



Mission Critical Metallics®

ATI 38-644™ Beta Titanium Alloy

GENERAL

ATI 38-644 beta titanium Alloy (UNS R58640) is equivalent to Beta C™* (Ti-3Al-8V-6Cr-4Mo-4Zr). This grade is a metastable beta titanium alloy known for its exceptional ductility in the solution treated (annealed) condition, and for its high strength and ductility in the solution treated and aged condition (STA) condition. Improved tensile properties can be achieved, while maintaining good ductility and a low modulus of elasticity. Fatigue strength is also good in the STA condition.

This alloy is produced by one of two basic primary melting methods: vacuum arc (VAR) or plasma arc cold-hearth melting (PAM). Primary melting is followed by a vacuum arc remelt. Typical product forms are forged billet, rolled bar, rolled and/or drawn rod and wire. These products find applications in high strength aerospace and commercial applications, structural parts, gas and petroleum down-hole piping systems and tooling, and high strength coil springs and fasteners. ATI 38-644 alloy can be used for extended periods in elevated temperature environments below 660° F (349° C).

SPECIFICATIONS - AMS

- SAE AMS 4957 – Bar and Wire
- SAE AMS 4958 – Bar and Rod
- ASTM B 348 Grade 19 – Bar and Billet

PHYSICAL PROPERTIES

Melting Range: 2,830° F – 3,000° F (1,554 - 1,649° C)

Density: 0.174 lbs/in³ (4.82 gm/cm³)

Specific Heat @ 70° F (21° C), 0.123 Btu/lb F° (515 J/kg °K)

Beta Transus Temperature: typically 1,350° F +/-25° F (732° C +/-14° C)

Elastic Modulus: As-rolled / solution h.t.: 13 – 14 Mpsi

Solution treated + aged: 14 – 16 Mpsi.

HEAT TREATMENT

For high-strength applications, heat treating usually consists of solution annealing followed by aging during final production manufacturing. Cold drawing prior to aging will increase strength, while good ductility is still retained. Solution annealing should be performed at least 50° F (28° C) above the transus temperature, preferably in the range of 1,450 - 1,700° F (788-927° C), and product may be air cooled or water quenched. Aging is achieved at temperatures of 850 - 1,000° F (454 - 538° C) for 4 to 24 hours with air cooling. Specific aging time and temperature may be varied to achieve a desired strength level.

HARDNESS

Typical hardness in the solution annealed condition can range from 250-300 HB. In the STA condition, hardness ranges can be 350-440 HB.

FORGEABILITY/ FORMABILITY

ATI 38-644 alloy has good fabricability when forming in the hot or warm condition in the preheat range of 1,500-1,900° F (816-1,038° C). Cold formability is very good, and ductility levels of 60-70% RA for a 30% cold-drawn product are possible after solution annealing.

MACHINABILITY

In general, titanium alloys have a machinability ranging from annealed austenitic stainless steels to ¼-hard and ½-hard stainless steels. ATI 38-644 alloy machines similarly to Ti-13V-11Cr-3Al and other beta titanium alloys in the solution treated and aged condition. Chlorine-containing coolant fluids are generally not recommended.

WELDABILITY

ATI 38-644 alloy is weldable in the solution annealed condition. However, care should be taken to weld in an inert environment (or ensure adequate inert gas shrouding takes place during welding) to avoid excessive nitrogen or oxygen pick-up. Welds may be somewhat strengthened by aging, with some ductility loss. Welding should not be performed following solution + age heat treatments.



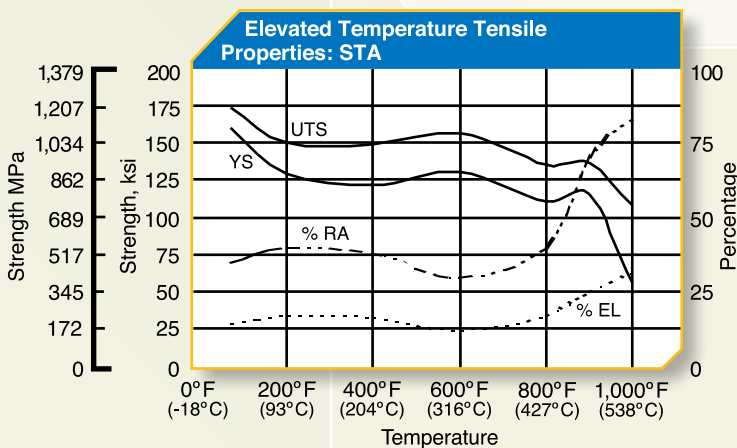
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SPECIAL PRECAUTIONS

Like many beta titanium alloys, ATI 38-644 alloy is susceptible to hydrogen pick-up and accelerated hydrogen diffusion during heat treating and etching operations. However, nominal hydrogen content levels do not detract from properties as with alpha-beta titanium alloys (i.e., Ti-6Al-4V).

Chemical Composition											
	AL	V	Cr	Mo	Zr	Fe	O	N	C	H	Ti
wt %, min.	3.0	7.5	5.5	3.5	3.5	-	-	-	-	-	Bal.
wt %, max.	4.0	8.5	6.5	4.5	4.5	0.35	0.12	0.03	0.05	0.02-0.03 max	Bal.

Mechanical Properties (Specification Minimum Values)					
	Form/condition	Thickness, inches	UTS, ksi	% elongation (4D)	% RA
AMS 4957	Bar and Wire - Cold Drawn	Under 0.187"	190 - 210	10	20
		0.187"-0.375"	185 - 205	10	20
		0.375"-0.625"	180 - 200	8	20
AMS 4958	Bar and Wire - solution annealed, ground, and aged	Not specified	180	8	20
ASTM B3438 Grade 19	Billet and Wire - solution annealed, ground, and aged	Not specified	180	8	20

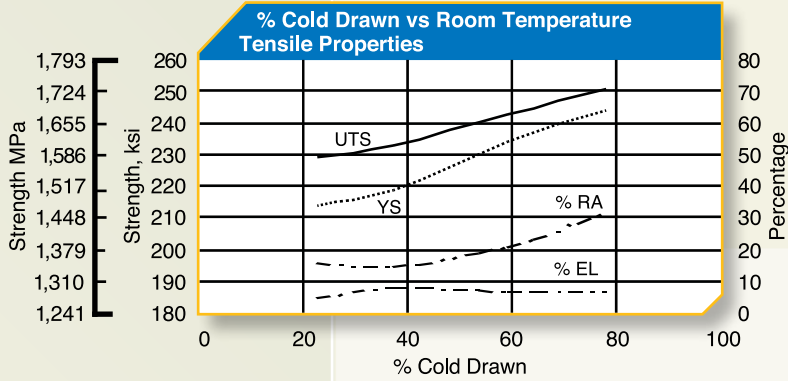


Note: 0.500" diameter bar; 1,500° F solution + 1,050° F, 6 hours, air cool age

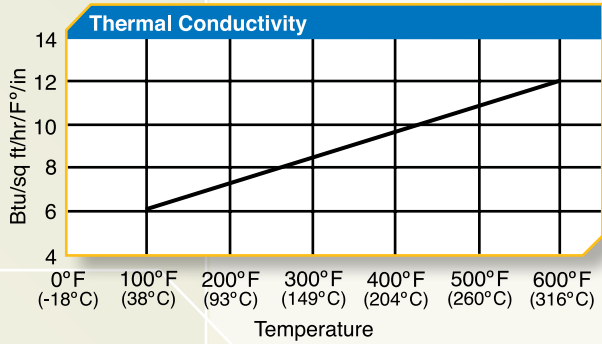
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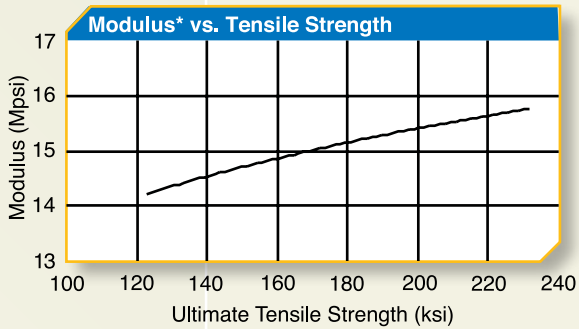
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Note: Starting with .373" diameter rod, solution annealed, drawn, aged at 900° F for 6 hours, AC.



Note: Conductivity for as-rolled and heat treated + aged samples is equivalent.



Note: Composite modulus line was estimated using results from various % CD + aging process routes.

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