DONGBEI SPECIAL STEEL GROUP CO.,LTD.
FUSHUN SPECIAL STEEL CO.,LTD.

Titanium Alloy

Advancement in Solution Plan for Metallic Materials

CHINA · FUSHUN

Introduction

Fushun Special Steel Co.,Ltd.(hereinafter referred to as FSSS for short)was set up in 1937, the former Fushun Steel Plant, which is the scientific research and production base of wrought superalloys for aerospace and aviation in China. FSSS, Dalian Iron and Steel Plant and Beiman Special Steel Plant were reorganized to form Dongbei Special Steel Group Co., Ltd. in Sep., 2004. FSSS has the total assets of 10 billion RMB with the manufacturing capacity of 1 million tons of steel and 0.9 million tons of finished products. FSSS has employees of over 8,600, of which special technicians are over 1,100. FSSS has one technical center, which was promoted to one of the first batch of National Enterprise Technical Centers in 1993, and became Enterprise Postdoctoral Science and Research base in Liaoning Province in 2007. There are 5 senior engineers at professor level as well as 30 senior engineers in Technical Center, which is the largest in size and the highest in specializing level among Enterprise Technical Centers.

FSSS began to engage in the development and production of Titanium and Titanium alloy as early as 1960s, and it is one of the enterprises that produced titanium alloy from the earliest time in China. Titanium alloy bars and sheets can be produced in FSSS, which are applied in the sophisticated fields such as aviation and aerospace, and other general industry including chemical-petroleum, metallurgy, electric power, traffic, marine, medical treatment, environment protection, construction, sports, touring and so on.

FSSS has a long history in manufacturing titanium alloy. TA7 sheets were developed in 1965, which were used in First Man-made Earth satellite-No.1 Red East. Titanium bars for WP-6 engine vane and TA7 large bars for WP-7 and WP-13 were developed earlier or later in the following three years. After 1980, titanium alloy of TC4,TC6,TC10 and TC11 were developed and produced for aviation engines and were granted several items of national awards, and especially TC11 titanium alloy disc forging was awarded First Prize of National Prize for Progress in Science and Technology, which was approved by vice premier Fangyi himself at that time. FSSS invested 0.45 billion RMB to renovate the titanium alloy production line in 2010. Titanium and Titanium alloy products were checked by AQSIQ(General Administration of Quality Supervision, Inspection and Quarantine)and granted Production License of Titanium and Titanium alloy processing products in 2011.

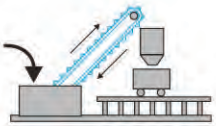
FSSS has formed a systematic and perfect system for titanium alloy including development and trail-production system, production and organization system, quality control system and quality assurance system with nearly 60 years' development of titanium alloy. FSSS has a completed titanium production line and owns production equipments of state-of-art which are introduced from Germany, Austria and USA etc.

Product Name	Product Dimension (mm)	Common Standard	Common Grade
Bars	Forged bars ϕ90-ϕ600 Rolled bars ϕ8-ϕ90	GB/T3621-2007 GB/T2965-2007 GB/T13810-2007 GJB2505A-2008 GJB2218A-2008 GJB2219-2008 GJB2220-2008 GJB494A-2008 GJB1538A-2008 GJB2744A-2007	TA2,TA4, TA6,TA7, TA15,TA19, TB2,TB3, TB4,TB6, TB10,TC1, TC2,TC4, TC4ELI, TC6,TC10, TC11,TC16, TC17,TC18, TC25
Sheets (Thickness×Width×Length)	Hot-rolled sheets (4.0-20.0)X(650-1000)X(1000-2000) Cold-rolled sheets (0.8-4.0)X(700-1000)X(1000-2000)		
Discs (Diameer×Thickness)	ϕ300-800X≥100		
Rings	Various dimensions		
Flats	(40-50)X(130-200)		
Wires	Various dimensions		

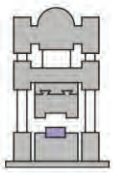
Manufacturing Process

Automatic Mixing

Electrode Pressing

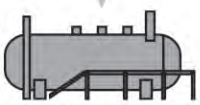


Automatic Mixing



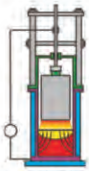
Hydraulic Press

Electrode welding



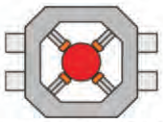
Electrode welding

VIM

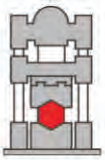


Double or Triple VIM

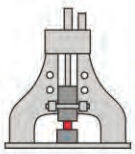
Forging



Radial Forging Machine

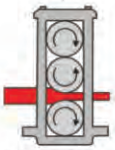


Hydraulic Open-die Forging Press



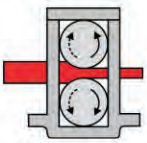
Electro-hydraulic Hammer

Rolling

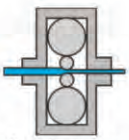


430、250Rolling Mill

Sheet-rolling



Hot-sheet Rolling Mill

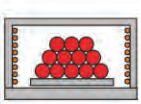


Cold-sheet Rolling Mill

Heat Treatment

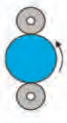
Machining

NDT

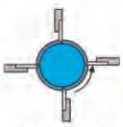


Heat Treatment

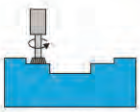
Turing



Grinding

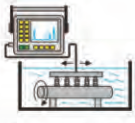


Peeling



Milling

Phase array UT



ImmersionUT

UT

Certificate of Awards

Items	Awards Name and Level
1	The First Prize of National Scientific and Technological Progress Award for Research on Technology of Titanium Alloy Materials and Disc Forgings
2	The First Prize of Scientific and Technological Achievements Award for Superalloy and Titanium Alloy for XXX Engines
3	The Second Prize of Scientific and Technological Contribution Award for Titanium Alloy TC11 for XXX Engines
4	The Second Prize of Scientific and Technological Achievement in Metallurgy for the Development of Titanium Alloy TC4 and its Application in Aviation Engines
5	The Second Prize of Scientific and Technological Progress Award for the Application of Titanium Alloy TC4 in Type XXX Fighters
6	The Third Prize of Scientific and Technological Contribution Award for Titanium Alloy TC4 for XXX Engines
7	The Third Prize of Scientific and Technological Contribution Award in Metallurgy for Titanium Alloy TC4 for XXX Engines
8	The Third Prize of Scientific and Technological Achievement Award in National Defense for Titanium Alloy TC10 for Artillery
9	The Third Prize of Excellent New Product Award of Liaoning Province for Titanium Alloy TA7 Rolling Rings and Die forgings
10	The Fourth Prize of Scientific and Technological Contribution Award for Titanium Alloy TC10 for Artillery
11	The Fourth Prize of Scientific and Technological Achievement in Metallurgy for Titanium Alloy TC10 for Mortars
12	The Fourth Prize of Scientific and Technological Achievement in Metallurgy for Titanium Alloy TC6 for Aviation Engines

The First Prize of Scientific and Technological Achievements Award for Superalloy and Titanium Alloy for XXX Engines

The First Prize of National Scientific and Technological Progress Award for Research on Technology of Titanium Alloy Materials and Disc Forgings

The Second Prize of Scientific and Technological Progress Award for the Application of Titanium Alloy TC4 in Type XXX Fighters

The Fourth Prize of Scientific and Technological Achievement in Metallurgy for Titanium Alloy TC6 for Aviation Engines

Titanium Alloy for Aviation and Aerospace

Titanium alloy is a new type of important structural material for aviation and aerospace industry. It has intermediate specific gravity, strength, and working temperature that are between aluminum and steel, while it has high specific strength and excellent corrosion resistance and ultra–low temperature property, which makes it use more and more in aviation and aerospace industry. Generally, titanium alloy takes up 20 to 30 percent of the total structural weight of airplane engine, and it is mainly applied for the components of gas compressors, such as titanium forged fans, discs and vanes of gas compressors, gas compressor cases made by casted titanium, intermediate cases and bearing housings etc. Titanium alloy products are also made into various kinds of pressure vessels, fuel storage containers, fasteners, instrument binds, frameworks and rocket shells in aircrafts using their high specific strength, corrosion resistance and low–temperature proof ability. Besides, welded parts of titanium alloy sheets are used in man–made satellite, lunar module, manned spacecraft and aviation planes.

Main grade, applications and products of titanium alloy for aviation and aerospace

Grade	Application	Main Products
TC4	Fan disc of engines, gas compressor discs	Forged bars, forgings, rolled products and sheets
TC6	Gas compressor discs, vanes and fasteners etc.	Forged bars and rolled products
TC10	Disc of gas compressor and vanes etc.	Forged bars, rolled products
TC11	Gas compressor Discs, vanes, drums etc.	Forged bars, forgings and rolled products
TC16	Rivet wires	Wires
TA7	Gas compressor cases, high–pressure gas containers	Forged bars, forgings and sheets
TA15	Parts of engines, structural parts of planes and the like.	Forged bars, rolled products and sheets

★Example of Product and its Application

Grade	TC11		
Main Feature	The alloy has the advantages of high specific strength, good property at medium temperature, good corrosion –resisting property, light quality, high yield strength, high fatigue strength etc, and it can be used at temperature of no higher than 500℃ for a long period.	Main Application	It is the ideal material for components and parts of engines for aviation and aerospace, which are mainly applied to gas compressor discs, vanes, fasteners, turbine discs, casings of airplane engines. Besides, it is also widely used in energy and chemical industry etc.

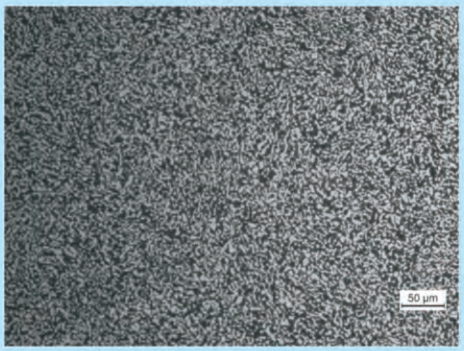
Chemical Analysis wt%

Al	Mo	Zr	Si	Fe	C	N	H	O
5.8 ~ 7.0	2.8 ~ 3.8	0.8 ~ 2.0	0.2 ~ 0.35	≤0.25	≤0.08	≤0.05	≤0.012	≤0.15

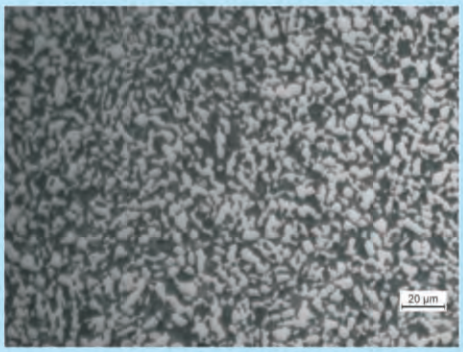
Melting Method

Electrode Pressing+ Triple VAR

Micrograph



X200



X500

Mechanical Property for Φ28 rolled bars (in the longitudinal direction)

Heat–treatment System: 950℃x1h; air cooling plus 530℃x6h; air cooling

	Rm, MPa	Rp0.2, MPa	A, %	Z, %	KV2, J	HBW
Room Temperature (at 20℃)	1133	1054	16.0	46	49	341
	1138	1065	18.0	50	44.3	333
High Temperature (at 500℃)	795	—	20	66	σ (640) MPa ≥35h	—
	795	—	20	65.5		—
500℃ × 100h Hot Exposure	1136	1078	17.0	47.0	—	—
	1125	1063	16.5	46.0	—	—

★Example of Product and its Application

Grade	TA15		
Main Feature	The alloy has better comprehensive property, hot stability and good welding ability, and it can be used at temperature up to 500℃ for a long period.	Main Application	It is mainly used in the main structural components like main force-loading components and parts, engine casings and special-shaped castings etc.

Chemical Analysis wt%

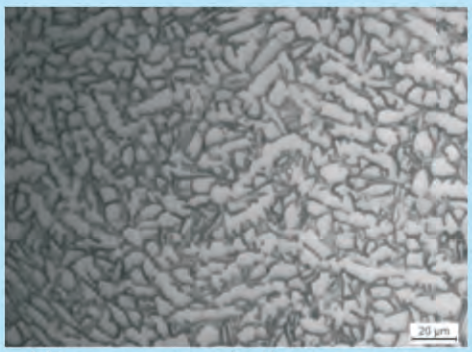
Al	Mo	V	Zr	Si	Fe	C	N	H	O
5.5 ~ 7.1	0.5 ~ 2.0	0.8 ~ 2.5	1.5 ~ 2.5	≤0.15	≤0.25	≤0.08	≤0.05	≤0.015	≤0.15

Melting Method

Electrode Pressing+ Triple VAR

Macrograph and Micrograph(for steel bar with the diameter of 250mm)

Macrostructure in the transverse direction



Microstructure in the transverse direction at X500

Mechanical Property for Φ250 forged bar(in the transverse direction)

Heat-treatment System: 850℃x2h，air cooling

	Rm，MPa	$R_{p0.2}$，MPa	A，%	Z，%	KV2，J	HBW
Room Temperature (at 20℃)	947	885	15.0	51.0	33.3	—
	976	861	15.5	39.0	37.5	—
High Temperature (at 500℃)	734	—	19.5	56	σ（470）MPa ≥50h	—
	696	—	27	64		—
500℃ x 100h Hot Exposure	1077	949	11.6	35.5	—	—
	1060	946	14.0	28.5	—	—

Titanium Alloy for Submarines and Conventional Weapons

Submarine and nuclear submarine possess the characteristic of good-hiding ability and deep-diving ability, and they bear great static load and dynamic load at high speed under winds and waves, while the huge hulls cannot be heat treated after welding, so it is required that the material have high strength, good plasticity and toughness as well as fatigue resistance. Therefore, in all aspects, titanium is the best choice for being the shell material for submarines. Meanwhile, as titanium alloy has non-magnetic ability, it is hard to be discovered by enemy, and it is also not easy to be attacked by magnetic submarine mines. Besides, titanium alloy has high coefficient in sound-penetrating, which makes it suitable for sonar guide covering to improve the detecting ability of submarine. Typical grades include TA7, TA16, TA17 and TC4.

Lightening is the development trend of conventional arms and weapons. Light weapons are easier to carry, so as to improve the fighting ability of the army, and mobility can be improved for heavy weapons such as tankers, fighting cars. After titanium alloy products are used in weapons, it is easier for weapons to store and less in maintenance cost at the same time for their good corrosion resistance.

It is seen from the development trend of modern tankers of USA that the number, thickness and quality of protection layers are continuously increased in order to improve the anti-destructive ability of tankers. However, it is not good for tank to travel as the quality of tank increases. Therefore, titanium alloy can be used in tankers to lighten the tank, so as to improve the fighting ability.

Titanium alloy is also widely used in other heavy and light weapons, for example, it can be made into the components and parts for light howitzer, the cabins and frames for anti-tank missiles, the cannon body and base plates for interference missile launchers and mine throwers, besides, bulletproof clothes and helmet can also be made from titanium alloy. If Titanium memory alloys are installed on the missile, guide cannonball and the cannonball tail, they can be precisely guided and controlled. If titanium alloy products are applied to machinegun, the quality of machinegun can be lightened and backseat force can be reduced. Typical grades include TA1, TA7, TA18, TC4, TC9 and TC18.

★Example of Product and its Application

Grade	TC18		
Main Feature	The alloy has the advantages of high strength, high plasticity, good hardenability and weldability etc. The alloy is the kind of alloy which has the highest strength in the annealing condition, and there are basically equal amount of α –phase and β –phase in the annealing structure. It is well weldable after annealing and it can be welded by various ways. The highest working temperature for the alloy is 400℃.	Main Application	It is mainly applied to large force–bearing components and parts on the plane body and landing gears, as well as fan discs and vanes of engine with the working temperature of no higher than 350℃, and also applied to key force– bearing components such as wheel forks and torque arms of the leading gears. Besides, it is also applied to rockets, artilleries, mortars, bombs etc.

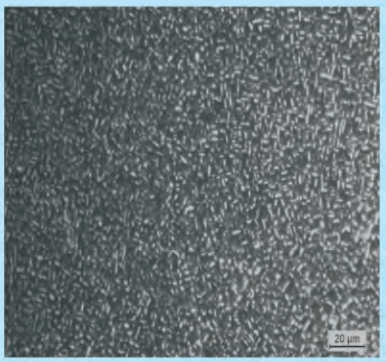
Chemical Analysis wt%

Al	Mo	V	Cr	Fe	Si	Zr	C	N	H	O
4.4 ~ 5.7	4.0 ~ 5.5	4.0 ~ 5.5	0.5 ~ 1.5	0.5 ~ 1.5	≤0.15	≤0.30	≤0.08	≤0.05	≤0.015	≤0.18

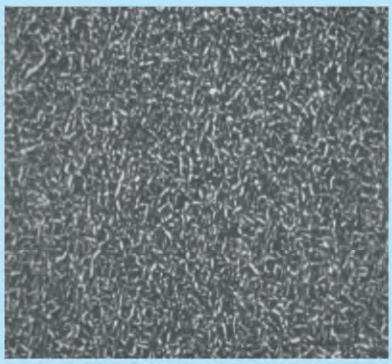
Melting Method

Electrode Pressing + Triple VAR

Micrograph of Die Forgings



X500



X500

Mechanical Property for die forgings (in the transverse direction)

Heat–treatment System: 830℃x2h furnace cooling to 750℃x2h air cooling plus 540℃x6h； air cooling

	Rm , MPa	$R_{p0.2}$, MPa	A, %	Z, %	HBW
Room Temperature (at 20℃)	1218	1188	12	42	370
	1193	1166	13	36	378

★Example of Product and its Application

Grade	TA7		
Main Feature	Currently, it is the most widely used titanium alloy which is free from β stable elements. Compared with other titanium alloys, it has better medium strength and weldability and higher thermal strength while poorer plasticity at room temperature. It can be working at the temperature of no higher than 450℃ for a long period and it is available at 850℃ for a relatively short period. Another obvious character is that it has sufficient toughness and comprehensive properties at ultra-low temperature of minus 235℃ if the content of interstitial elements is lower in the alloy, so it is the excellent titanium alloy for using at low temperature.	Main Application	It can be made into the extension section of radiation cooling spraying pipe for thrusting rocket engines as well as connecting flange. In the aviation industry, it can be made into non-rotating parts on aviation engines such as gas compressor engine casing. In the weapon industry, it can be made into some parts such as bases for mortar. It can be made into parts serving at low temperature, such as liquid hydrogen storage container and low-temperature and high - pressure vessels and so on. It also can be used to manufacture heat exchanger, pumps, channels, pipes and hydraulic equipments and so on. Compared to other titanium alloys, it is the most suitable material for being made into parts with medium strength and weldability.

Chemical Analysis wt%

Al	Sn	Fe	C	N	H	O
4.0 ~ 6.0	2.0 ~ 3.0	≤0.50	≤0.08	≤0.05	≤0.015	≤0.20

Melting Method

Electrode Pressing + Triple VAR

Mechanical Property for φ36 rolled bars(in the longitudinal direction)

Heat-treatment System : 800℃ × 2h ; air cooling

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Z, %
Room temperature (at 20℃)	826	784	18.0	39.0
	820	776	17.5	43.0

Mechanical Property for 3.0mm hot-rolled sheets(in the transverse direction)

Heat-treatment System : 800℃ × 1h ; air cooling

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Bending angle
Room Temperature (at 20℃)	775	761	23.0	>40°
	814	791	23.0	>40°

Mechanical Property for 4.5mm hot-rolled sheets(in the transverse direction)

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Bending angle
Room Temperature (at 20℃)	785	751	17.5	>40°
	786	753	20.0	>40°

Titanium Alloy for Medical Treatment and Daily Life

Titanium has low density, proper strength and good corrosion resistance; it is well consistent with human biology and it is not poisonous; it is well consistent with human body mechanics and matches well with human bones; it is suitable for being used in the medical treatment for a series of characteristics including having the shape memory function and super elasticity. Therefore, titanium is reputed as the non-poisonous material for human beings.

Titanium is a new type of material for artificial bones and knuckles with excellent comprehensive property. It has been applied to clinical artificial knuckles such as hip knuckle, knee knuckle, arm bone, elbow knuckle, thigh bone, palm and finger knuckle, knuckle between fingers, jawbone, and artificial vertebrate and so on. As it has good curative effect in long-term clinical application, it has been used more and more widely. Besides, titanium is a new kind of teeth material, such as the artificial tooth root and tooth bed. Additionally, it is used as the artificial heart valve, chest expander, artificial heart and the like. It is also applied to operation instrument, auxiliary equipment of medical treatment and the like.

Titanium has many advantages such as small density, high specific strength, good elasticity, good corrosion resistance and beautiful appearance etc. It is born with special silver color, which can be changed into bright golden yellow or blue after surface treatment. Titanium can not only be used as high-grade appliance, but also as top-level decorations for its comprehensive property. Therefore, titanium products are used wider and wider in sports and durable consumables, and they become much more popular. The examples of titanium usage in daily life are given as follows:

Item	Examples of Applications
Sport Instruments	Tennis bat, battledore; the long club handle of golf ball, metallic ball head; mask for fencing; ice cane, nail, and screw for climbing; reel for fishing; handle and skis for skiing; traveling bicycle; racing bicycle; the base nail of football shoes.
Durable consumables	Instrument, timekeeper, engraved metallic pictures, print hammer and wheel for printer, camera body and shutter; shells of computers and cell phones; holder of sounder, titanium drum for music instrument, loud-speaker vibrate plate; hard disk of computer; glasses holder; watchcase; decoration; dinner service.
Environment and Health	Sewage and sludge processing mechanism; waste water disposal equipment; storage equipment for radioactivity waste; disposal equipment for excrement.

★Example of Product and its Application

Grade	TC4		
Main Feature	It has excellent comprehensive properties, good technological characteristics, medium strength at room temperature and elevated temperature, good creep resistance and thermal stability, higher fatigue properties, crack propagation resistance in seawater, and satisfied fracture toughness and thermal salt stress corrosion property; components and parts which are designed by the principle of damaging tolerance have excellent technical plasticity and super plasticity, so as to be welded and machined by various ways.	Main Application	In aviation and aerospace industry, it is mainly made into beams, bulkhead, slide rail and gear beams for airplane structure, fans for aviation engine, discs and vanes gas for compressors as well as shell for aviation rocket, pressure vessels and various types of fasteners. In civil industry, it is made into vanes of gas turbine in electric power industry, ship propellers in shipping industry, drilling platform of offshore oil field in ocean projects, various kinds of corrosion resistant pumps in chemical industry, artificial implants in medical science, various kinds of bulletproof armors and sports instruments.

Chemical Analysis wt%

Al	V	Fe	C	N	H	O
5.5 ~ 6.75	3.5 ~ 4.5	≤0.30	≤0.08	≤0.05	≤0.015	≤0.20

Melting Method

Electrode Pressing+ Triple VAR

Mechanical Property for ϕ55 rolled bars(in the longitudinal direction)

Heat-treatment System : 700℃ × 1.5h ; air cooling

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Z, %
Room Temperature (at 20℃)	959	909	16.8	49
	948	900	16	54

Mechanical Property for 1.0mm cold-rolled sheets(in the transverse Direction)

Heat-treatment System : 830℃ × 0.5h ; air cooling

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Bending angle
Room Temperature (at 20℃)	1083	963	21	>105°
	1096	985	25	>105°

Mechanical Property for 8.0mm hot-rolled sheets(in the transverse direction)

Heat-treatment System : 840℃ × 1h ; air cooling

	Rm, MPa	$R_{p0.2}$, MPa	A, %	Z, %
Room Temperature (at 20℃)	999	955	17	—
	1000	949	15	—

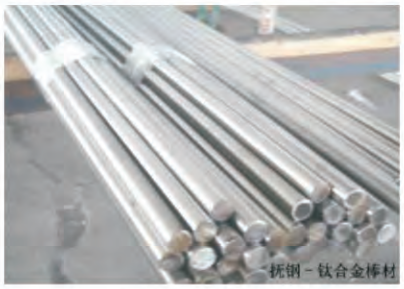
Titanium Alloy Production Line and Products

VAR

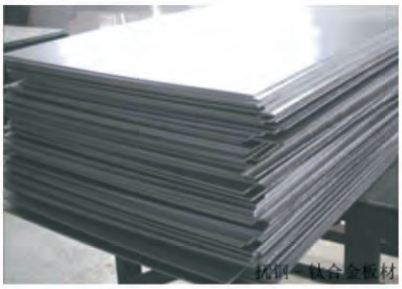
automatically weighing and mixing system

8000t Hydraulic Pressing Machine

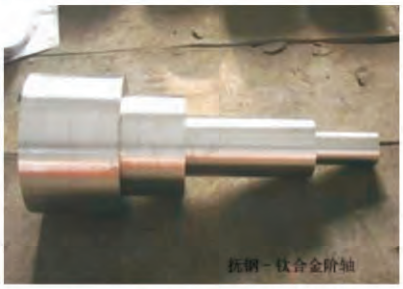
Vacuum Plasma Welding Box



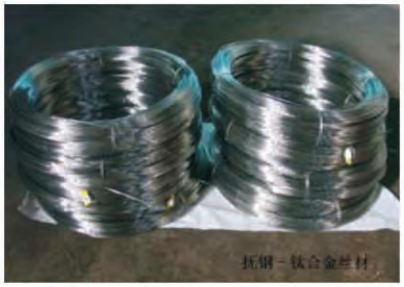
Titanium bars



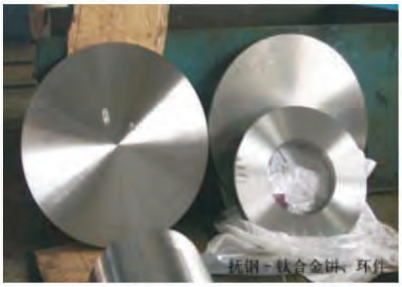
Titanium sheets



Titanium step shafts



Titanium wires



Titanium discs and rings

Titanium special–shaped parts

Central Laboratory

Central Lab of FSSS takes on the tasks of testing and determining of purchased raw materials as well as inspecting the quality of steel products, and has passed the attestations of CNAS and Nadcap respectively in 2006 and 2007.

Central Lab possesses 300 sets of the inspecting equipments and instruments of the state of art which can satisfy the inspecting requirements of users on chemical composition analysis, microstructure and mechanical property as follows: Photoelectric Direct-reading Spectrometer, Infrared Carbon and Sulphur analyzer, Joint Measurement of Oxygen and Nitrogen analyzer, X-ray fluorescence Spectrometer, Hydrogen analyzer, Analytic Balance, Spectrophotometer, Mass Spectrometer, ICP Spectrum Analyzer, Precision Microscope, Scanning Electron Microscope(SEM), Electro-hydraulic Servo Universal Testing Machine, Electronic Tensile Testing Machine, High-temperature Tensile Testing Machine, Endurance Testing Machine, Impact Tester for Metallic Materials, Various Hardness Tester, Computer group Controlled Heating treatment Furnace.

CNAS Attestation(in 2006)

Nadcap Attestation(in 2007)

Quality Testing Equipments

Equipment Items	Type No.	Main Purpose	Photographs
Electro-hydraulic Servo Universal Testing Machine	DDL series	Suitable for testing the mechanical properties of metallic materials	
High-frequency Fatigue Tester	GPS100	Suitable for testing the fatigue property and mechanical property after fracture at the condition of tension, shrinkage, preset crack as well as tension and pressure alternating loads at high frequency for metallic materials, components and parts.	
Electronic Creep and Endurance Testing Machine	PDW30050 Mode involving two types of RD50 and RD50A	Suitable for testing the properties of endurance, creep and strain slack for metallic materials	

Quality Testing Equipments

Equipment Items	Type No.	Main Purpose	Photographs
Infrared Carbon and Sulphur analyzer	CS–600 Type (LECO)	Suitable for determination of the contents of carbon and sulphur using infrared method for iron and steel, and superalloys	
ICP Spectrum Analyzer	Axios Pw4400 Type (PANalytical B.V.); S8TIGER Type (Bruck)	Suitable for determination of the contents of elements such as Mn, Si, P, Ni, Cr, W, V, Mo, Al, Ti, Cu, Co, Nb and Fe in Fe–base alloy, Ni–base alloy and Co–Base alloy and high–alloy steel	
Atomic Absorption Analyzer	Z–2000 Type (HITACHI)	Suitable for analysis of trace elements such as Cu, Co, Ni, Mg, Pb, Ca in superalloys and raw materials; suitable for analysis of five deleterious elements, Ag, Se and Te.	
Oxygen and Nitrogen Analyzer	TC–600 Type (LECO)	Suitable for determination of the nitrogen content in various types of high–alloy steels and low–alloy steels, superalloys and ferroalloys using the testing method of pulse heating the inert gas fusion thermal conductivity. Suitable for analysis of oxygen content ranging from 0.05ppm to 5.0 percent, and analysis of nitrogen content ranging from 0.05ppm to 3.0 percent	
Inverted Microscope	GX51 (OLYMPUS)	Equipped with PE and CIR analysis software from Clemex Compay of Canada, of which PE software is for analyzing various kinds of metallurgical structures such as grain size, decarburization layer, the content of the second phase area, spheroidizing rate, granule size, dimension and surface roughness,and CIR is mainly for testing the non–metallic inclusions	
SEM (Scanning Electron Microscope)	EVO18 (ZEISS)	Equipped with INCA Energy 450 spectrum as well as X–MAX20 Premuem Probe, the first domestic company to customize INCA MICS F with high solution of 124eV, the third generation of image selection and analysis processor, and the second generation of wave selection and processing analyzer of INCA X–Stream 2; Employing the spectrum analyzer with the highest solution capacity and analyzing function using the latest and the most advanced Navigator and various kinds of Intelligent software	

Environment-friendly Steel
Low Carbon Living

Fushun Special Steel Co.,Ltd.

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