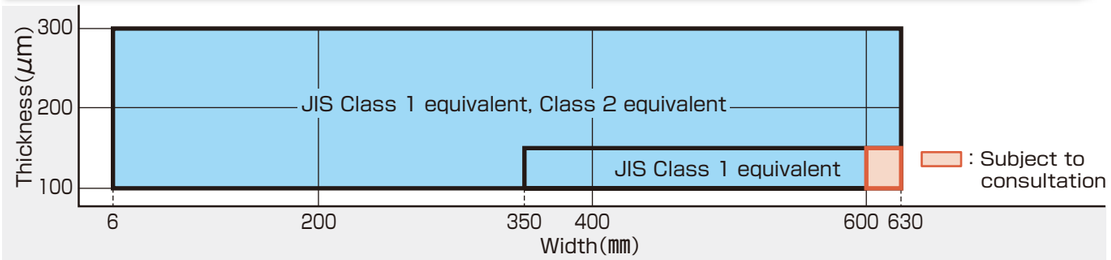
※ Anodised finish is applicable to sheets 2400 mm or less in length. Please consult us for other sheet sizes.

Titanium Foils

Applicable standards

Standard	Grade
ASME SB 265	Gr.1 equivalent
ASTM B265	Gr.1 equivalent
JIS H 4600	Class 1 equivalent, Class 2 equivalent

Available sizes



(Note 1) Commercial rights for foils less than 100μm in thickness has been transfered to NIPPON STEEL Chemical & Material Co., Ltd.

Plates

Applicable standards

● ASME SB 265 ● ASTM B265 ● JIS H 4600

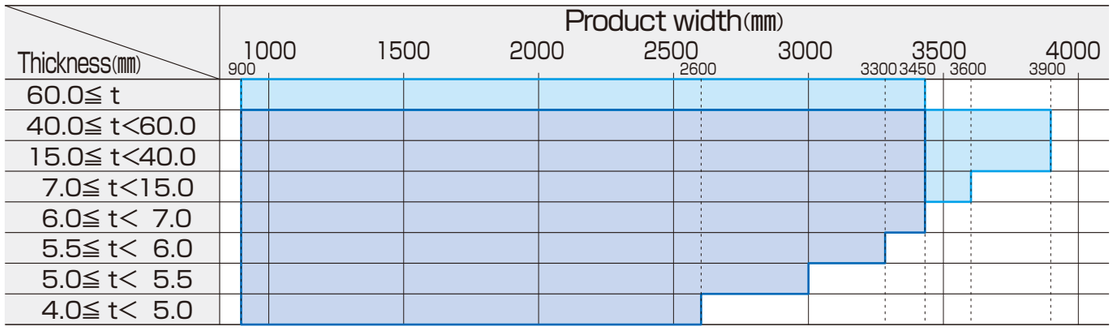
Surface finish

Pickling, Polishing

Available grades and size range

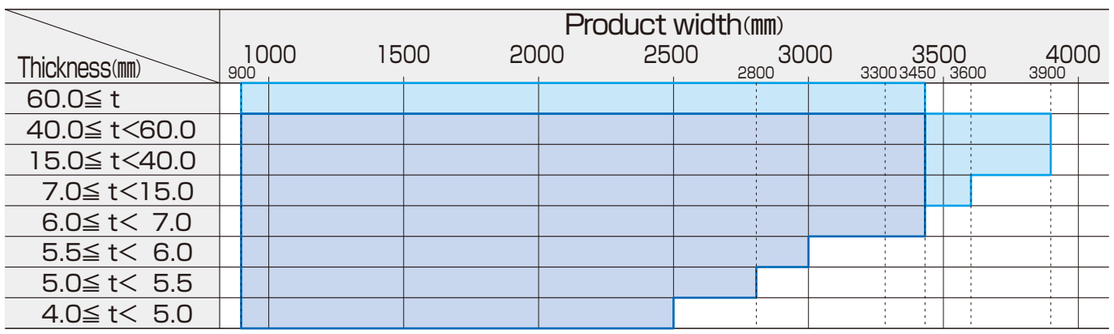
Available grades

● ASME Gr.1 ● ASTM Gr.1 ● JIS TP270H
● ASME Gr.11 ● ASTM Gr.11 ● JIS TP270PdH
● ASME Gr.17 ● ASTM Gr.17 ● JIS TP240PdH



Available grades

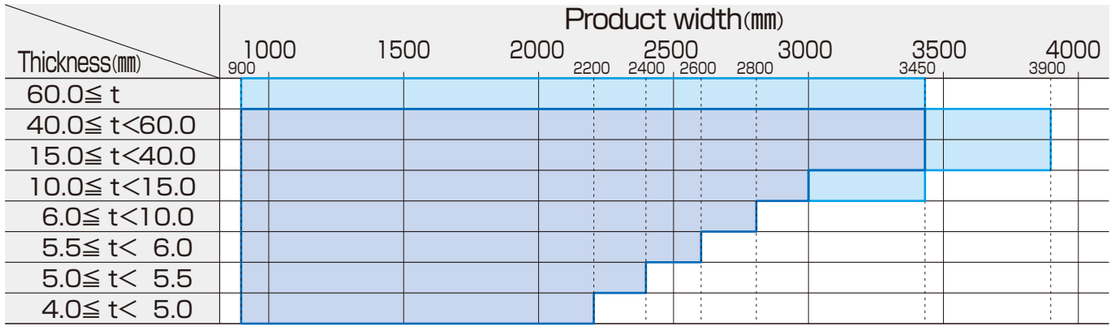
● ASME Gr.2 ● ASTM Gr.2 ● JIS TP340H
● ASME Gr.7 ● ASTM Gr.7 ● JIS TP340PdH



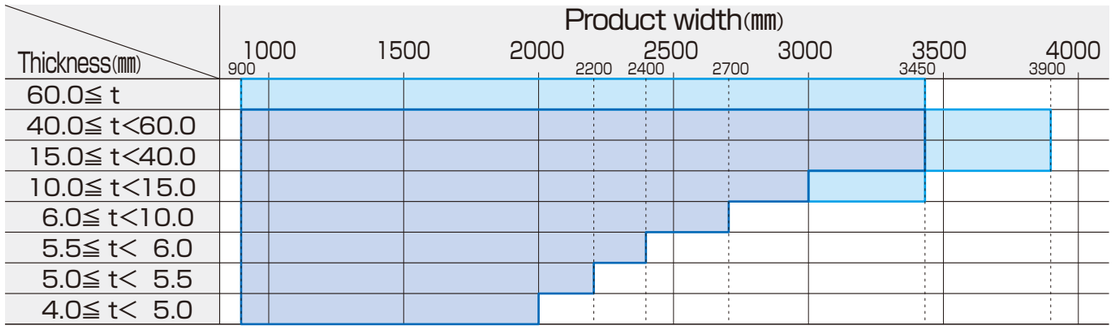
: Available size range : Please consult us when placing an order.

(Note) The maximum product length is 10000 mm (10 m).
Please consult us for products whose length is in the range 10000～14000 mm.

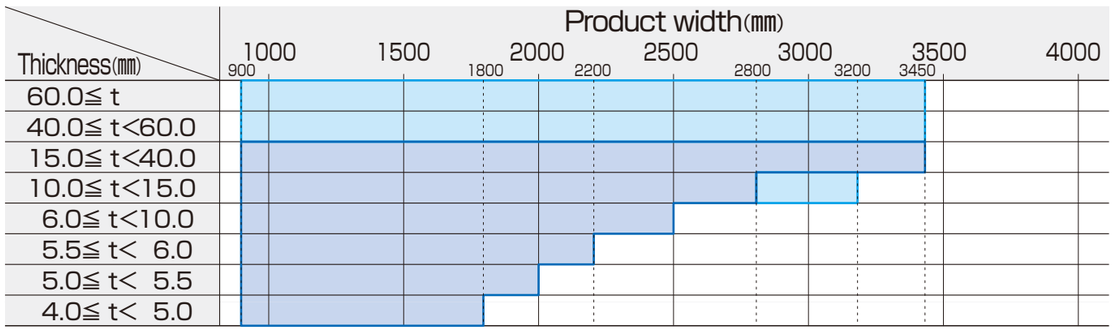
Available grades ● JIS TP480H ● JIS TP480PdH



Available grades ● ASME Gr.3 ● ASTM Gr.3



Available grades ● ASME Gr.4 ● ASTM Gr.4 ● JIS TP550H



: Available size range : Please consult us when placing an order.

(Note) The maximum product length is 10000 mm (10 m).
Please consult us for products whose length is in the range 10000～14000 mm.

Available grades ● ASME Gr.5 ● ASTM Gr.5 ● JIS TAP6400H

Available sizes please consult us.

Wire Rods and Bars

Applicable standards

	Standard	Grade
Wire rods	Equivalent of ASTM B348·B863	Gr.1, Gr.2, Gr.3, Gr.4, Gr.7, Gr.9(Ti-3Al-2.5V), Gr.19(Ti-3Al-8V-6Cr-4Mo-4Zr)
	Equivalent of JIS H 4650·H4670	Class 1, Class 2, Class 3, Class 4, Class 11, Class 12, Class 13, Class 61, 15-3-3-3 (TIS1736)
	Company specifications	Super-TIX™800, Super-TIX™51AF, Super-TIX™523AFM, 15-3-3-3 equivalent
Bars	ASTM B348	Gr.5
	JIS H 4650	Class 2
	Company specifications	Super-TIX™800, Super-TIX™51AF, Super-TIX™523AFM, SSAT™-2041CF

(Please consult us for any other materials to be applied to Bars.)

Surface finishes

Wire rods SF(Super Finish※), SF + Annealing, SF + Annealing + Pickling ※Special peeling finish.

Bars Peeling
(Please consult us for any other surface finish.)

Available sizes

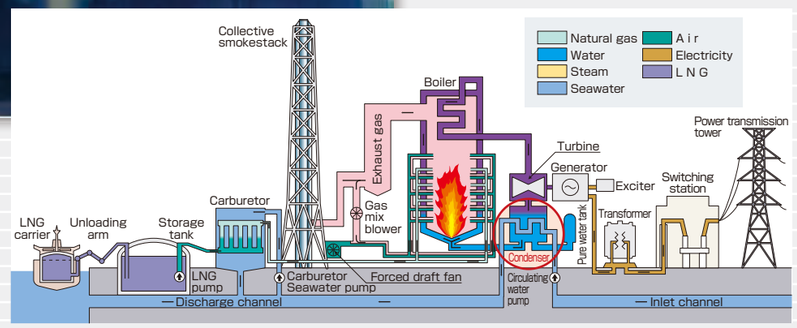
Wire rods φ6.0, φ6.5, φ7.0, φ7.5, φ9.5, φ12.0, φ15.0, φ15.5 (mm)
(Please consult us for any other product size.)

Bars φ8～φ350 (mm)
(Please consult us for any other product size.)

Examples of Applications of Titanium

Electric Power, Energy and Seawater Desalination

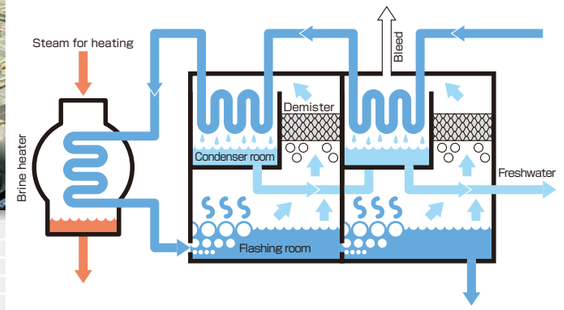
Ordinary thermal power generation (using LNG)



Ras Az Zawr Phase-1 Package "D"

Seawater Desalination Plant (MSF)

Principle of operation of multi-stage flash (MSF) distillation process

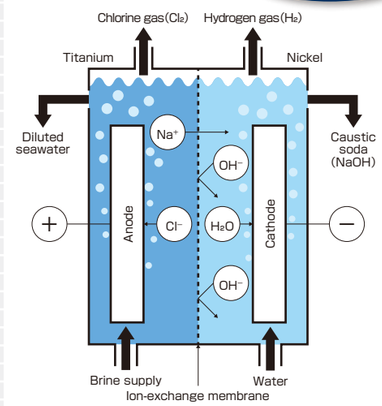


Examples of Applications of Titanium

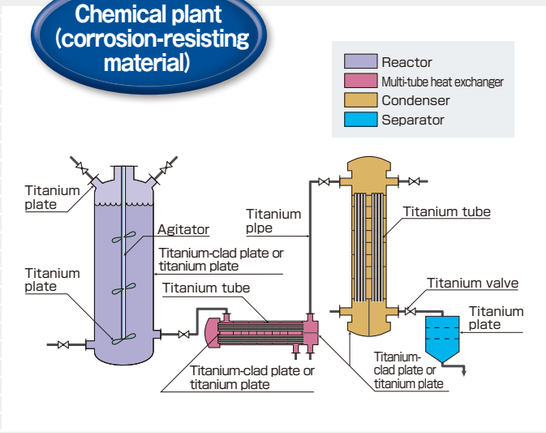
Chemical Plants and Electrolysis

General view of soda electrolytic tank

Conceptual diagram of electrolytic tank with ion exchange membrane



Chemical plant (corrosion-resisting material)



General view of wet-type Nickel Refining Plant

Conceptual diagram of Nickel Refining Plant

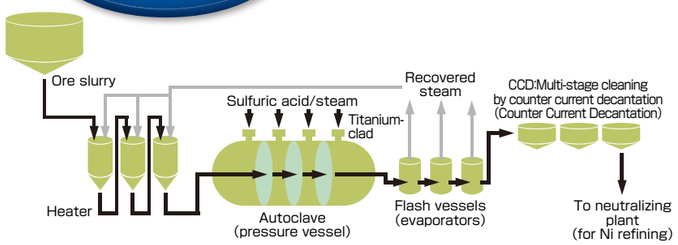
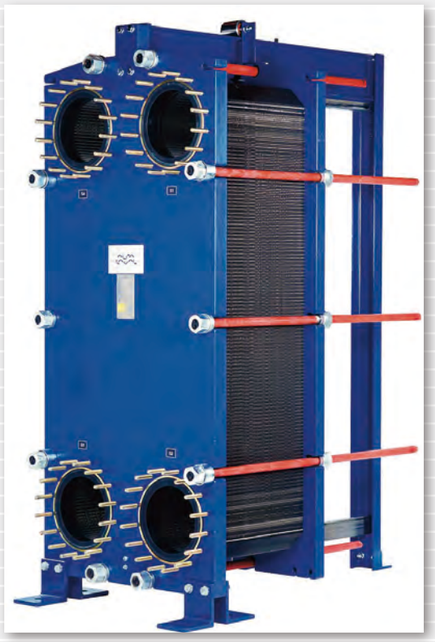
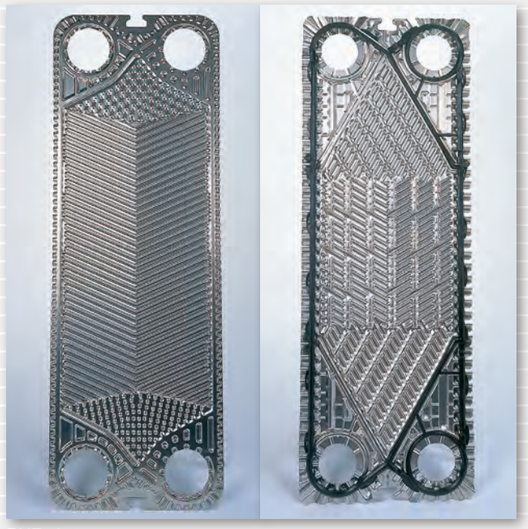


Plate Heat Exchanger (PHE)

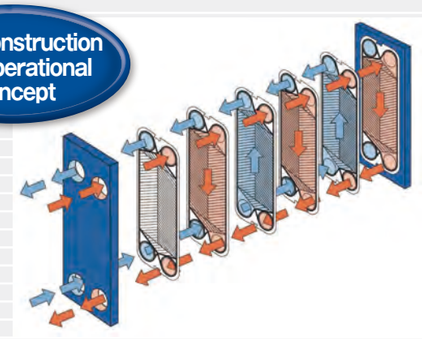


PHE equipment



PHE plate

PHE construction and operational concept

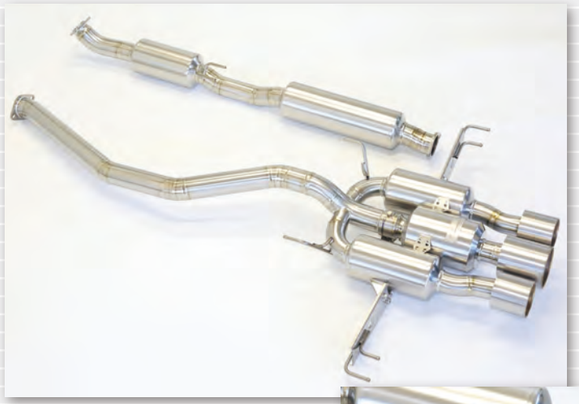


Aircraft (Fuselage, Jet Engine)

Airbus A350-1000

Examples of Applications of Titanium

Automobiles, Consumer Appliances, Sports and Medical Care



Amuse CIVIC exhaust system

YAMAHA YZF-R1

CASIO OCEANUS

Provided by: Snow Peak Co., Ltd.

SNOWPEAK Aurora Bottle

DUNLOP XXIO12

Eyeglassesframe

Civil Engineering and Architectural Materials

Hozo-mon Gate (Nio-mon Gate) of Kinryuzan Sensoji Temple

Kyushu National Museum

Katase-Enoshima Station

Hirosaki Museum of Contemporary Art

Marques de Riscal Winery Hotel

Tokyo International Airport D-runway pier

Standards of Titanium Products [Commercially-Pure Titanium/Corrosion-Resistant Titanium Alloys]

Classification	Standard	Chemical composition [mass%]										Tensile properties		
		C	H	O	N	Fe	Pd	Co	Ru	Ni	Ti	0.2%proof stress [MPa]	Tensile strength [MPa]	Elongation [%]
Commercially-Pure titanium	ASTM/ASME Grade1	≦0.08	≦0.015	≦0.18	≦0.03	≦0.20	–	–			rem.	138–310	≧240	≧24
	ASTM/ASME Grade2	≦0.08	≦0.015	≦0.25	≦0.03	≦0.30	–	–			rem.	275–450	≧345	≧20
	ASTM/ASME Grade3	≦0.08	≦0.015	≦0.35	≦0.05	≦0.30	–	–			rem.	380–550	≧450	≧18
	ASTM/ASME Grade4	≦0.08	≦0.015	≦0.40	≦0.05	≦0.50	–	–			rem.	483–655	≧550	≧15
	JIS Class 1	≦0.08	≦0.013	≦0.15	≦0.03	≦0.20	–	–			rem.	≧165	270–410	≧27
	JIS Class 2	≦0.08	≦0.013	≦0.20	≦0.03	≦0.25	–	–			rem.	≧215	340–510	≧23
	JIS Class 3	≦0.08	≦0.013	≦0.30	≦0.05	≦0.30	–	–			rem.	≧345	480–620	≧18
	JIS Class 4	≦0.08	≦0.013	≦0.40	≦0.05	≦0.50	–	–			rem.	≧485	550–750	≧15
Corrosion-resistant titanium alloys	ASTM/ASME Gr.17	≦0.08	≦0.015	≦0.18	≦0.03	≦0.20	0.04–0.08	–			rem.	138–310	≧240	≧24
	ASTM/ASME Gr.30	≦0.08	≦0.015	≦0.25	≦0.03	≦0.30	0.04–0.08	0.20–0.80			rem.	275–450	≧345	≧20
	ASTM/ASME Gr.31	≦0.08	≦0.015	≦0.35	≦0.05	≦0.30	0.04–0.08	0.20–0.80			rem.	380–550	≧450	≧18
	JIS Class 17	≦0.08	≦0.015	≦0.18	≦0.03	≦0.20	0.04–0.08	–			rem.	≧170	240–380	≧24
	JIS Class 19	≦0.08	≦0.015	≦0.25	≦0.03	≦0.30	0.04–0.08	0.20–0.80			rem.	≧275	345–515	≧20
	JIS Class 20	≦0.08	≦0.015	≦0.35	≦0.05	≦0.30	0.04–0.08	0.20–0.80			rem.	≧380	450–590	≧18
	ASTM/ASME Grade11	≦0.08	≦0.015	≦0.18	≦0.03	≦0.20	0.12–0.25	–			rem.	138–310	≧240	≧24
	ASTM/ASME Grade7	≦0.08	≦0.015	≦0.25	≦0.03	≦0.30	0.12–0.25	–			rem.	275–450	≧345	≧20
	JIS Class 11	≦0.08	≦0.013	≦0.15	≦0.03	≦0.20	0.12–0.25	–			rem.	≧165	270–410	≧27
	JIS Class 12	≦0.08	≦0.013	≦0.20	≦0.03	≦0.25	0.12–0.25	–			rem.	≧215	340–510	≧23
	JIS Class 13	≦0.08	≦0.013	≦0.30	≦0.05	≦0.30	0.12–0.25	–			rem.	≧345	480–620	≧18
	ASTM/ASME Grade13	≦0.08	≦0.015	≦0.10	≦0.03	≦0.20			0.04–0.06	0.4–0.6	rem.	≧170	≧275	≧24
	ASTM/ASME Grade14	≦0.08	≦0.015	≦0.15	≦0.03	≦0.30			0.04–0.06	0.4–0.6	rem.	≧275	≧410	≧20
	JIS Class 21	≦0.08	≦0.015	≦0.10	≦0.03	≦0.20			0.04–0.06	0.40–0.60	rem.	≧170	275–450	≧24
	JIS Class 22	≦0.08	≦0.015	≦0.15	≦0.03	≦0.30			0.04–0.06	0.40–0.60	rem.	≧275	410–530	≧20

Standards of Titanium Products [Titanium Alloys]

Alloy classification	Nominal composition or company standard	Product form			Chemical composition (mass%)													Examples of Tensile properties at room temperature (minimum values)				Advantageous features	Main related standards, etc.
		Plate	Sheet	Bar/ wire rod	Al	V	Mo	Cr	Zr	Sn	Si	Cu	Nb	Fe	O	N	C	Heat treatment *	0.2%proof stress min.(MPa)	Tensile strength min.(MPa)	Elongation min. (%)		
α + β alloy	Ti-3Al-2.5V			○	2.5–3.5	2.0–3.0								≦0.25	≦0.15	≦0.03	≦0.08	Annealing	485	620	15	Good cold formability	ASTM Gr.9
																			483	620	15		JIS Class 61
	Ti-6Al-4V			○	5.5–6.75	3.5–4.5								≦0.40	≦0.20	≦0.05	≦0.08	Annealing	828	895	10	Versatility	ASTM Gr.5
β alloy	Ti-3Al-8V-6Cr-4Mo-4Zr			○	3.0–4.0	7.5–8.5	3.5–4.5	5.5–6.5	3.5–4.5					≦0.30	≦0.14 ≦0.12	≦0.03	≦0.05	ST STA	759 1100	793 1170	15 4	Good cold formability Good age hardenability	ASTM Gr.19, β-C
	Ti-15V-3Cr-3Sn-3Al		○*	○	2.5–3.5	14.0–16.0		2.5–3.5		2.5–3.5				≦0.25	≦0.13	≦0.05	≦0.05	ST STA	689 965	703 1100	12 7	Good Cold formability Good age hardenability	AMS4914* TIS1736
Company standard product	Super-TIX™800		○	○										0.50–1.50	0.25–0.45	≦0.02	≦0.08	Annealing	550	700	10	High strength between Gr. 9 (Class 61) and Gr. 5 (Class 60)	Original
	Super-TIX™800N	○												0.50–1.50	0.20–0.40	0.02–0.05	≦0.08	Annealing	550	700	10	High strength between Gr. 9 (Class 61) and Gr. 5 (Class 60)	Original
	Super-TIX™51AF(Ti-5Al-1Fe)		○	○	4.50–5.50									0.50–1.50	≦0.25	≦0.05	≦0.08	Annealing	700	800	10	High strength comparable to Gr. 5 (Class 60)	Original, AMS4947
	Super-TIX™52AFS		○		Confidential													–	–	–	–	High strength comparable to Gr.5, Cold formability	Original
	Super-TIX®523AFM(Ti-5Al-2Fe-3Mo)			○	4.50–5.50		2.5–3.5							1.50–2.50	≦0.25	≦0.05	≦0.08	STA	1150 1120 1100	1300 1250 1200	6 8 10	Strength superior to Gr. 5 (Class 60) Adjustable depend on HT	Original
																		Annealing	870	950	10	Strength superior to Gr. 5 (Class 60)	
	Super-TIX™05CU(Ti-0.5Cu)	○										0.40–0.70		≦0.20	≦0.18	≦0.03	≦0.08	Annealing	165	270	27	Homogeneous structure	Original
	Super-TIX™10CU(Ti-1Cu)		○									0.80–1.20		≦0.20	≦0.15	≦0.03	≦0.08	Annealing	270	360	35	Good heat resistance	Original
	Super-TIX™10CUNB(Ti-1Cu-0.5Nb)		○									0.80–1.20	0.40–0.60	≦0.20	≦0.15	≦0.03	≦0.08	Annealing	270	360	35	Good heat resistance	Original
	Super-TIX™10CSSN-1(Ti-1Cu-1Sn-0.20Si-0.40Nb)		○								0.10–0.35	0.80–1.50	0.30–0.50	≦0.20	≦0.15	≦0.03	≦0.08	Annealing	270	395	20	Good heat resistance	Original
	Super-TIX20™AFG (Ti-2Al-0.2Fe)		○		1.50–2.50									0.10–0.30	≦0.15	≦0.05	≦0.08	Annealing	250	370	18	Good polishability Good machinability	Original
	Ti-20V-4Al-1Sn		○		3.0–3.6	19.0–22.5				0.80–1.20				≦0.20	≦0.20	≦0.05	≦0.08	ST STA	600 950	630 1050	15 10	Good cold formability	Original

*: Please consult us when placing an order.

*ST : Solution treatment STA : Solution treatment + aging

Technical Data

Physical Properties

The advantageous physical properties of pure titanium are as follows.

①Light weight 【Specific gravity】(60% of specific gravity of steel and about 1.7 times that of aluminum)
②Low thermal expansion 【Hermal expansion coefficient】(ne-half that of 18-8 stainless steel and one-third that of aluminum)
③Low hear conductivity 【Heat conductivity】(nearly the same as 18-8 stainless steel)
④Low electric conductivity 【Electric conductivity】(about 3% of copper)
⑤High flexibility 【Longitudinal elastic modulus】(one-half of iron or stainless steel and the same as copper)
⑥6 Non-magnetism 【Magnetic permeability】(non-magnetic material; magnetic permeability = 1.0001)

Comparison of physical properties between titanium and other metallic materials

Item	Atomic number	Atomic weight	Specific gravity	Melting point (℃)	Linear expansion coefficient (/K)	Specific heat (KJ/Kg·K)	Thermal conductivity (w/m·K)	Specific resistivity (μΩ·m)	Electric conductivity (% ratio to copper)	Young's modulus (GPa)
Titanium	22	47.90	4.51	1668	8.4×10^{-6}	0.519	17	0.55	3.1	106.3
titanium alloy Ti-6Al-4V	—	—	4.43	1650	8.8×10^{-6}	0.610	7.5	1.71	1.1	110
Iron	26	55.85	7.9	1530	12×10^{-6}	0.460	63	0.097	18	205.8
18-8stainless steel (SUS 304)	—	—	7.9	1400 ~1420	17×10^{-6}	0.502	16	0.72	2.4	199.9
Aluminum	13	26.97	2.7	650	23×10^{-6}	0.879	205	0.027	64	69.1
Aluminum alloy (7075)	—	—	2.8	476 ~638	23×10^{-6}	0.962	121	0.058	30	71.5
Magnesium	12	24.32	1.7	650	25×10^{-6}	1.004	159	0.043	40	44.8
Nickel	28	58.69	8.9	1453	15×10^{-6}	0.460	92	0.095	18	205.8
Hastelloy C	—	—	8.9	1305	11.3×10^{-6}	0.385	13	1.3	1.3	204.4
Copper	29	63.57	8.9	1,083	17×10^{-6}	0.385	385	0.017	100	107.8

Note) 18-8 stainless steel : Cr(18%)-Ni(8%)-Fe(R)
Aluminum alloy 7075 : Super-super duralumin
[Cu(1.6%)-Mg(2.5%)-Cr(2.3%-Zn(5.6%)-Al(R) subjected to solution heat treatment and aging)
Hastelloy C : 54Ni-17Mo-15Cr-5Fe-4W

■ Properties other than those shown above
Crystal structure
α titanium (885℃ or lower) : Close-packed hexagonal lattice
β titanium (above 885℃) : Body-centered cubic lattice
Latent heat of fusion : 60.7 J/g, relative magnetic permeability : 1.0001 (Source: Japan Titanium Society)

Corrosion Resistance

Comparison of corrosion resistance between titanium and other metallic materials

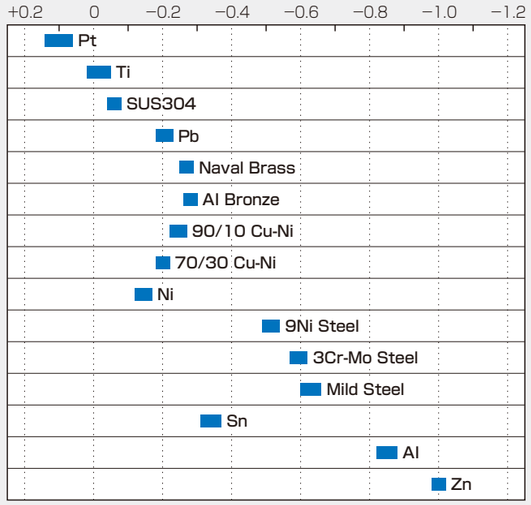
Corroding medium	Composition (%)	Temperature (℃)	Corrosion resistance: Titanium	18-8 stainless steel	Hastelloy C
Hydrochloric acid	10	24	○	×	◎
	30	24	×	×	◎
	10	80	×	–	○
	30	80	×	–	△
Sulfuric acid	10	24	△	–	◎
	50	24	×	×	◎
	10	100	×	–	◎
	50	100	×	–	◎
Nitric acid	10	24	◎	◎	◎
	50	24	◎	◎	–
	10	100	◎	◎	△
	50	100	◎	○	–
Aqua regia	$HCl{:}HNO_3$ 3 : 1	24	◎	×	△
		100	○	–	–
Chromic acid	5	24	◎	–	◎
Hydrogen fluoride	5	30	×	×	△
Phosphoric acid	10(with aeration)	24	○	◎	◎
	50(with aeration)	24	△	◎	◎
	10(with aeration)	100	×	◎	◎
	50(with aeration)	100	×	○	◎
Ferric chloride	10	24	◎	×	◎
	30	24	◎	×	◎
	10	100	◎	–	×
	30	100	◎	–	×
Cupric chloride	10	24	○	×	○
	30	24	○	×	○
	10	100	○	–	–
	30	100	○	–	–
Sodium chloride	10	24	◎	○	○
	40	24	◎	○	○
	10	100	◎*	○*	○
	40	100	◎*	○*	○
Calcium chloride	10	24	◎	◎	◎
	50	24	◎	○	◎
	10	100	◎*	–	◎
	50	100	◎*	×	◎
Ammonium chloride	10	24	◎	△	◎
	40	24	◎	–	◎
	10	100	◎*	–	◎
	40	100	◎*	–	◎
Magnesium chloride	10	24	◎	△	◎
	40	24	◎	○	◎
	10	100	◎*	△*	◎
	40	100	◎*	–	◎
Ferrous sulfate	10	24	◎	○	○
	50	24	◎	○	○
	10	100	◎	○	○
	50	100	◎	–	○

Corroding medium	Composition (%)	Temperature (℃)	Corrosion resistance: Titanium	18-8 stainless steel	Hastelloy C
Ammonia	10	24	◎	◎	◎
	30	24	◎	◎	◎
	10	80	◎	○	○
	30	80	◎	○	◎
Caustic soda	10	24	◎	◎	◎
	50	24	◎	◎	–
	10	100	◎	◎	◎
	50	100	○	○	◎
Carbonic soda	10	24	◎	◎	◎
	30	24	–	–	–
	10	100	◎	◎	◎
	30	100	◎	◎	◎
Hydrogen sulfide	Dry gas	24	◎	△	◎
	Wet gas	24	◎	○	○
Chlorine	Dry gas	24	×	–	◎
	Wet gas	24	◎	–	△
	Dry gas	100	–	◎	○
	Wet gas	90	◎	–	△
Sulfur dioxide	Dry gas	30~60	◎	–	–
	Wet gas	30~90	◎	–	–
Seawater	Rapidly flowing water	24	◎	–	–
	Still water	100	◎*	–	◎
Acetic acid	10	24	◎	◎	◎
	60	24	◎	◎	◎
	10	100	◎	◎	◎
	60	100	◎	○	◎
Formic acid	10	24	○	○	◎
	50	24	○	○	◎
	10	100	○	×	◎
	30	100	×	×	◎
Lactic acid	10	24	◎	○	○
	50	24	◎	○	◎
	10	100	◎	○	○
	50	100	◎	×	○
Oxalic acid	10	24	○	○	○
	20	52	×	–	○
	50	24	–	○	○
	10	100	–	–	○
	50	100	–	×	○
Citric acid	10	24	◎	○	◎
	50	24	◎	○	◎
	10	100	◎	○	◎
	50	100	×	×	◎

Note) *There are cases in which pitting or other local corrosion occurs with the material.
Corrosion rate ◎ : <0.127 ○ : <0.127~0.508
△ : 0.508~1.27 × : >1.27mm/year
(Source: Japan Titanium Society)

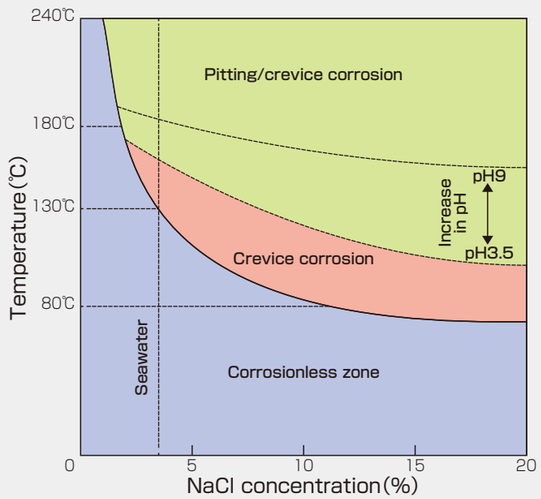
Corrosion Resistance in Seawater

Corrosion potential in seawater (flowing water)



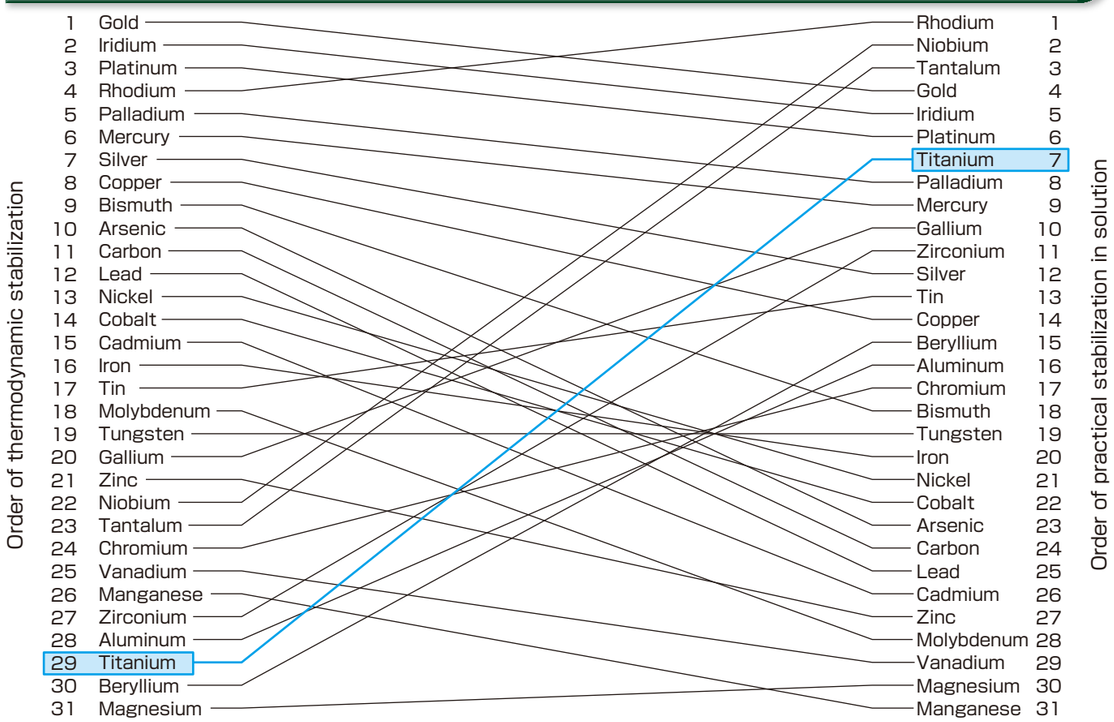
Use of Sumitomo Metal's brochure : Since 2007

Influences of temperature, concentration and pH on pitting/crevice corrosion of commercially pure titanium in salty water



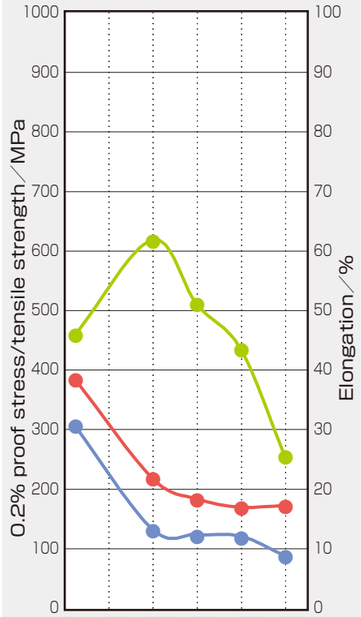
Use of Sumitomo Metal's brochure : Since 2007

Orders of Stabilization of Metals

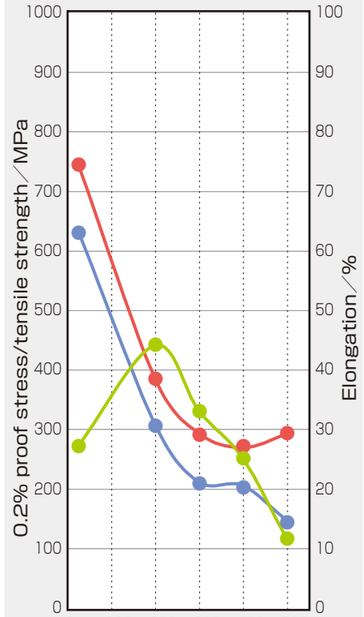


Tensile Properties in High Temperature

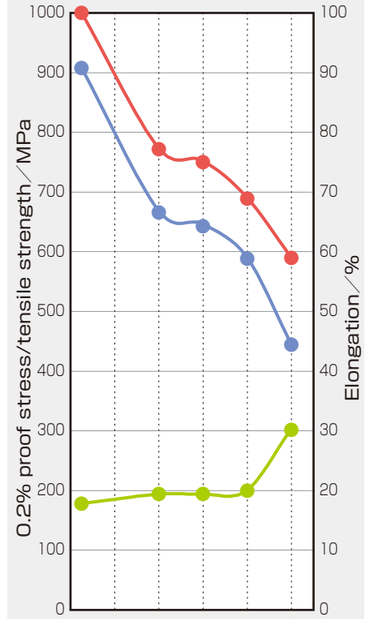
Commercially pure titanium Class 2



Commercially pure titanium Class 4



Ti-6Al-4V Titanium Alloy



0.2% proof stress　Tensile strength　Elongation

Clarke Number (Note)

Rank	Element		Proportion of existence(%)	Cumulative total
1	Oxygen	O	49.50	49.5
2	Silicon	Si	25.80	75.3
3	Aluminum	Al	7.56	82.9
4	Iron	Fe	4.70	87.6
5	Calcium	Ca	3.39	91.0
6	Sodium	Na	2.63	93.6
7	Potassium	K	2.40	96.0
8	Magnesium	Mg	1.93	97.9
9	Hydrogen	H	0.87	98.8
10	Titanium	Ti	0.46	99.2
11	Chlorine	Cl	0.19	99.4
12	Manganese	Mn	0.09	99.5
13	Phosphorus	P	0.08	99.6
14	Carbon	C	0.08	99.7
15	Sulfur	S	0.06	99.7

Rank	Element		Proportion of existence(%)	Cumulative total
16	Nitrogen	N	0.03	99.8
17	Fluorine	F	0.03	99.8
18	Rubidium	Rb	0.03	99.8
19	Barium	Ba	0.02	99.9
20	Zirconium	Zr	0.02	
21	Chromium	Cr	0.02	
22	Strontium	Sr	0.02	
23	Vanadium	V	0.015	
24	Nickel	Ni	0.010	
25	Copper	Cu	0.010	
26	Tungsten	W	0.006	
27	Lithium	Li	0.006	
28	Cerium	Ce	0.005	
29	Cobalt	Co	0.004	
30	Tin	Sn	0.004	

Note) Clarke Number is defined as orders in composition of element to be existing in upper crust of the earth. (Source: Kagaku Daijiten(Chemical Encyclopedia))
Titanium is the 4th most abundant of practical metals existing in upper crust of the earth, following Aluminum, Iron and Magnesium.