BLACK TITANIUM
DATA SHEET

ABOUT BLACK TITANIUM
Black Titanium is a unique titanium base alloy that offers attractive properties for a wide range of applications. It exhibits a martensitic microstructure at room temperature after being quenched from 850°C (1562°F) (beta transus approximately 635°C(1175°F)).

After aging at 425°C–550°C (797°F–1022°F), the tensile and yield strengths are increased significantly. It also exhibits a low modulus of elasticity, excellent castability, and superplasticity at elevated temperatures. It is readily weldable and machinable before and after hardening.

An extraordinary characteristic of Black Titanium is the capability of being surface hardened to depths that produce very high wear resistance. The hardened layer is highly adherent rendering it excellent for wear applications. The primary elements in the alloy, titanium, zirconium, and niobium, are all non-toxic and non-carcinogenic. The alloy is produced by traditional metallurgical processing, requiring no special costly treatment.

PRODUCT FORMS
• Pipe • Bar • Castings

FORMABILITY
Black Titanium is very amenable to hot or warm forging, particularly closed die forging. Sharp corners, indentations and other details can be accurately produced. This is made possible by the fact that the alloy exhibits superplasticity at about 732°C (1350°F). Oxidation during forging can be greatly reduced by the use of high temperature coatings. Black Ttanium exhibits excellent detail reproduction in investment castings. No appreciable segregation is present and surface quality is very good.

POTENTIAL APPLICATIONS
Although this alloy exhibits excellent characteristics for biomechanical uses such as prosthetic devices, it has distinct potential in other areas; such as high impact parts where weight, strength, and wear resistance are important. Due to this alloy's low stiffness, it can be used for strong lightweight springs.

Another potential use is large hand tools. Shipwrights, millwrights and others may welcome large hand tools that are 40% lighter to handle than steel. The initial cost would be higher, but the hardened surface of the Black Titanium tool would greatly extend the tool's life span.

CHEMICAL COMPOSITION

ELEMENT	WEIGHT %
ZIRCONIUM	34.0-36.0
NIOBIUM	10.7-11.7
OXYGEN	0.07-0.13
TITANIUM	REMAINDER
CARBON	≤ 0.0120 (≤120 ppm)
HYDROGEN	≤ 0.0025 (≤25 ppm)
NITROGEN	≤ 0.0100 (≤100 ppm)

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MECHANICAL PROPERTIES

FIG 2. MECHANICAL PROPERTIES (TYPICAL) FOR BLACK TITANIUM - TENSILE STRENGTH (ROOM TEMP)

CONDITION	UTS		0.2 YS		% ELONGATION	E_0, PSI	
FULLY HARDENED	160 ksi	1103 MPa	150 ksi	1034 MPa	12	10.4×10^6 psi	71.7 GPa
BETA QUENCHED	120 ksi	827 MPa	65 ksi	448 MPa	25	9.5×10^6 psi	65.5 GPa

MECHANICAL PROPERTIES

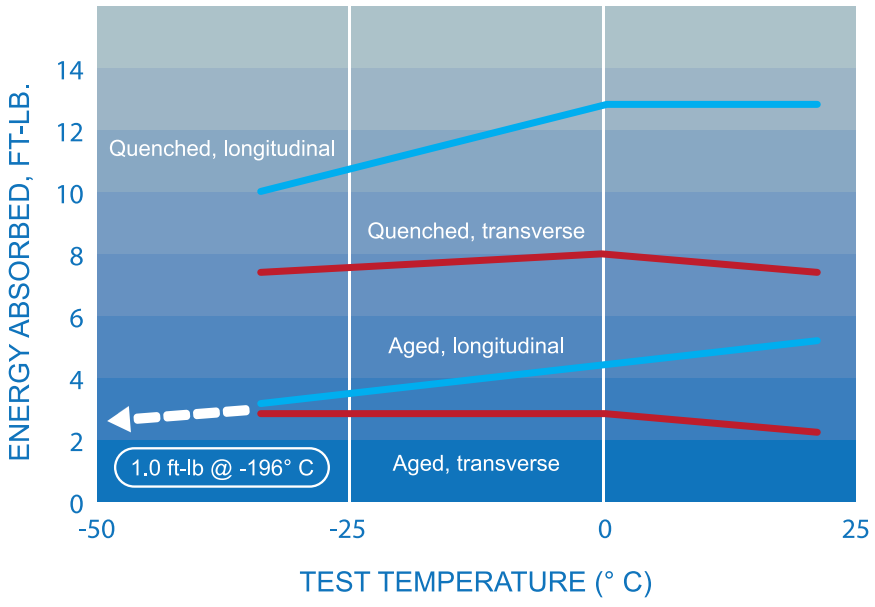
FIG 3. OTHER PROPERTIES (TYPICAL) FOR BLACK TITANIUM - PROPERTY VALUE AT TEMPERATURE (C°)

PROPERTY	UNITS	23	100	500
COEFFICIENT OF THERMAL EXPANSION	$mm/mm \cdot C^{-1}$	7.6×10^{-6}	7.6×10^{-6}	1.3×10^{-5}
THERMAL DIFFUSIVITY	cm^2/s	0.033	0.039	0.058
THERMAL CONDUCTIVITY	$W/cm \cdot K^{-1}$	0.0758	-	0.1807
	BTU per $hr \cdot ft^2 \cdot F$	52.6	-	125
HEAT CAPACITY	$W \cdot s/g \cdot K^{-1}$	0.423	-	0.584
VICKERS HARDNESS	HV (200 g wgt)	250	-	-
DENSITY	g/cm^3	5.25	-	-
	lb/in^3	0.189	-	-

IMPACT ENERGY TESTING

Results of Impact Energy Testing (Charpy V-notch) are represented by the graph pictured at the right. The curves indicate no ductile-to-brittle transition. Scanning electron microscopy shows ductile fracture at all temperatures to -196°C (-320°F)

FIG 1.IMPACT ENERGY TESTING



CORROSION RESISTANCE

FIG 4. CORROSION RATES IN VARIOUS MEDIA

CORROSIVE MEDIA	TEMPERATURE	CORROSION RATE			
		BLACK TITANIUM	TI-2	Zr702	NB
SEAWATER	AMBIENT	<1	<1	<1	<1
20% HCl	106	>200	>200	<5	50
20%HCl + 200 ppm Fe^{+3}	106	>200	>200	PITTED / SCC	<5
100% ACETIC	118	<1	<1	<1	<1
70% HNO_3	116	<1	5	<1	<1
65% H_2SO_4	150	28	>200	PROPERTY	150