ATI Titanium 6Al-4V Alloy

GENERAL

ATI Ti-6Al-4V Alloy (UNS 56400) is the most widely used titanium grade. It is a two phase α+β titanium alloy, with aluminum as the alpha stabilizer and vanadium as the beta stabilizer. This high-strength alloy can be used at cryogenic temperatures to about 800° F (427° C). ATI Ti-6Al-4V alloy is used in the annealed condition and in the solution treated and aged condition. Some applications include: compressor blades, discs, and rings for jet engines; airframe and space capsule components; pressure vessels; rocket engine cases; helicopter rotor hubs; fasteners; critical forgings requiring high strength-to-weight ratios.

This alloy is produced by primary melting using vacuum arc (VAR), electron beam (EB), or plasma arc hearth melting (PAM). Remelting is achieved by one or two vacuum arc steps.

SPECIFICATIONS

- AMS 4928 - Bars, Forgings, and Forging Stock (Annealed)
- AMS 4965 - Bars, Forgings (Solution treated and aged)
- AMS 4967 - Bars, Forgings (Annealed, Heat Treatable)

PHYSICAL PROPERTIES

Melting Range: 2,800-3,000° F (1,538 - 1,649° C)
Density: 0.160 lbs/cu. in.; 4.47 gm/cc
Beta Transus Temperature: 1830° F (± 25°); 999° C (± 14°)

HEAT TREATMENT

Annealing at 1,700-1,900° F (927 - 1,038° C) is done where high hardness, tensile and fatigue strength are desired. A ATI Ti-6Al-4V alloy can be heat treated in several ways.

1. Anneal: 1,275 -1,400° F; (691 - 760° C), ½ to 2 hours, air or furnace cool
2. Stress Relief Anneal: 1,000 -1,200° F; (538 - 649° C), 1 to 8 hours, air or furnace cool
3. Solution Heat Treatment: 1,675 -1,750° F; (913 - 954° C), 1 hour, water quench
4. Aging Treatment: 975 -1,025° F; (524 - 552° C), 4 to 8 hours - air cool

The very best of properties in the solution treated and aged condition are obtained in small cross sections that are rapidly quenched. Larger sections sizes and/or a quench delay may cause properties to be lower than the optimum values.

HARDNESS

Typical hardness in the annealed condition is Rockwell C 30-34, and about Rockwell C 35-39 in the solution and aged condition.

FORGEABILITY/ FORMABILITY

ATI Ti-6Al-4V alloy is finish-forged from 1,750° F; (954° C) with a finishing temperature of 1,450° F; (788° C). Minimum reductions of 35% are recommended to obtain optimum properties.

ATI Ti-6Al-4V alloy is difficult to form at room temperature even in the annealed condition. Therefore severe forming operations such as bending or stretching are performed on annealed material at temperatures up to 1,200° F; (649° C) without affecting mechanical properties. Hot sizing or shaping can be done by creep forming in the 1,000 - 1,200° F; (538 - 649° C) range.

MACHINABILITY

ATI Ti-6Al-4V alloy can be machined using practices for austenitic stainless steels with slow speeds, heavy feeds, rigid tooling, and large amounts of non-chlorinated cutting fluid.

WELDABILITY

ATI Ti-6Al-4V alloy is easily welded in the annealed condition, or in the solution and partially aged condition, with aging being completed during the post weld heat treatment. 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.

ATI Allvac
2020 Ashcraft Ave., P.O. Box 5030
Monroe NC 28110-5030 USA
704-289-4511
www.allvac.com

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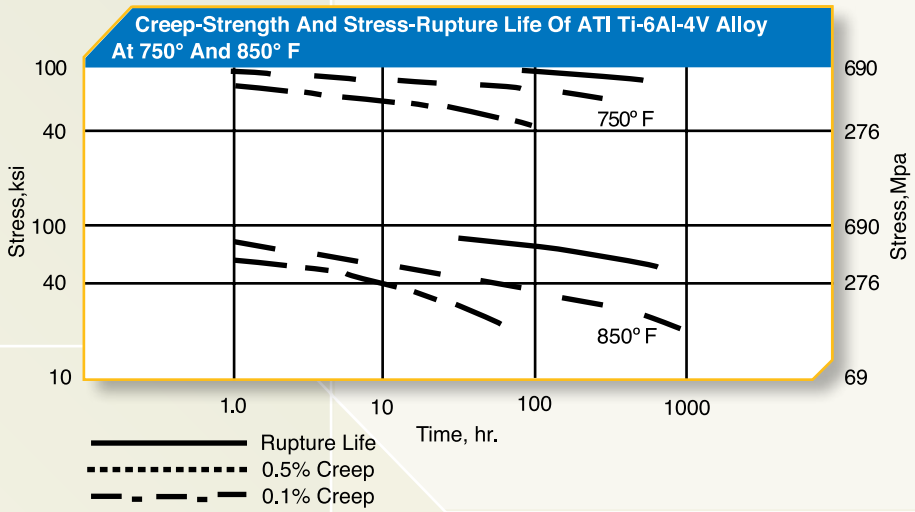
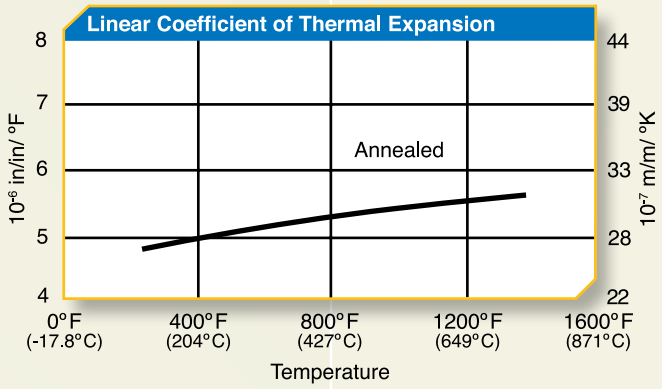
SPECIAL PRECAUTIONS

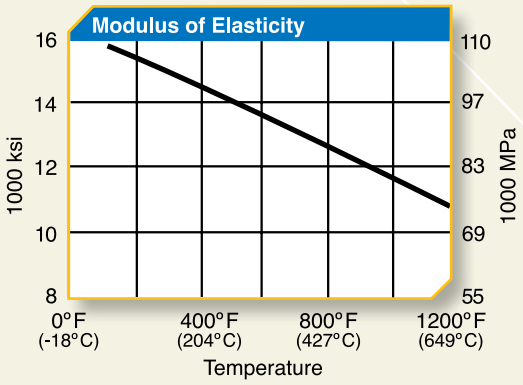
ATI Ti-6Al-4V alloy can be subjected to hydrogen contamination during improper pickling and by oxygen, nitrogen, and carbon pickup during forging, heat treating, brazing, etc. This contamination could result in a deterioration in ductility which would adversely affect notch sensitivity and forming characteristics.

Chemical Composition

	N	C	H	O	Fe	Al	V	Ti	Other Elements
% w/w, min.	-	-	-	-	-	5.50	3.50	-	-
% w/w, max.	0.05	0.10	0.0125	0.20	0.30	6.75	4.50	Bal	0.40 Total 0.10 Each







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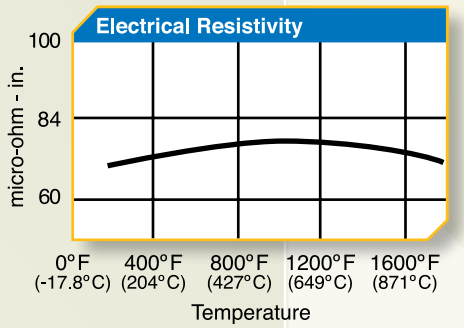

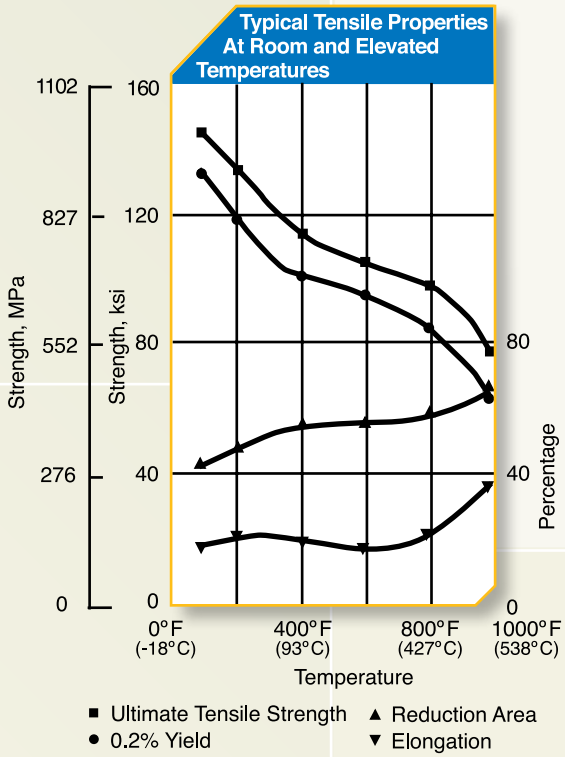

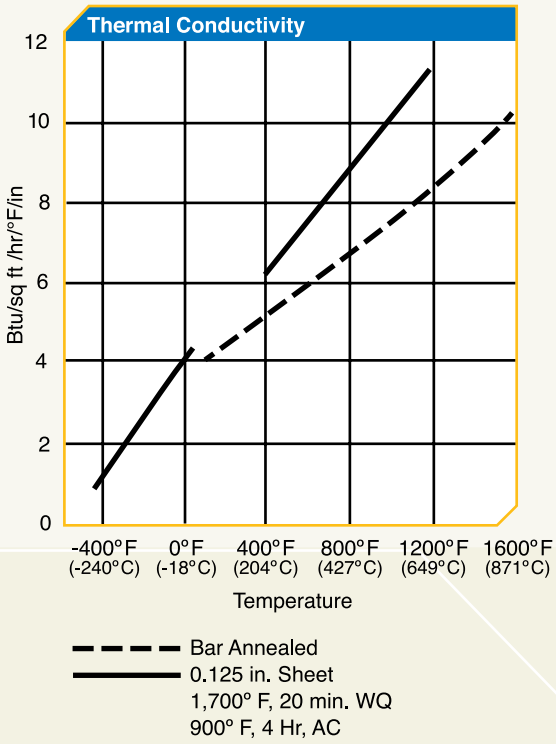

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