

**TIMETAL<sup>®</sup> 5111****HIGH TOUGHNESS, HEAVY SECTION WELDABLE ALLOY**

TIMETAL 5111 (pronounced 5 triple 1) is a near alpha titanium alloy of intermediate strength. This alloy has been designed for high toughness, good weldability, stress-corrosion cracking resistance, and room temperature creep resistance.

TIMETAL 5111 is ideally suited for applications in marine environments where toughness and corrosion resistance are essential. The alloy has been produced on a commercial scale. Forging and machining characteristics of TIMETAL 5111 are very similar to TIMETAL<sup>®</sup> 6-4. TIMETAL 5111 was developed jointly with the Navy, and has been selected as the material of choice for a submarine application. TIMETAL 5111 is included in the ASTM standards as ASTM Grade 32.

**TABLE 1****CHEMICAL COMPOSITION**

ELEMENT	WEIGHT %	
	Min.	Max.
Aluminum	4.5	5.5
Tin	0.6	1.4
Vanadium	0.6	1.4
Zirconium	0.6	1.4
Molybdenum	0.6	1.2
Iron	—	0.25
Silicon	0.06	0.14
Oxygen	—	0.11
Carbon	—	0.08
Nitrogen	—	0.03
Hydrogen	—	0.015
Titanium	Remainder	

**TABLE 2****PHYSICAL PROPERTIES**

Property	T (°F)	T (°C)	Value	Value (SI)
Density	72	22	0.160 lb in <sup>-3</sup>	4.43 g cm <sup>-3</sup>
Beta Transus	1795	980		
Thermal 75		24	4.3 Btu hr <sup>-1</sup> ft <sup>-1</sup> °F <sup>-1</sup>	7.5 W m <sup>-1</sup> K <sup>-1</sup>
Conductivity 295		146	5.1	8.87
		300	6.2	10.7
Specific Heat Capacity	75	24	0.127 Btu lb <sup>-1</sup> °F <sup>-1</sup>	0.533 J kg <sup>-1</sup> K <sup>-1</sup>
	295	146	0.137	0.572
	572	300	0.147	0.613
Electrical Resistivity	75	24	60 μΩ•in	1.53 μΩ•m
	306	152	65	164
	574	301	68	173
Mean 122 Coefficient 212 of Thermal Expansion		50	4.6 x 10 <sup>-6</sup> in in <sup>-1</sup> °F <sup>-1</sup>	8.2 x 10 <sup>-6</sup> m m <sup>-1</sup> °C <sup>-1</sup>
		100	4.8	8.7
	302	150	5.0	8.9
	392	200	5.1	9.1
	482	250	5.2	9.3
	572	300	5.2	9.4
Modulus of Elasticity	RT	RT	15.5-16.5 Msi	1.07-1.14 GPa

**FIGURE 1****MARINE APPLICATIONS**

**TIMETAL 5111 HAS EXCELLENT TOUGHNESS PROPERTIES (β FORGED)<sup>(1)</sup>**

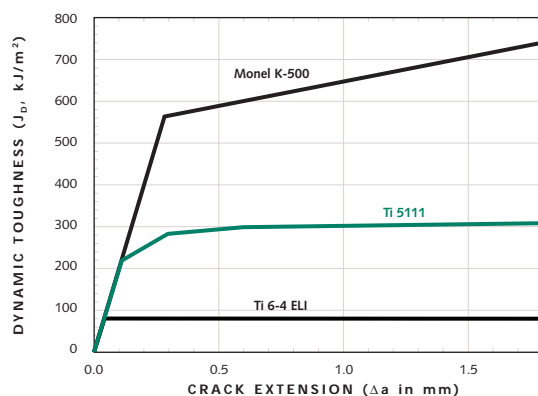


TABLE 3

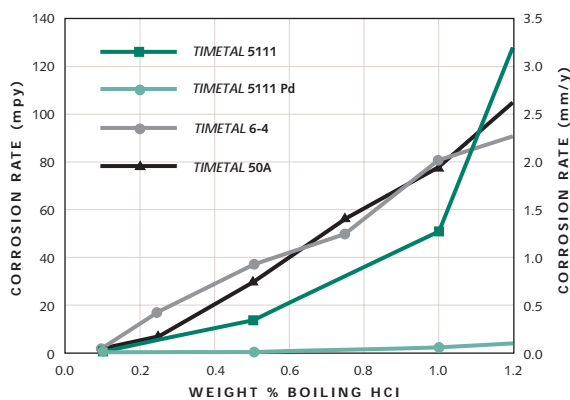
TYPICAL TENSILE PROPERTIES OF PLATE AND SHEET

Direction	Ultimate Tensile Strength ksi (MPa)	0.2% Yield Strength ksi (MPa)	0.2% Comprehensive Yield Strength ksi (MPa)	Elongation 4D %	Reduction in Area %
<i>1" and 2" plate β roll plus α/β anneal (60 min @ 1750°F (954°C), air cool)</i>					
L	121 (835)	104 (720)	109 (750)	13	28
T	125 (865)	112 (775)	118 (811)	14	29
<i>3/8" plate β roll plus α/β anneal (60 min @ 1745°F (952°C), air cool)</i>					
L	118 (814)	103 (710)	—	15.5	29
T	128 (883)	117 (807)	—	15	35
<i>.050" sheet β roll plus α/β anneal (30 min @ 1725°F (941°C), air cool)</i>					
L	132 (910)	116 (800)	—	10	—
T	140 (965)	129 (889)	—	11.5	—

FIGURE 2

CORROSION RESISTANCE

TIMETAL 5111 COMPARES FAVORABLY WITH TI 6-4 AND GRADE 2 TITANIUM IN BOILING ACID SOLUTIONS



One inch pre-cracked *TIMETAL 5111* compact tension specimens, loaded up to their  $K_{Ic}$  value, showed no crack propagation after a 26-day test in seawater. In other words,  $K_{ISCC} > K_{Ic}$  <sup>(2)</sup>.

Slow strain rate tests showed excellent resistance to environmental cracking in freely corroding 3.5% NaCl solution and under cathodic polarization conditions ranging from -0.85 to -1.25  $V_{SCE}$  <sup>(1)</sup>.

The addition of 0.05% Pd to *TIMETAL 5111* offers a considerably improved resistance to crevice corrosion as well as to corrosion in reducing acid environments. *TIMETAL 5111 Pd* was fully corrosion resistant in concentrated geothermal brine at 446°F (230°C) and pH 2-3 with and without the addition of 1000 ppm of ferric ions. The presence of ferric ions renders an oxidizing environment. *TIMETAL*® 6-4 Pd/Ru exhibits SCC at these oxidizing conditions.

TABLE 4

ROOM TEMPERATURE CREEP PROPERTIES OF PLATE

Thickness	Stress Level, Fraction of Yield Strength	Max. Creep @ 1500 hrs, %
1" (25 mm)	0.75	0.13
	0.9	1.4
2" (51 mm)	0.75	0.16
	0.9	1.7

The data and other information contained herein are derived from a variety of sources which TIMET believes are reliable. Because it is not possible to anticipate specific uses and operating conditions, TIMET urges you to consult with our technical service personnel on your particular applications.

References

- (1) Tregoning, R.L., Aylor, D.M., Caplan, I.L., "High Strength Titanium Alloys for Naval Fastener Application," Titanium '95: Science and Technology, pp1726-1733 (1996).
- (2) Judy, R.W., Naval Research Laboratory, 1988.
- (3) Bania, P.J., Allen, P.G., Parris, W.M., "Development of a Near-Alpha Alloy with Excellent Energy Related Toughness," Titanium '95: Science and Technology, pp1419-1426 (1996).

For more information, please contact the TIMET Sales Office/Service Center nearest you, TIMET's Technical Laboratories or TIMET's Website @ [www.timet.com](http://www.timet.com)

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