AD-A102 641 BATTELLE COLUMBUS LABS OH F/G 11/6
MECHANICAL-PROPERTY DATA TI-6AL-4V ALLOY, POWDER METALLURGY PRO--ETC(U)
MAY 81 F33615-80-C-5168
UNCLASSIFIED NL

1 OF 1
AD A
102641

END
DATE
FILMED
9-81
DTIC

MECHANICAL-PROPERTY DATA
Ti-6Al-4V ALLOY

POWDER METALLURGY PRODUCT
CHIP

Issued by

Air Force Wright Aeronautical Laboratory
Materials Laboratory
Wright-Patterson Air Force Base, Ohio

May 1981

Prepared by

BATTELLE
Columbus Laboratories
Columbus, Ohio 43201

F33615-80-C-5168

This data sheet was prepared by Battelle's Columbus Laboratories under Contract No. F33615-80-C-5168, under the direction of the Air Force Wright Aeronautical Laboratories, Materials Laboratory, by Mr. Neal Ontko, MLSA, Technical Monitor.

Notices

Ti-6Al-4V Alloy (CHIP)

Material Description

This Ti-6Al-4V alloy, a powder metallurgy product from Dynamet Technology, was received as sixty 5/8" diameter x 5" bars, seven 0.125" x 2" x 12" strips, and nine 3/4" x 3" x 3" blanks.

The chemical composition of this lot is ~~as follows:~~

Chemical Composition	Percent Weight
Aluminum	5.70
Vanadium	4.22
Carbon	0.024
Hydrogen	0.0013
Nickel	0.0112
Oxygen	0.19
Others	0.043
Titanium	Balance.

Processing and Heat Treating

The Ti-6Al-4V alloy was received in the "CHIP"ed condition. "CHIP" (Cold Hot Isostatically Pressed) processing means the material was cold isostatically pressed at 60,000 psi (413.7 MPa), vacuum sintered at 2250 F (1505 K) for 3 hours and furnace cooled, and hot isostatically pressed at 15,000 psi (103.4 MPa) at 1650 F (1172 K) to achieve the desired density and mechanical properties.

Results of ~~this evaluation~~ show slightly lower strength values than for the wrought annealed material. The tensile and compression results were slightly lower while the bearing and shear results were slightly higher.

A

Ti-6Al-4V

Condition: CHIP[a]

Properties	RT	(RT)	400	(477)	800	(700)
	Temperature, F (K)					
Tension						
TUS, ksi (MPa)	127.4	(878.4)	96.0	(661.9)	76.6	(528.2)
TYS, ksi (MPa)	115.8	(798.4)	83.2	(573.7)	60.4	(416.5)
RA, percent	12.2	(12.2)	16.1	(16.1)	26.7	(26.7)
e, percent in 1 in. (25.4 mm)	6.7	(6.7)	7.0	(7.0)	10.8	(10.8)
E, 10^3 ksi (GPa)	16.9	(116.5)	15.7	(108.3)	13.6	(93.8)
Compression						
CYS, ksi (MPa)	123.8	(853.6)	83.3	(574.4)	61.0	(420.6)
E_c, 10^3 ksi (GPa)	15.9	(109.6)	15.0	(103.4)	13.2	(91.0)
Shear						
SUS, ksi (MPa)	88.8	(612.3)	71.3	(491.5)	55.3	(381.4)
Bearing						
e/D = 1.5						
BUS, ksi (MPa)	212.6	(1465.7)	154.6	(1065.8)	151.1	(1041.8)
BYS, ksi (MPa)	209.7	(1446.1)	142.8	(984.3)	120.6	(831.4)
e/D = 2.0						
BUS, ksi (MPa)	262.0	(1806.0)	195.4	(1347.6)	192.6	(1328.3)
BYS, ksi (MPa)	242.0	(1669.0)	173.5	(1196.1)	140.7	(970.3)
Fracture Toughness						
K_{IC}, ksi$\sqrt{\text{in.}}$ (MPa$\cdot$m$^{1/2}$)	36.7[b]	(40.4)	NA[c]		NA	
Axial Fatigue						
Unnotched, R = 0.1						
10^3 cycles, ksi (MPa)	124	(854)	NA		73	(503)
10^5 cycles, ksi (MPa)	64	(441)			48	(331)
10^7 cycles, ksi (MPa)	45[d]	(310)			35[d]	(241)
Notched, K_t = 3.0, R = 0.1						
10^3 cycles, ksi (MPa)	(e)		NA		62[d]	(427)
10^5 cycles, ksi (MPa)	34	(234)			25	(172)
10^7 cycles, ksi (MPa)	19	(131)			15	(103)

Ti-6Al-4V (Continued)

Properties	Temperature, F (K)					
	RT	(RT)	400	(477)	800	(700)
Creep						
0.2% plastic deformation, 100 hr, ksi (MPa)	NA		NA		47.5	(327.5)
0.2% plastic deformation, 1000 1000 hr, ksi (MPa)	NA		NA		34.0	(234.4)
Stress Rupture						
Rupture, 100 hr, ksi (MPa)	NA		NA		50.0	(344.7)
Rupture, 1000 hr, ksi (MPa)	NA		NA		42.1	(290.3)

Stress Corrosion[f]

K_{ISCC} - 15 ksi$\sqrt{\text{in.}}$ (16.5 MPa·$m^{1/2}$)

Coefficient of Thermal Expansion

6.0 x 10^{-6} in./in./F (70 - 800 F) [10.8 x 10^{-6} m/(m·k) (295 - 700 K)]

Density

0.159 lb./in.^{3} (4.41 g/cm^3)

(a) Cold isostatically pressed, vacuum sintered and hot isostatically pressed. Values are average of triplicate tests conducted at Battelle under the subject contract unless otherwise indicated. Fatigue, creep, and stress-rupture values are from curves generated using the results of a greater number of tests.

(b) K_{IC} is valid as per ASTM E399.

(c) NA, not applicable.

(d) Estimated.

(e) Insufficient tests to estimate.

(f) This value is an approximate determination of K_{ISCC} at 10^{-8} in./sec. (25.4 x 10^{-8} mm/sec.). The increasing K tests lasted an average of 3 days and were conducted at 75 F (297 K) in 3-1/2% NaCl. Compact-tension-type specimens were used.

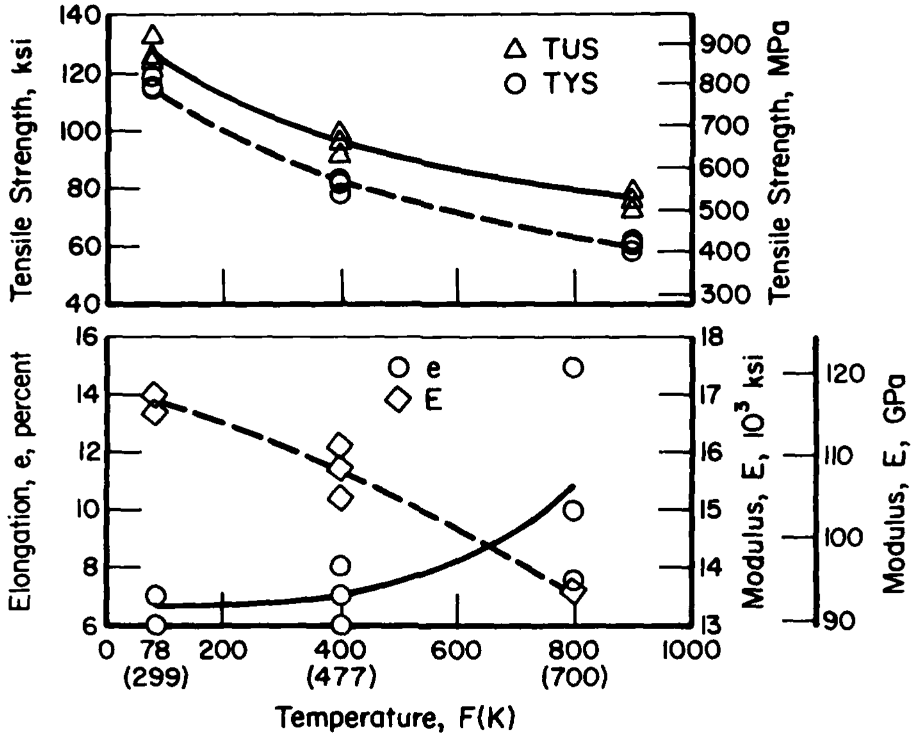

Figure 1. *Effect of temperature on the tensile properties* of Ti-6Al-4V (CHIP) Alloy.

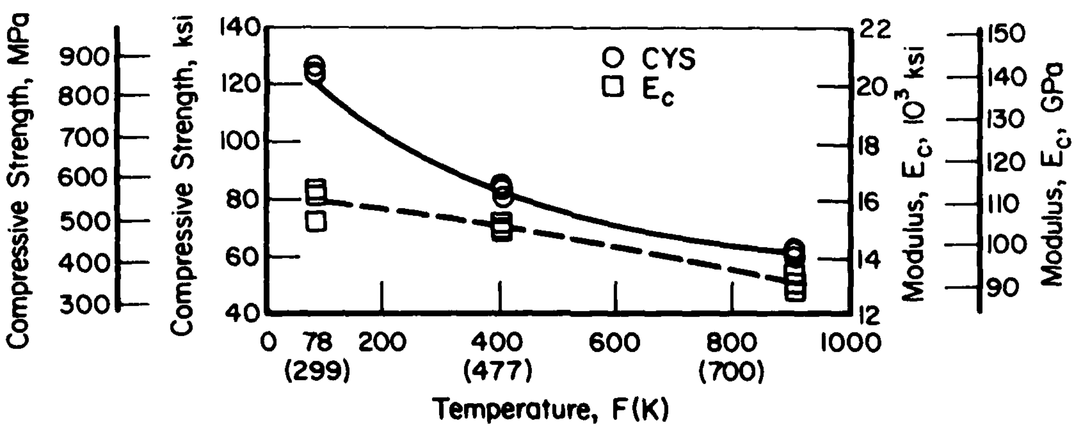

Figure 2. Effect of temperature on the compressive properties of Ti-6Al-4V (CHIP) Alloy.

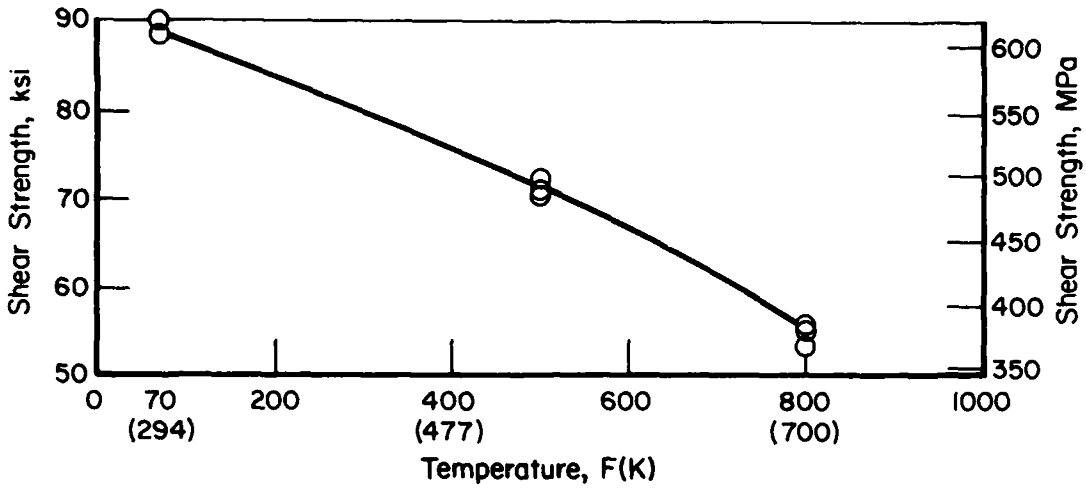

Figure 3. Effect of temperature on the pin shear properties of Ti-6Al-4V (CHIP) Alloy.

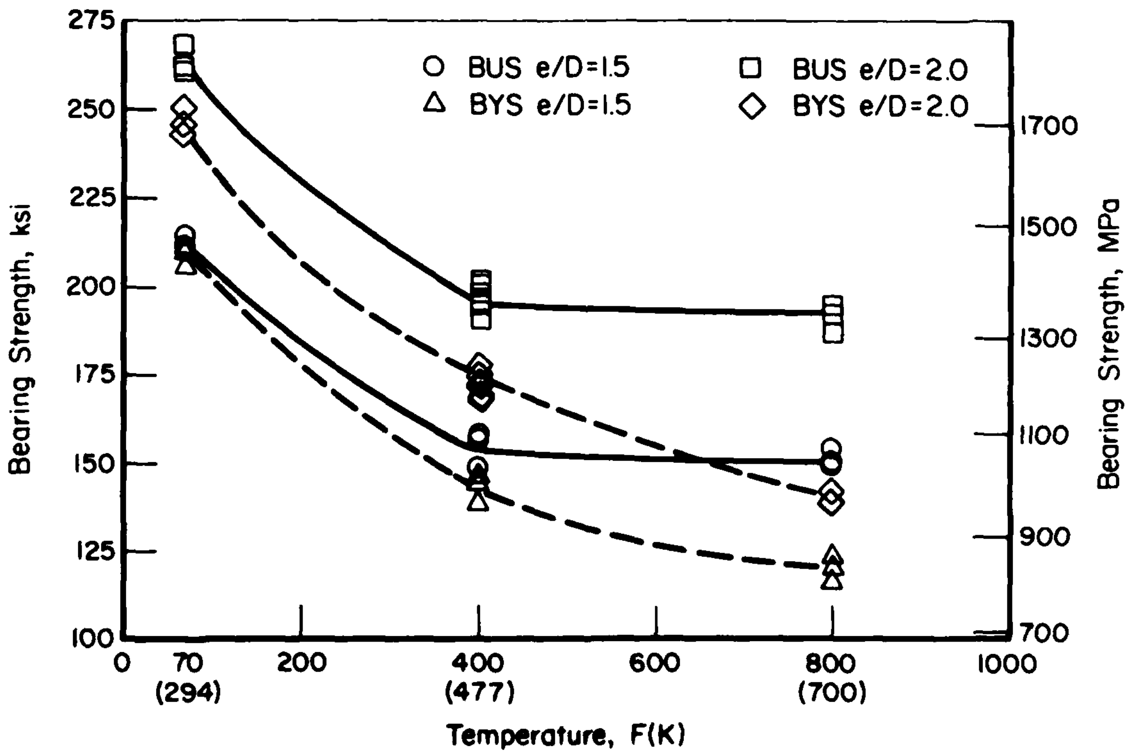

Figure 4. Effect of temperature on the bearing properties of Ti-6Al-4V (CHIP) Alloy.

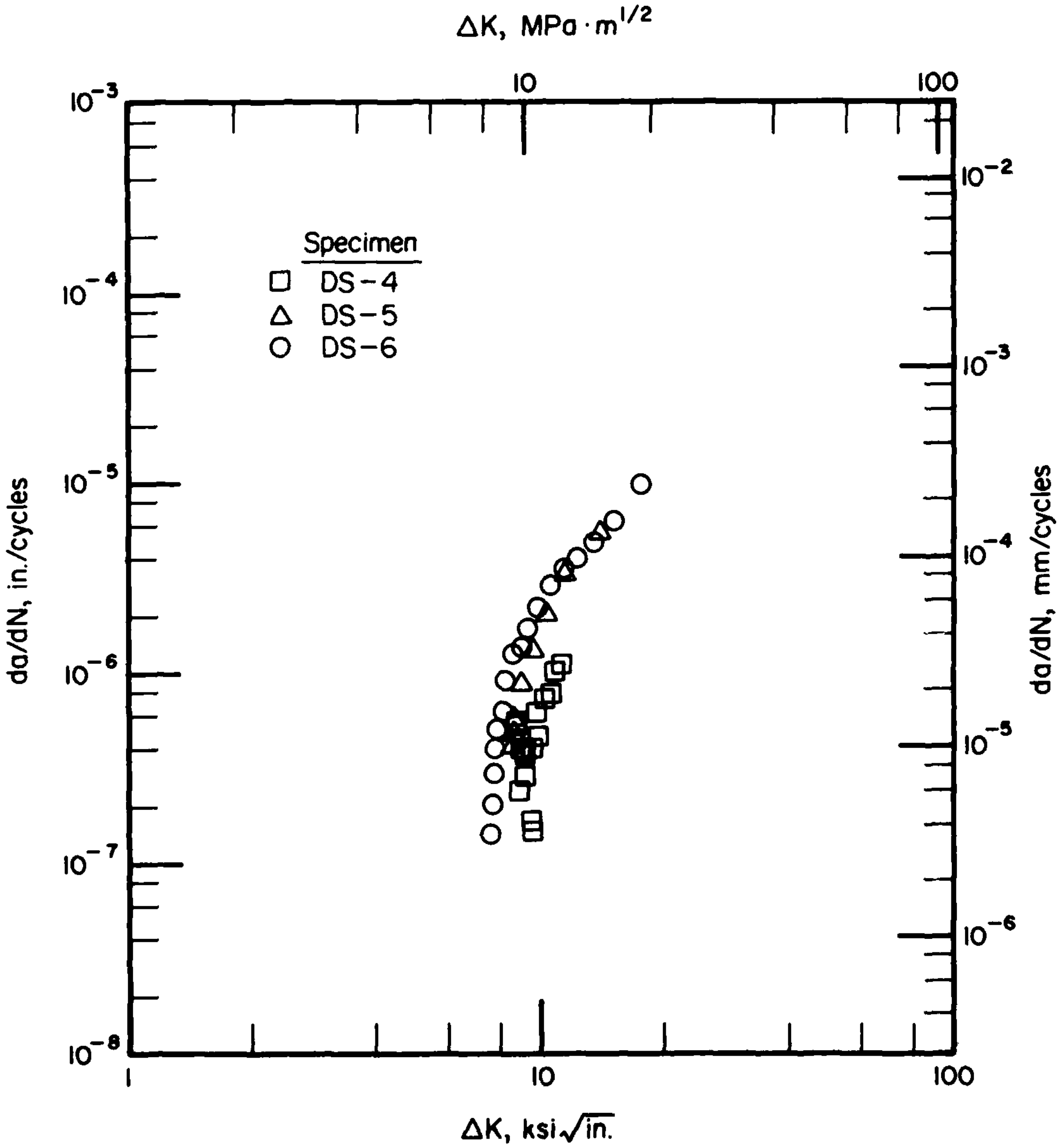

Figure 5. da/dN versus delta K for Ti-6Al-4V (CHIP) Alloy.

Lab Air
R = 0.1
Frequency = 20 Hz

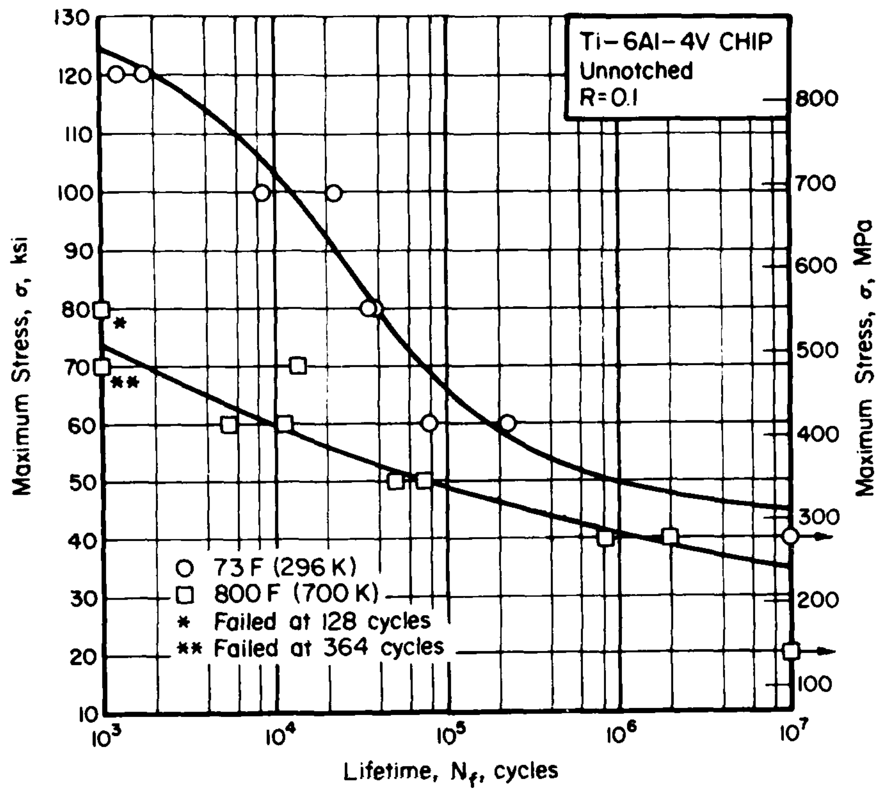

Figure 6. Axial load fatigue behavior of unnotched Ti-6Al-4V (CHIP) Alloy.

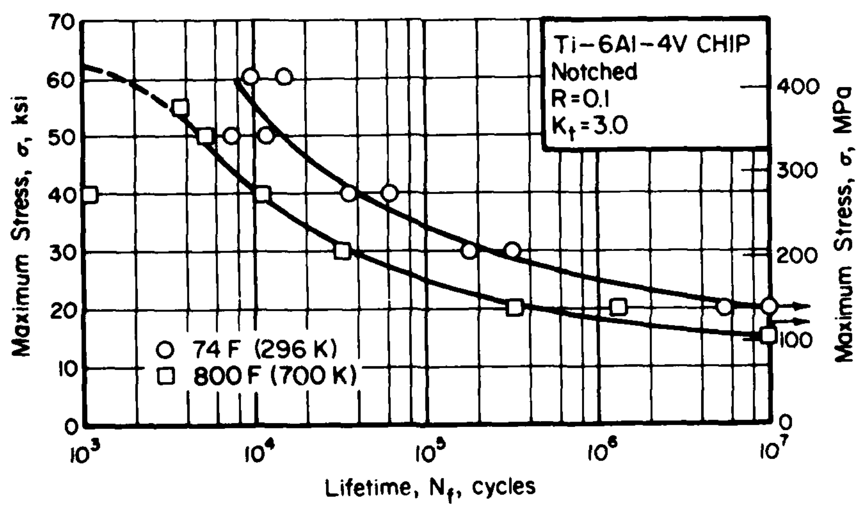

Figure 7. Axial load fatigue behavior of notched (k_t = 3.0) Ti-6Al-4V (CHIP) Alloy.

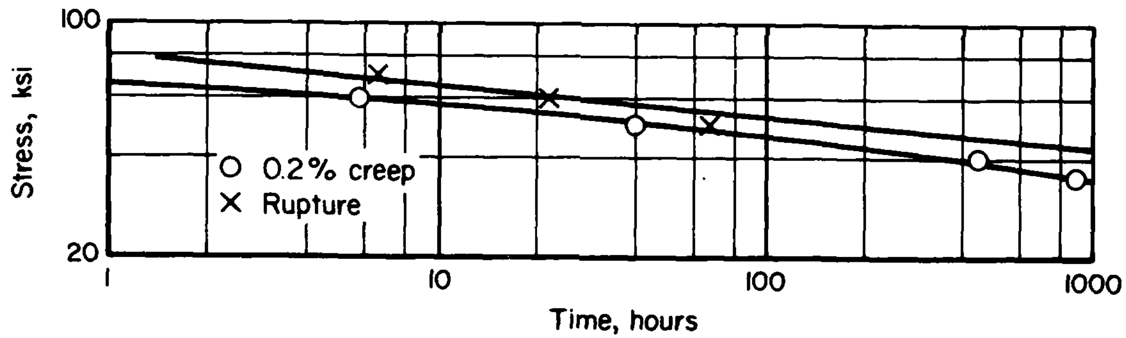

Figure 8. Stress-rupture and plastic deformation curves for Ti-6Al-4V (CHIP) Alloy.

ATE

LMED

-8