Grade	Specification	Product Form	Standard Condition	Maximum Diameter or Thickness
Gr.1	ASTM B348-Gr.1	Bars and Billets	No Requirement	
	ASTM F-67(Gr.1)	Unalloyed Titanium for Surgical Implants	Annealed	
	ISO 5832-2(Gr.1)	Unalloyed Titanium for Surgical Implants	Annealed	
Gr.2 (CP 40)	ASTM B348-Gr.2	Bars and Billets	No Requirement	
	ASTM F-67(Gr.2)	Unalloyed Titanium for Surgical Implants	Annealed	
	ISO 5832-2(Gr.2)	Unalloyed Titanium for Surgical Implants	Annealed	
Gr.3	ASTM B348-Gr.3	Bars and Billets	No Requirement	
	ASTM F-67(Gr.3)	Unalloyed Titanium for Surgical Implants	Annealed	
	ISO 5832-2(Gr.3)	Unalloyed Titanium for Surgical Implants	Annealed	
Gr.4 (CP-70)	ASTM B348-Gr.4	Bars and Billets	No Requirement	
	AMS 4921	Bars, Wires, Forgings, Rings	Annealed	
	MIL-T-9047 Ti-CP-70	bars, reforging stock	Various Conditions	
	ASTM F-67	Unalloyed Titanium for Surgical Implants	Annealed	
	ISO 5832-2(Gr.4)	Unalloyed Titanium for Surgical Implants	Annealed	
Ti3Al2.5V	ASTM B348-Gr.9	Bars and Billets	No Requirement	
Ti6Al4V	AMS 4928	Bars, Wires, Forgings, Rings and Drawn Shapes	Annealed	
	AMS 4963			
	AMS 4965	Bars, Wires, Forgings, Rings	Solution Treated and Aged	
	AMS 4967	Bars, Wires, Forgings, Rings	Annealed	
	AMS 6930	bars, forgings	Solution Treated and Aged	
	AMS 6931	bars, forgings	Annealed	
	ASTM F-1472	Surgical Implant applications	Annealed +	
	ISO 5832-3	Implants for Surgery-Metallic materials		75 mm
	AMS-T-9047 obsolete	bars, reforging stock	Various Conditions	
	MIL-T-9047 obsolete	bars, reforging stock	Various Conditions	

Ti6Al4V ELI	ASTM B348-Gr.23	Bars and Billets	No Requirement	
	AMS 4930	Bars, Wires, Forgings, Rings	Annealed	
	AMS 6932	bars, forgings, and forging stock	Annealed	
	ASTM F-136	Surgical Implant applications	Annealed +	
Ti6Al7Nb	ASTM F1295			
	ISO 5832-11	Implants for Surgery-Metallic materials		100 mm
Ti4.5Al3V2Mo2Fe	AMS 4964	Bars, Wires, Forgings, Rings	Annealed	
Ti6Al6V2Sn	AMS 4971	Bars, Wires, Forgings, Rings	Annealed	
	AMS 4978	Bars, Wires, Forgings, Rings	Annealed	
	AMS 4979	Bars, Wires, Forgings, Rings	Solution and Precipitation Heat Treated	
	MIL-T-9047			
Ti6Al2Sn4Zr2Mo	AMS 4975	Bars, Wires, Rings	Solution and Precipitation Heat Treated	
	AMS 4976	forgings	Solution and Precipitation Heat Treated	
	MIL-T-9047			
	AMS 6935	bars, forgings, and forging stock	Solution Treated and Aged	
	AMS 6936	bars, forgings, and forging stock	Annealed	
	AMS 6905	bars, forgings, and forging stock	Duplex Annealed	
Ti6Al2Sn4Zr6Mo	AMS 4981	bars, forgings, and forging stock	Heat Treated	
	Mil-T-9047			
	AMS 6906			
	AMS 6907			
Ti8Al1Mo1V	AMS 4972	bars, forgings, and forging stock	Heat Treated	
Ti10V2Fe3Al	AMS 4983A			
	AMS 4984			
	AMS 4986	forgings		
	AMS 4987			
Ti3Al8V6Cr4	AMS 4957	Bar, wire	Solution Treated& cold drawn	
	AMS 4958	Bar, billet	Solution Treated	

Mo4Zr			and Aged	
	ASTM B348-Gr.29	Bars and Billets		

Ti-6Al-4V

Ti-6Al-4V is a kind of typical α＋β titanium alloy, which is of medium/high strength, excellent fracture toughness, fatigue performance and good processing performance. Ti-6Al-4V alloy has most widely application scope at present, which are mainly used in manufacture of aircraft structure, engine blade and fastener . Fermi can supply a wide range size of Ti-6Al-4V finished products with dia.1.6mm to dia.400mm in form of billets, forgings, slabs, bars, rods and wires according to various industry specifications. Currently Ti-6Al-4V alloy is one of typical products.

Table 1

Chemical Composition											
Ti	Al	V	Fe	C	N	H	O	Y	Si	Total	
										Each	Total
balance	5.5~6.5	3.5~4.5	≤0.30	≤0.05	≤0.03	≤0.0125	≤0.20	≤0.005	≤0.10	≤0.1	≤0.30

Table 2

Mechanical Properties					
Diameter	Direction	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
≤50.8	L LT	≥931	≥862	≥10 ≥10	≥25 ≥20
>50.8～101.6	L LT ST	≥896	≥827	≥10 ≥10 ≥10	≥25 ≥20 ≥15
>101.6～152.4	L LT ST	≥896	≥827	≥10 ≥10 ≥8	≥20 ≥20 ≥15

Ti-4.5Al-3V-2Fe-2Mo

Ti-4.5Al-3V-2Fe-2Mo (SP700) is a kind of α + β titanium alloy of rich beta phase through adding beta stable elements of Mo and Fe based on Ti-6Al-4V alloy. Compare to Ti-6Al-4V alloy, SP700 is of better cold and hot process formability, higher strength, plasticity, fracture toughness and fatigue strength. The most prominent is that SP700 titanium alloy can get excellent mechanical properties through choosing suitable heat treatment condition and controlling microstructure.

Table 1

Chemical Composition											
Ti	Al	V	Mo	Fe	C	N	H	O	Y	Residual	
										each	Total
balance	4.00-5.00	2.50-3.50	1.80-2.20	1.70-2.30	≤0.08	≤0.05	≤0.015	≤0.18	≤0.005	≤0.1	≤0.40

Table 2

Mechanical Properties						
AMS 4964	Diameter(mm)	Direction	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
	≤50.8	L	≥931	≥862	≥10	≥25
		L T			≥10	≥20
		S T			-	-
	50.8～101.6	L	≥896	≥827	≥10	≥25
		L T			≥10	≥20
		S T			≥10	≥15
	101.6～152.4	L	≥896	≥827	≥10	≥25
		L T			≥10	≥20
		S T			≥8	≥15

Ti6Al4V ELI

Ti-6Al-4V ELI alloy has higher strength and good processing performance, which are widely used in medical industry and covers a broad range of applications including joint replacement, dental implants, bone plate for fracture fixation and surgical instruments.

Table 1

Chemical Composition										
Ti	Al	V	Fe	C	N	H	O	Y	Other	
									Each	Total
Balance	5.6~6.5	3.4~4.5	≤0.25	≤0.08	≤0.05	≤0.0125	≤0.13	≤0.005	≤0.1	≤0.40

Table 2

Mechanical Properties						
Specification	Diameter (mm)	Direction	σb (MPa)	σ0.2 (MPa)	δ5 (%)	Ψ (%)
AMS4930	≤38.10	L	≥862	≥793	≥10	≥25
	＞38.10-50.80	L	≥827	≥758	≥10	≥20
	＞50.80-63.50	L	≥827	≥758	≥8	≥15
	＞63.50-101.60	L	≥827	≥758	≥8	≥15
WS/D99/102	＜44.45	L	≥860	≥795	≥10	≥25
INST5.0.11.1	44.45～＜63.5	L	≥860	≥780	≥10	≥20
	63.5～75	L	≥860	≥780	≥10	≥15
	＞75～101.6	L	≥825	≥760	≥8	≥15
FRM 6.1.0.45	＜65.5	L	≥900	≥800	≥12	≥35
TIS380.Z	≤6.35	L	≥998	≥860	≥16	≥35
	＞6.35	L	≥860	≥790	≥10	≥25

ASTM F136	＜4.75 4.75-44.45 ＞44.45-63.5 ＞63.5-101.6	L L L L	≥860 ≥860 ≥825 ≥825	≥795 ≥795 ≥760 ≥760	≥10 ≥10 ≥8 ≥8	≥25 ≥20 ≥15

Table 3

Ultrasonic Test				
Diameter	Class	FBH (mm)	Noise Signal (dB)	Loss of Back Echo
≤60	AA	≤0.8	-6	≤50％
＞60	A1	≤2.0	-6	≤50％

Ti -6Al -6V -2Sn

Ti-662 alloy is successfully researched by New York university in US and is a kind of high strength α＋β titanium alloy developed based on Ti-6Al-4V titanium alloy, which is famous with good comprehensive performance. Ti-662 alloy is of excellent oxidation resistance, weld ability and corrosion resistance. At the same time, the high V content and Sn element bring high strength and performance, which tensile strength can reach to 1050MPain annealed condition and reach to 1175MPa after quench and aging treatment at 450℃temperature. Hence, Ti-662 alloy is much better than Ti-6Al-4V alloy on hardening and effect of heat treatment. At the meanwhile, it is broader than Ti-6Al-4V alloy on performance tuning range. At present, this kind of alloy has attracted more and more attention.

Table 1

Chemical Composition												
Ti	Al	V	Sn	Fe	Cu	C	O	N	H	Y	Residual	
											Each	Total
balance	5.0-6.0	5.0-6.0	1.5-2.5	0.35-1.0	0.35-1.0	≤0.05	≤0.20	≤0.04	≤0.015	≤0.005	≤0.10	≤0.40

Table 2

Mechanical Properties						
	Diameter	Direction	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
AMS 4978F	≤50.8	L	≥1034	≥965-1138	≥10	≥20
		T			≥8	≥15
	>50.8～101.6	L	≥1000	≥931-1103	≥10	≥15
		T			≥8	≥15

Table 3

Mechanical Properties							
	Diameter	Size of cross section when heat treatment	Direction	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
AMS 4971F	≤25.4	≤25.4	L	≥1207	≥1103	≥8	≥20
			T		≥1207	≥6	≥15
	>25.4~50.8	≤25.4	L	≥1207	≥1103	≥8	≥20

			T		≥1207	≥6	≥15
		>25.4~50.8	L	≥1172	≥1069	≥8	≥20
			T			≥6	≥15
	>50.8～76.2	≤25.4	L	≥1172	≥1103	≥8	≥20
			T			≥6	≥15
		>25.4~50.8	L	≥1138	≥1069	≥8	≥20
			T			≥6	≥15
		>50.8~76.2	L	≥1069	≥1000	≥8	≥20
			T			≥6	≥15
	>76.2~101.6	≤25.4	L	≥1138	≥1069	≥8	≥20
			T			≥6	≥15
		>25.4~50.8	L	≥1103	≥1034	≥8	≥20
			T			≥6	≥15
		>50.8~76.2	L	≥1069	≥1000	≥8	≥20
			T			≥6	≥15
		>76.2~101.6	L	≥1034	≥965	≥8	≥20
			T			≥6	≥15

Ti-6Al-7Nb

Due to good bio-compatible and low elastic modulus, Ti6Al7Nb are broadly used in bio-medical fields. Ti6Al4V alloy currently having most applications is queried because of containing poisonous V element for body cell, so Ti6Al7Nb alloy is best replacement through using nontoxic Nb element instead of V element. WST supply Ti6Al7Nb bars according to ISO 5832-11 and ASTM F1295 standards, mainly used for joint replacement and trauma products etc.

Table 1

Chemical Composition										
Ti	Al	Nb	Ta	Fe	C	N	H	O	Other	
									Each	Total
balance	5.6~6.5	6.5-7.5	≤0.50	≤0.25	≤0.08	≤0.05	≤0.009	≤0.20	≤0.1	≤0.40

Table 2

Mechanical Properties					
Delivery Condition	Direction	σb (MPa)	σ0.2 (MPa)	δ5 (%)	ψ (%)
Annealed	L	≥900	≥800	≥10	≥25
Hot Processed	L	≥900	≥800	≥10	≥25
Cold Processed	L	≥1100	≥800	≥10	≥25

Table 3

Ultrasonic Test			
Class	FBH (mm)	Noise Signal (dB)	Loss of Back Echo
A1	≤2.0	-6	≤50%

Ti-6Al-2Sn-4Zr-6Mo

Ti-6Al-2Sn-4Zr-6Mo is kind of α+β titanium alloy that can be strengthened by solution treatment,
The long-term use of temperature of this alloy can up to 450℃, which is lower a little than that of Ti-6Al-2Sn-4Zr-2Mo high temperature alloy. But Ti-6Al-2Sn-4Zr-6Mo is of higher strength at the high temperature, which is used for manufacture of aircraft engine spare parts with high bearing capacity in middle temperature section like discs of compressor etc. At the same time, the short-term use of temperature of Ti-6Al-2Sn-4Zr-6Mo alloy can up to 540℃. Besides having excellent strength of high temperature and creep resistance, Ti-6246 alloy is not sensitive for fatigue way with full load. This alloy become the first choice material of compressor spare parts working for long time at 400℃-450℃ in order to meet long life and high reliable design requirement of aircraft engine.

Table 1

Chemical Composition												
Ti	Al	Sn	Zr	Mo	Fe	O	N	C	H	Y	Residual	
											Each	Total
balance	5.50-6.50	1.75-2.25	3.50-4.50	5.50-6.50	≤0.15	≤0.15	≤0.04	≤0.04	≤0.0125	≤0.005	≤0.1	≤0.40

Table 2

Mechanical Properties						
AMS 4981F	Diameter(mm)	Temperature	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
	>12.70-63.50	Room temperature	≥1172	≥1103	≥10	≥20
	>63.50-76.20		≥1138	≥1069	≥8	≥15
	>76.20-101.60		≥1103	≥1034	≥8	≥15
		427℃	≥931	≥724	≥10	≥30
Creep			427℃/35h/655Mpa, ≤0.20%			

Ti-6Al-2Sn-4Zr-2Mo

Ti-6Al-2Sn-4Zr-2Mo is near α titanium alloy with high creeping resistance, which is working at 470℃-550℃ and mainly used for manufacture of discs and blades of high pressure compressor of aero-engine. This alloy was successfully developed in 1974 by foreign and was done a lot of basic and applied research and development. At present, Ti-6242 alloy has been successfully used for aero-engine of F414, F119 and TRENT800 aircrafts.

Table 1

Chemical Composition												
Ti	Al	Sn	Zr	Mo	Si	Fe	O	N	C	H	Y	Residual
												Each Total
balance	5.50-6.50	1.80-2.20	3.60-4.40	1.80-2.20	0.06-0.10	≤0.10	≤0.15	≤0.05	≤0.05	≤0.01	≤0.005	≤0.1 ≤0.30

Table 2

Mechanical Properties						
AMS 4976H-2012	Diameter	Temperature	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
	20<Φ≤350mm	Room temperature	≥896	≥827	≥10	≥25
		482℃	≥621	≥483	≥15	≥30
		Creep	510℃/35h/241Mpa, ≤0.10%			
		KIc	1170 MPa, ≥5h			

Table 3

Ultrasonic Test as per AMS 2628							
Ultrasonic Classification	Near-Surface Hole Depth Inch	Billet Diameter Inches	Calibration FBH Diameter Inch	Calibration Amplitude	Max Acceptable Amplitude	Max Acceptable Signal-to-Noise Ratio	Data Recording
A	0.20	≤10	2/64	80%	70%	2.5	Digital
		>10	3/64	80%	40%(1)	2.5	
					60%(2)	2.5	

Ti-10V-2Fe-3Al

Ti-1023 alloy is a kind of high strength and high toughness titanium alloy, which was developed in the late 1970s for adapting the requirement of design principle of damage tolerance.

Table 1

Chemical Composition										
Ti	V	Fe	Al	O	C	N	H	Y	Residual	
									Each	Total
balance	9.0-11.0	1.6-2.2	2.6-3.4	≤0.13	≤0.05	≤0.05	≤0.010	≤0.005	≤0.1	≤0.30

Table 2

Mechanical Properties						
Direction	σb (MPa)	σ0.2 (MPa)	δ5 (%)	Ψ (%)	HB	K1C (MPa)√m
L	1100-1250	≥1000	≥6	≥15	≥320	-
T	1100-1250	≥1000	≥4	≥10	≥320	-
C-R	-	-	-	-	-	≥50

Ti -8Al-1Mo-1V

Ti-811 alloy is a kind of near α titanium alloy with high content of Al element, which was successfully researched in USA in 1954. It has excellent mechanical properties at the room temperature and high temperature, which tensile strength at the room temperature is similar with that of Ti-6Al-4V and tensile strength and creep properties at 425℃ high temperature is better than other α and α+β titanium alloy. Due to higher Young's modulus and good vibration damping performance, Ti-811 alloy can stably work for a long time at 450℃ temperature and is one of ideal material of the first three section of the blade on high pressure

compressor of aero-engine. At present, Fermi can supply Ti-811 bars in size of dia.16-60mm with length of 500-3200mm according to AMS 4972G-2011.

Table 1

Chemical Composition											
Ti	Al	V	Mo	Fe	C	N	H	O	Y	Residual	
										Each	Total
balance	7.35-8.35	0.75-1.25	0.75-1.25	≤0.30	≤0.08	≤0.05	≤0.0125	≤0.12	≤0.005	≤0.1	≤0.30

Table 2

Mechanical Properties						
	Diameter	Temperature	σb (MPa)	σ0.2 (MPa)	A (%)	Z (%)
AMS 4972G-2011	16<Φ≤60mm	Roomtemperature	≥895	≥825	≥10	≥20
		425℃	≥620	≥485	≥10	≥25
		425℃/100h	≥895	≥825	≥9	≥18
		Creep	425℃/100h/410Mpa, ≥0.2%			
		KIc	Φ<40mm	1035 MPa, ≥5h		
			Φ≥40mm	895 MPa, ≥5h		

Table 3

Ultrasonic Test		
Diameter	FBH(mm)	Noise Signal(dB)
16<Φ≤60mm	Φ≤0.8	-12

CP -Ti

CP-Ti is a kind of commercial pure titanium including Gr1, Gr.2 and Gr.3, usually only requiring tensile strength, microstructure and macrostructure at the room temperature according to ISO 5832-2, TIS381P, AMS 4921L and MIL-T-9047G. At present, WST can supply CP-Ti bars in size of dia.1.2-250mm, with tensile strength between 200Mpa to 700Mpa and elongation of 20-25%, which has the very good match of tensile strength and plasticity.

Table 1

Chemical Composition								
Grade	Ti	Fe	C	N	O	H	Other	
							each	total
Gr1	Balance	≤0.20	≤0.10	≤0.03	≤ 0.18	≤0.0125	≤0.1	≤0.30
Gr2	Balance	≤0.30	≤0.10	≤0.03	≤ 0.25	≤0.0125	≤0.1	≤0.30
Gr3	Balance	≤0.30	≤0.10	≤0.05	≤ 0.35	≤0.0125	≤0.1	≤0.30

Table 2

Mechanical Properties				
Grade	Direction	σb (MPa)	σ0.2 (MPa)	δ5 (%)
Gr1	L	≥240	≥170	≥24
Gr2	L	≥345	≥275	≥20
Gr3	L	≥450	≥380	≥20

Table 3

Ultrasonic Test			
Class	FBH (mm)	Noise Signal (dB)	Loss of Back Echo
AA	≤3.2	-6	≤50%
A1	≤2.0	-6	≤50%
A	≤1.2	-6	≤50%
B	≤0.8	-6	≤50%

Ti-3Al-2.5V

Ti-3Al-2.5V is a kind of near α titanium alloy, whose tensile strength at the room temperature and high temperature are higher by 20% to 50% than that of CP titanium, and welding and cold forming performance are more excellent than that of Ti-6Al-4V. Beta transfer temperature of Ti-3Al-2.5Vis around 925℃. Microstructure of Ti-3Al-2.5V is equiaxed alpha phase and a few beta phase in annealed condition and elongated alpha phase in cold process condition. Fermi can supply Ti-3Al-2.5V wires in size of dia.2.0mm to dia.6.0mm according to ASTM B348 standard, which are mainly used in manufacture of welding structure parts that require higher tensile strength and good cold forming performance, and high-end spectacle frames.

Table 1

Chemical Composition										
Grade	Ti	Al	V	N	O	Fe	C	H	Other	
									Each	Total
Gr9	Balance	2.5~3.5	2.0~3.0	≤0.03	≤ 0.15	≤0.25	≤0.08	≤0.015	≤0.1	≤0.40

Table 2

Mechanical Properties (at room temperature)					
Specification	Diameter (mm)	σb (MPa)	σ0.2 (MPa)	Δ4D (%)	Ψ (%)
ASTM B348-13	2.0~6.0	≥620	≥483	≥15	≥25

Ti-CP-70

Ti-CP-70 is a kind of commercial pure titanium, which are very similar to Gr.4 and has same microstructure and mechanical properties with Gr.4 material, usually only requiring tensile strength, microstructure and macrostructure at the room temperature according to AMS 4921L and MIL-T-9047G. At present, WST can supply Ti-CP-70 bars in size of dia.30-70mm, with tensile strength between 650Mpa to 720Mpa and

elongation of 20-30%, which has the very good match of tensile strength and plasticity.

Table 1

Chemical Composition							
Ti	Fe	C	N	O	H	Other	
						each	total
Balance	≤0.50	≤0.08	≤0.05	≤ 0.40	≤0.0125	≤0.1	≤0.30

Table 2

Mechanical Properties						
Specification	Diameter (mm)	Direction	σb (MPa)	σ0.2 (MPa)	δ5 (%)	Ψ (%)
AMS4921L	≤101.6	L	≥552	≥483	≥15	≥30
MIL-T-9047G	≤101.6	L	≥551	≥482	≥15	≥30

Table 3

Ultrasonic Test			
Class	FBH (mm)	Noise Signal (dB)	Loss of Back Echo
AA	≤3.2	-6	≤50%
A1	≤2.0	-6	≤50%
A	≤1.2	-6	≤50%
B	≤0.8	-6	≤50%