Austral Wright Metals
at the cutting edge

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PRODUCT DATA SHEET

Titanium Grade 2

UNS R50400

Titanium Alloys

Titanium grade 2 is commercially pure titanium. It has outstanding corrosion resistance and useful strength (similar to austenitic stainless steels) at low density. It has good weldability and is easily formable. It is the most commonly used grade of titanium.

Typical Applications Most of the applications of this grade are in the chemical industries. The most common uses are reactor autoclaves, piping and fittings, valves, heat exchangers and condensers.

Chemical Composition

(ASTM B338 – Seamless & welded titanium & titanium alloy tubes for condensers & heat exchangers)

Element	%	Element	%
Titanium	Balance	**Iron**	0.30 max
Nitrogen	0.03 max	**Oxygen**	0.25 max
Carbon	0.08 max	**Residuals, each**	0.1 max
Hydrogen	0.015 max	**Residuals, total**	0.4 max

Specified Minimum Mechanical Properties

(ASTM B338 – Seamless & welded titanium & titanium alloy tubes for condensers & heat exchangers)

	Annealed
0.2% Proof Stress, MPa	275 – 450
Tensile Strength, MPa	345
Elongation, %	20

Description Titanium grade 2 is a commercially pure grades. It has excellent corrosion resistance in oxidising conditions, and is effectively immune from stress corrosion cracking, pitting corrosion and crevice corrosion in chloride solutions below 70°C. Titanium grade 2 is widely used in heat exchangers, where despite the low thermal conductivity of titanium the efficiency of heat transfer is high due to good strength, high resistance to erosion corrosion and the fouling resistance of the hard, smooth surface.

At room temperature grade 2 is an alpha alloy. It transforms to beta phase at 913 ±15°C, and the alpha phase returns on cooling 890 ±15°C.

Titanium is reactive, with a very high affinity for oxygen, which forms a skin of very stable and highly adherent oxide. The skin gives excellent corrosion resistance, despite the reactivity of the metal. The oxide layer forms spontaneously and rapidly on exposure to the atmosphere. However, when new parent metal is exposed to anhydrous conditions or in the absence of air, rapid corrosion may occur. Care should also be taken if titanium is to operate in contact with hydrogen, as hydrogen embrittlement from hydride formation can increase strength, with loss of ductility.

Austral Wright Metals can supply this alloy as plate, sheet and strip, rod and bar, seamless and welded pipe, weld fittings, seamless and welded tube, forging billet and forgings. It is widely used as tube in condensers and heat exchangers.

Pressure Vessels AS1210 & ASME Boiler & Pressure Vessel Code pre-qualify titanium 2 for use in pressure vessels up to 300°C. AS4041 Pressure Piping qualifies the alloy to 325°C.

Corrosion Resistance Titanium has excellent resistance to general corrosion, with low or negligible loss rates in many media. See Austral Wright Metals data sheet "Corrosion of Titanium and alloys" for more detail. The table at the end of this data sheet illustrates the excellent erosion corrosion performance of grade 2 in sea water.

Physical Properties

Property	at	value	unit	Property	at	Value	unit
Density	20°C	4,507	kg/m³	Specific Heat	20°C	519	J/kg . °C
Melting Range		1668 ± 10	°C	Mean Coefficient of Expansion	20°C	8.41	x 10^{-6} / °C
Modulus of Elasticity Tension	20°C	103	GPa	Thermal Conductivity	20°C	11.4	W / m . °C
				Electrical Resistivity	20°C	0.420	micro-ohm . m

Erosion corrosion rates of unalloyed titanium, grade 2.

Location	Flow Rate m/sec	Type of Test	Test Duration months	Erosion Corrosion Rate mm/year
Brixham Sea	9.8	Model condenser	12	0.003
Kure Beach, NC	1	Ducting	54	7.5×10^{-7}
Kure Beach, NC	8.5	Rotating disc	2	1.3×10^{-4}
Kure Beach, NC	9	Micarta wheel	2	2.8×10^{-4}
Kure Beach, NC	7.2	Jet impingement	1	5.0×10^{-4}
Wrightsville Beach, NC	1.3	–	6	1.0×10^{-4}
Wrightsville Beach, NC	9	Micarta wheel	2	1.8×10^{-4}
Mediterranean Sea	7.2	Jet impingement	0.5	0.5 mg/day
Dead Sea	7.2	Jet impingement	0.5	0.5 mg/day

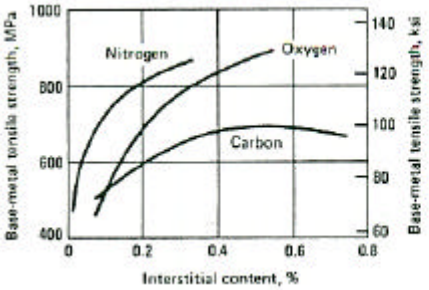
Fabrication Titanium grade 2 is forged by conventional processes within the narrow temperature range 815 - 900°C. Titanium and its alloys generally are more difficult to forge than both aluminium and alloy steels, due to the narrow temperature range, and high strain rate and temperature dependence of strength. Hot forging leaves a thick, extremely hard layer of titanium oxide on the surface, called "alpha case". It is usually removed by pickling in a mixture of nitric and hydrofluoric acids. As supplied, titanium alloys are usually annealed, and can be readily cold formed in conventional machines using standard methods. When cold formed the alpha case does not form and pickling is not needed, except to remove embedded carbon steel pickup, which can cause pitting corrosion.

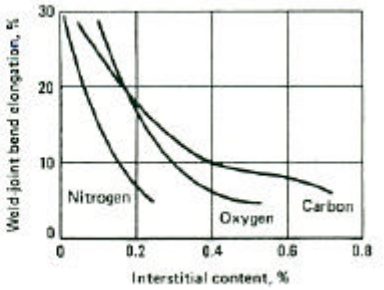
Machinability Titanium grade 2 is readily machinable by conventional methods. It is similar to austenitic stainless steels for machinability. Like stainless steel, titanium has a low thermal conductivity and heat dissipation is poor, so generous use of coolant is recommended. Sharp tools are essential. Cuts should be deep and continuous, with low cutting speeds.

Welding Titanium grade 2 is readily weldable by GMAW and GTAW processes. Preheat or post weld heat treatment are not needed. The area immediately surrounding the welds must be **CLEAN**, free from all grease and shop dirt, including pencil marks. Abrasive cleaning can be used, or solvent cleaning or pickling with a mixture of nitric and hydrofluoric acids. A trailing gas shield must be applied to all areas above 450°C in addition to the normal welding torch gas shield, to prevent heavy oxidation during cooling. Matching filler metal to AWS ERTi-2 is used. The gas shield must be low in hydrogen, oxygen and nitrogen, all of which readily dissolve in titanium and cause embrittlement.

Heat Treatment Titanium grade 7 is annealed at 650 - 760°C, still air cooled. Pickling to remove the alpha case may be needed before further fabrication or machining. Stress relief at 480 – 595°C, air cooled, may be required to improve dimensional stability for critical components.

Effects of interstitial elements on the strength and ductility of unalloyed aluminium





ASTM Product Specifications

Specification	Title
B265	Titanium and Titanium Alloy Strip, Sheet and Plate
B381	Titanium and Titanium Alloy Forgings
B348	Titanium and Titanium Alloy Bars and Billets
B337	Seamless and Welded Titanium and Titanium Alloy Pipe
B338	Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers
B363	Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
B367	Titanium and Titanium Alloy Castings