ATI

Technical Data Sheet

ATI 6-7™ Alloy

(UNS R56700)

INTRODUCTION

ATI 6-7™ Alloy (UNS R56700) was conceived and developed in 1977 by a team of researchers at Gebruder Sulzer in Winterthur, Switzerland[1]. The objective was to create a titanium alloy for medical and surgical device applications with properties nearly identical to ATI Ti-6Al-4V, substituting Niobium for Vanadium as the beta stabilizing element[2]. After six years of testing and evaluation, the alloy was introduced by Sulzer-Protek as Protasul® 100 in 1985, and has been used clinically since 1986[3]. ATI 6-7™ Alloy is widely used in the medical device industry, primarily for orthopaedic applications such as: total hip replacement systems, fracture fixation plates, intermedullary rods and nails, spinal devices, screws, and wires[4].

SPECIFICATIONS

- ASTM F 1295 - Bar, Rod, and Wire (Annealed)
- ISO 5832-11 - Bar (Annealed)

PHYSICAL PROPERTIES

Melting Range: 2,800 - 3,000°F (1,538 - 1,649°C)
Density: 0.163 lbs/cu. in.; 4.52 gm /cc
Beta Transus Temperature: 1,850°F (± 27F°); 1,010 °C (± 15C°)
Elastic Modulus: 105 GPa in the solution annealed condition

HEAT TREATMENT

ATI 6-7™ Alloy is usually supplied as a semi-finished mill product in the solution annealed condition.
1. Anneal: 1,300 -1,350°F; (704.4 - 732.2°C), 1 hour, air cool
2. Stress Relieving: 900 -1,200°F; (482.2 - 648.9°C), 1 hour, air cool.

HARDNESS

Typical hardness in the annealed condition is HRC 30-34.

FORGEABILITY/ FORMABILITY

Because the beta transus and other properties of ATI 6-7™ Alloy are so similar to those values for ATI Ti-6Al-4V alloy, mill and shop forging conditions are also similar. ATI 6-7™ Alloy can be finish forged from 1,750°F; (954.4°C) with a finishing temperature of 1,450°F; (787.8°C). Minimum reductions of 35% are recommended to obtain optimum properties. The formability of ATI 6-7™ Alloy is about the same as the standard grade ATI Ti- 6Al-4V alloy.

MACHINABILITY

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ATI 6-7™ Alloy can be machined using practices for austenitic stainless steels using slow speeds, heavy feeds, rigid tooling, and large amounts of non-chlorinated cutting fluid.

WELDABILITY

Like ATI Ti-6Al-4V and Ti-6Al-4V ELI Alloys, ATI 6-7™ Alloy can be easily welded in the annealed condition. Precautions must be taken to prevent oxygen, nitrogen, and hydrogen contamination. Fusion welding can be done in inert gas filled chambers or using inert gas welding of the molten metal and the adjacent heated zones using a trailing shield. Spot, seam, and flash welding can be performed without resorting to protective atmospheres.

SPECIAL PRECAUTIONS

ATI 6-7™ Alloy can be subject to hydrogen contamination during improper pickling and by oxygen, nitrogen, and carbon pickup during forging, heat treating, brazing, etc. This contamination results in a deterioration in ductility which could adversely affect notch sensitivity and forming characteristics.

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Chemical Composition

	Al	Nb	Ta	Fe	O	C	N	H	Ti
% w/w, min.	5.5	6.5	-	-	-	-	-	-	Bal.
% w/w, max.	6.5	7.5	0.50	0.25	0.20	0.08	0.05	0.009	Bal.

Samples for hydrogen shall be taken from the semi-finished mill product

Mechanical Property Data

	Product Form and Condition	Thickness, inches	UTS, min ksi (MPa)	YS 0,2%, min ksi (MPa)	% EL, min.	% RA, min.
ASTM F 1295	Bar, Rod, and Wire Annealed and Cold Finished	Up to 4,00 in, diameter or thickness	130.5 (900)	116 (800)	10	25
ISO 5832-11	Bar Annealed and Cold Finished	Up to 100 mm diameter or thickness	(900)	(800)	10	25

Specification minimum values

Comparison of Mechanical Requirements for Three Titanium Grades [3]

Titanium Material	ASTM Standard	UTS, min., ksi (MPa)	YS, min ksi (MPa)	EL, min %	RA, min. min.
Ti-CP-4	ASTM F 67	80 (552)	70 (483)	15	25
Ti-6Al-4V ELI	ASTM F 136	125 (862)	115 (793)	10	25
Ti-6Al-7Nb	ASTM F 1295	130.5 (900)	116 (800)	10	25

Per ASTM standards for 1.000" dia. bar.

High Cycle Fatigue Strength Data [3]

Titanium Material	Condition	Condition		
		10^4	10^7	$>10^7$
Ti-CP-4	Cold Worked	670 MPa	430 MPa	430 MPa
Ti-6Al-4V	Annealed	-	540 MPa	540 MPa
Ti-6Al-7Nb	Annealed	810 MPa	540 MPa	540 MPa

Fully reversed rotating bending fatigue test values

Data are typical and should not be construed as maximum or minimum values for specification or for final design.
Data on any particular piece of material may vary from those herein.

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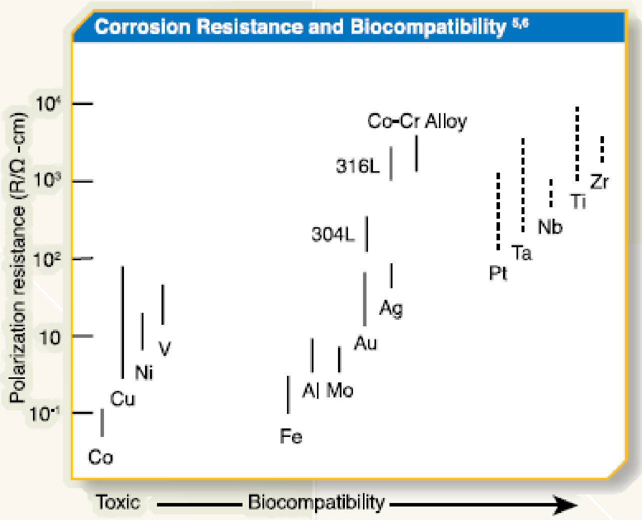
This diagram below illustrates the relationship between polarization resistance and biocompatibility of pure metals, cobalt-chromium alloy, and stainless steels. Corrosion studies in saline solutions suggest that vanadium and iron in titanium alloys are soluble elements, whereas aluminum and niobium produce stable and insoluble oxides (Al_2O_3, Nb_2O_5) as does titanium (TiO_2). This very dense and stable protective passive layer that forms on ATI 6-7™ Alloy surfaces is the reason for improved corrosion resistance and biocompatibility compared with ATI Ti-6Al-4V and ATI Ti-6Al-4V ELI alloys. The niobium oxide (Nb_2O_5) in the surface oxide layer is chemically more stable, less soluble, and more biocompatible than the vanadium oxide (V_2O_5) found in the Ti 6-4 surface oxide layers.



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