Technical Data Sheet

ATI 45Nb™ Alloy

Titanium Alloy

INTRODUCTION

Originally developed for application as an aerospace alloy because of its relative ease of formability, high strength and ductility at temperatures up to 427°C (801°F), ATI 45Nb™ Alloy is an ideal candidate for rivets that secure aluminum aircraft panels, particularly in areas exposed to high engine exhaust temperatures.

This alloy has been used as welded flange components that secure high energy physics RF linear accelerator cavities (made from high purity niobium), and has been drawn into superconductivity wire. It is used as a medical device material for cochlear hearing implants and its low elastic modulus makes the material a consideration for a variety of medical and dental devices.

ATI 45Nb™ Alloy is easily fabricated into structures and components. Although it is considered a refractory metal, processing techniques are the same as those for other titanium alloys. Parts are typically welded using the GTAW process but require the addition of trailing and backing shields and due to its simple metallurgical structure there is no requirement for post weld heat treatment. Machining requires the use of solid fixture setups, high torque at low RPM ridge machine tools with sharp high rake cutters.

With an exceptionally small bend radius capability (down to a bend radius of 1t where t=sheet thickness) and low modulus of elasticity, ATI 45Nb™ Alloy is highly formable and yet still retains excellent tensile and elongation properties. It can also be cast into shapes with the same processes used to cast CP titanium. .

ATI 45Nb™ Alloy readily accepts surface oxidation treatment to enhance its hardness and wear resistance. “Nobelizing” is a common commercially available process to apply this type of surface treatment.

ATI 45Nb™ Alloy provides improved corrosion resistance along with higher strength compared to that of Ti-7, 12, 16, and 26 in many chemical environments. ATI 45Nb™ Alloy has also proven to be a great success in the autoclave processing of gold ore. For many years gas vents, oxygen lances, steam spargers, valves and other pressure oxidation reactor components have been produced, put into service, and survived hot, concentrated sulfuric or hydrochloric acid. In addition the metal has been shown to have higher ignition resistance when compared to CP Ti, thereby allowing further process optimization.

Another chemical processing applications for ATI 45Nb™ Alloy is the oxygen-based, low-pressure, wet oxidation process (LoProx*) for the treatment of waste water and sludge. Because of its corrosion and higher ignition resistance this material is an ideal candidate for the 200°C (392°F), 20 bar pressure with oxygen environment. The superior corrosion resistance of ATI 45Nb™ Alloy makes it well suited for service in a variety of environments including most organic and mineral acids below 150°C (302°F). Because of its stable oxide film, ATI 45Nb™ Alloy has excellent resistance to oxidizing acids including mixtures of HNO3 and HCL; however it is susceptible to attack from HF and other fluoride ions.

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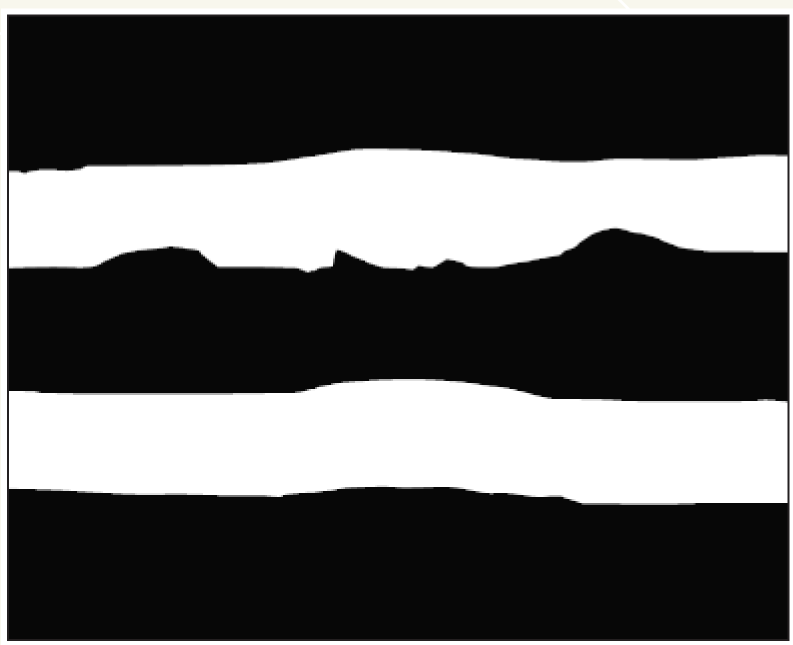
Acids and corrosive solutions that ATI 45Nb™ Alloy has shown good chemical resistance to include:

- Hydrochloric (HCL)
- Sulfuric (H2SO4)
- Hydrobromic (HBr)
- Hydroiodic (HI)
- Salt water / Brine / Salt Solutions

POTENTIAL APPLICATIONS

- Aerospace rivet material
- High pressure oxygenated gas vents
- Oxygen lances for pressure oxidation reactors
- Valves for corrosive oxygenated processes
- Chemical corrosion resistance
- Medical implant devices
- High energy physics and superconducting wire

Figure 1. Ferrallum* 255 super duplex stainless (top coupon) showed extensive corrosion (50% of wall thickness) after eight months in a mining autoclave. ATI 45Nb™ Alloy (bottom coupon) showed no measurable corrosion after four months and has tested well for nearly two years.



SPECIFICATIONS & CERTIFICATES

Plate, sheet, tube, pipe, bar, billet, extrusions, wire, castings.

*Trademarks of other respective owners.

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PRODUCT FORMS

ASTM

B265 – Titanium and Titanium Alloy Strip, Sheet and Plate
B338 – Seamless and Welded Titanium and Titanium Alloy Tubes
B348 – Titanium and Titanium Alloy Bars and Billets
B381 – Titanium and Titanium Alloy Forgings
B363 – Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
B861 – Titanium and Titanium Alloy Seamless pipe
B862 – Titanium and Titanium Alloy Welded Pipe
B863 – Titanium and Titanium Alloy Wire

AWS

AWS A5.16/A5.16M:2007 – Specification for Titanium and Titanium-Alloy Welding Electrodes and Rods. Ti
Grade 36 weld wire is designated in AWS A5.16/A5.16M as ERTi-36.

AWS G2.4/G2.4M:2007 – Guide for the Fusion Welding of Titanium and Titanium Alloys

COMPOSITION

Nominal 55 wt% Titanium, 45 wt% Niobium

Table 1. Ingot Chemistry

Ingot Chemistry	Nb	O	C	N	H	Fe	Ti
Typical	+/- 1.5%	850	175	75	5	250	+/- 1.5%
Specification	42.0-47.0	< 1600	< 400	< 200	< 35	< 300	Balance

Note: Interstitials are in units of ppm. To obtain units of wt%, divide by 10,000.

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PHYSICAL PROPERTIES

Table 2. Physical Properties	
Density	5.7 g/m³ (0.206 lb/cu.in)
Melting Point	1900° C (3452° F)
Phase Transition or Beta Transus	No beta transus. Alloy is beta phase to room temperature.
Coefficient of Thermal Expansion (CTE)	9.03 x 10^{-6}/°C (5.02 x 10^{-6}/°F)
Thermal Conductivity	10 W/m°K (5.78 BTU/hr-ft-°F)
Specific Heat	0.427 J/g°C (0.102 BTU/lb-°F)
Thermal Diffusivity	4.3 x 10^{-6} m²/s (46.3 ft²/sec)

MECHANICAL PROPERTIES

Table 3. Mechanical Properties	
Ultimate Tensile Strength (at RT)	450 MPa (65,000 psi)
Yield Strength (at RT)	Minimum 410 MPa (60,000 psi), Maximum 655 MPa (95,000 psi)
Elongation (at RT)	10% (in 2 inches)
High Temperature Strength Graphs	See Figure 2. and Table 4.
Bend Radius	Under 0.070 inch (1.8 mm) thickness = 4.5T 0.070 to 0.187 inch (1.8-4.75 mm) thickness = 5T
Modulus of Elasticity	62.05 GPa (9 x10^6 psi)

Figure 2. Tensile Strength

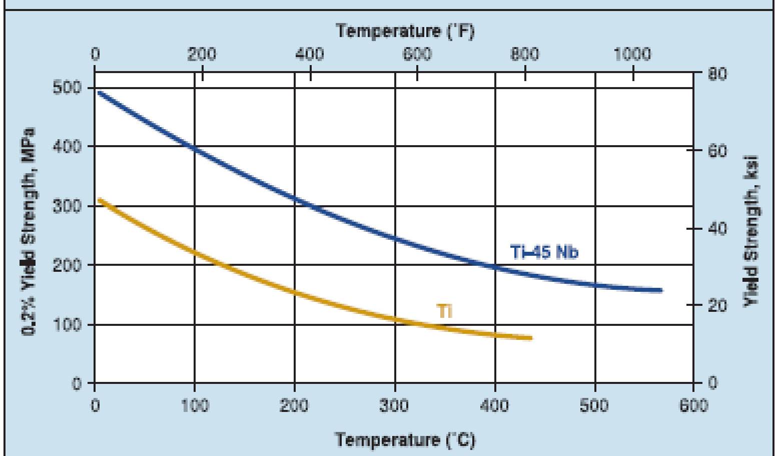

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Table 4. Mechanical Properties for Titanium Grade 2 and Niobium vs. Ti-45 Niobium						
Material	Property					
	Elastic Modulus (psi)	Yield Strength (psi)		Ultimate Strength (psi)		Integrated Thermal Contraction 293K to 1.88K (in/in)
		293K	1.88 K	293K	1.88 K	
Niobium	1.52E+07	5500	46000	16600	87000	0.0014
Ti-45 Niobium	9.00E+06	69000	N/A	79000	N/A	0.0019
Titanium Grade 2	1.55E+07	40000	121000	50000	162000	0.0015

FERMILAB Technical Division
Pressure Vessel Engineering Note For the 1.3-GHz Helium Vessel #1 in Cryomodule 1
Vessel No. IND-116 Rev. No. 0 Date: 12 August 2009
Authors: M. Wong Date: 12 August 2009

OTHER PROPERTIES AND PERTINENT INFORMATION

Figure 3. Ti Ignition Curve

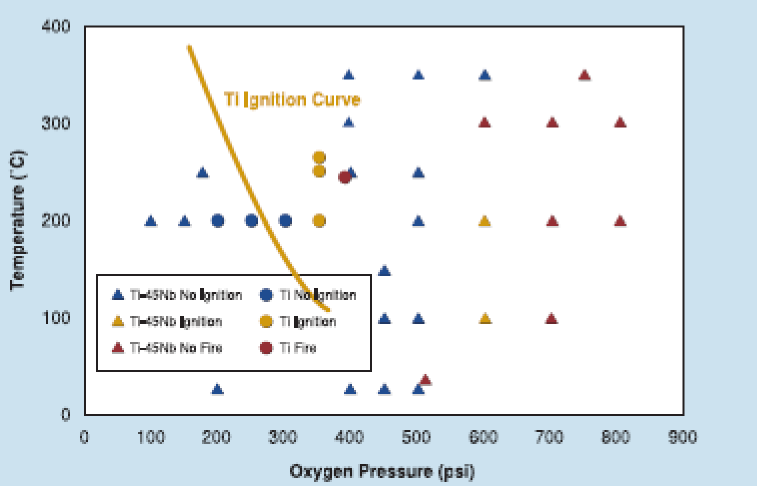

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Figure 4. 5 mil/year iso-corrosion curve in HCl.

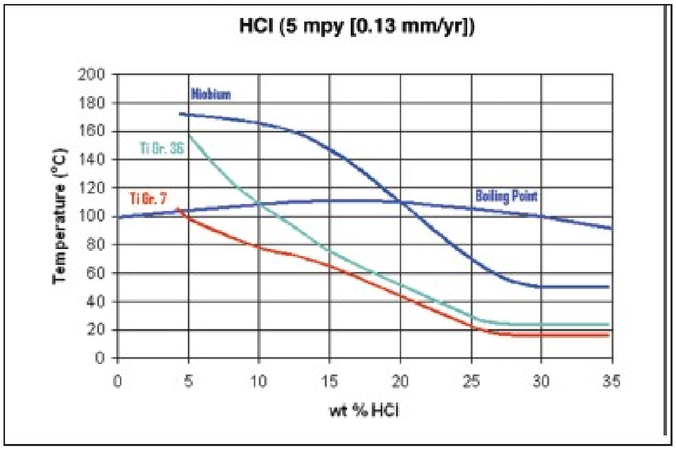


Figure 5. 2 mil/year iso-corrosion curve in HCl.

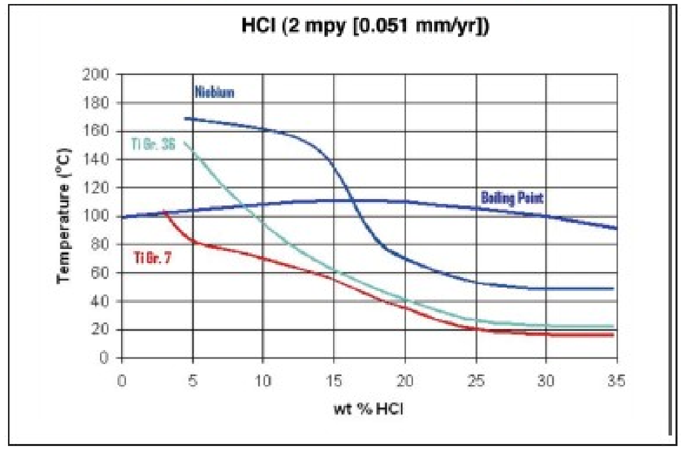


Figure 6. 2 mpy iso-corrosion curve in H_2SO_4

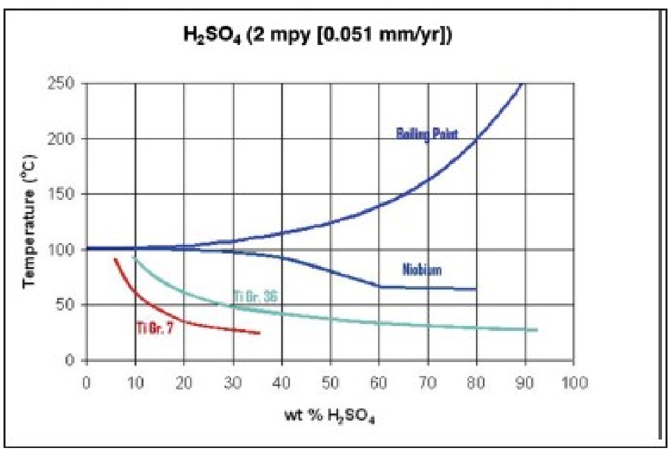


Figure 7. 5 mpy iso-corrosion curve in H_2SO_4

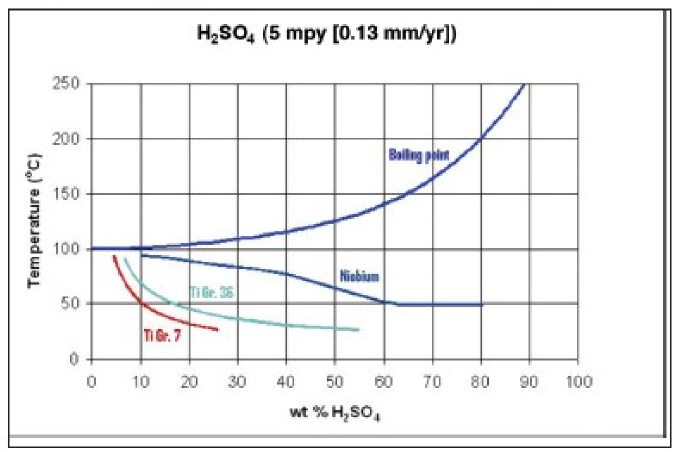


Figure 8. 5 mpy iso-corrosion curve in HBr

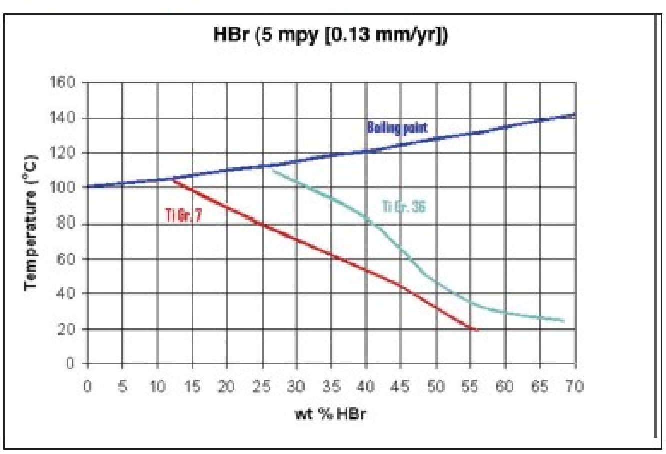
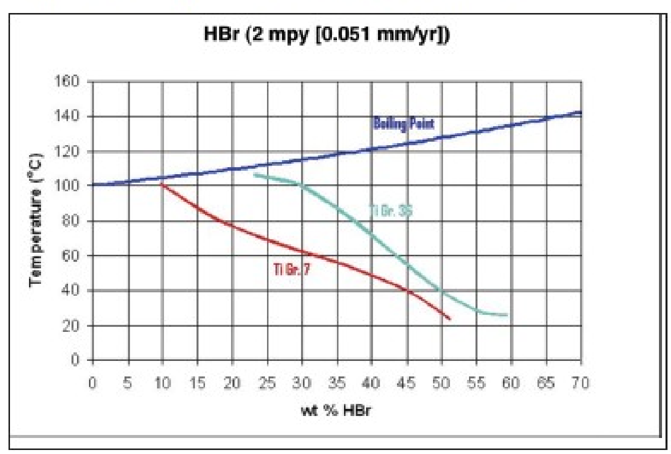


Figure 9. 2 mpy iso-corrosion curve in HBr.



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