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Sandvik Bioline Ti6Al4V ELI

(Bar)

Sandvik Bioline Ti6Al4V ELI is an alpha-beta titanium alloy mainly used for medical implant applications. It is an Extra Low Interstitial alloy with a high purity, which confers improved ductility and fracture toughness.

The grade meets the stringent requirements of all applicable standards for implant materials.

Sandvik Bioline Ti6Al4V ELI is characterized by:

- Excellent biocompatibility
- Good forgeability
- Advanced corrosion resistance
- High strength
- High purity
- A high quality surface finish

STANDARDS

- UNS R56401

Product standards
- ASTM F136
- ISO 5832-3

CHEMICAL COMPOSITION (NOMINAL) %

N max	C max	H max	Fe max	O max	Al	V	Ti
0.05	0.08	0.012	0.25	0.13	5.5 - 6.50	3.5 - 4.5	Balance

FORMS OF SUPPLY

Finishes and dimensions
Sandvik Bioline Ti6Al4V ELI alloy bar is produced in a large number of sizes within a standard size range comprising of 19-55 mm diameter. Smaller and larger sizes can be supplied on request.

Titanium alloy bar is supplied in the annealed condition with a belt grinded or peel turned surface. Other surface finishes are also available on request.

Lengths
Bars are delivered in lengths of 2.0-6.0 m, depending on customer requirements.

TOLERANCE WIDTH

Diameter mm	Standard tolerance width mm
19-30	+0 / -0.130
30-50	+0 / -0.160
50-55	+0 / -0.190

Other tolerances can be produced on request.

SURFACE CONDITIONS

Surface conditions	Diameter mm
Belt grinded	<35
Peel turned	>35

PHYSICAL PROPERTIES

TYPICAL DATA

Property		
Density (20°C)	4.42 g/cm^3	0.16 lb/in^3
Modulus of elasticity, (20°C)	114 GPa	17 X 10^3 ksi
Specific heat capacity (20°C)	0.56 J/(g °C)	0.13 Btu/(lb°F)
Thermal conductivity (20°C)	7.2 W /(m°C)	4.2 Btu/(ft h°F)
Thermal expansion, x10^{-6} (0-100°C)	8.8 per °C	4.9 per °F

MECHANICAL PROPERTIES

AT 20°C (68 ^{O}F), TYPICAL DATA

Proof strength	Tensile strength	Elongation		Reduction of area	Hardness
$R_{p0,2}$	R_m	in 4 D %	in 5 D %	%	Rockwell C
MPa	MPa	ASTM req	ISO req		
870	940	16	15	39	31

AT 20°C (68 ^{O}F), VALUES ACCORDING TO ASTM F136

Size	Proof strength	Tensile strength	Elongation	Reduction of area		
	$R_{p0,2}$		R_m		in 4 D	
mm	MPa	ksi	MPa	ksi	%	%
	min	min	min	min	min	min
≤ 44.45	795	115	860	125	10	25
> 44.45 ≤ 63.50	760	110	825	120	8	20

FABRICATION

Titanium has a high affinity to oxygen, nitrogen and hydrogen which makes the selection and control of process parameters critical to avoid brittleness.

Titanium reacts at high temperatures and burns readily in the presence of oxygen. Elevated temperature processing, therefore, must be carried out under special conditions (inert atmosphere for high temperature processing and melting under vacuum), in order to avoid diffusion of gasses into the titanium metal.

Titanium can be casted, but it must be done in a vacuum furnace because of its reactive nature.

Machining at room temperature needs to be performed under controlled conditions with adapted tooling to avoid galling or seizing of cutting tools.

Electrochemical machining and laser cutting are becoming more common in the machining of Titanium.

Workability
Sandvik Bioline Ti6Al4V ELI can be hot worked by rolling, forging, extrusion or pressing, and can also be cold drawn.

Typically, hot working is carried out in the alpha-beta temperature range (850 to 960 °C (1560- 1760 ^{O}F).

MACHINING

General turning
Cutting speed recommendations
The recommendations are valid for use with cutting fluid
and a specific cutting force kc 1, 0.4 = 1700 MPa
Carbide tool (insert) - SANDVIK COROMANT REFERENCES

Carbide tool (insert) SANDVIK COROMANT REFERENCES	H10	H10A	H13A	H10F	GC1025		
Titanium alloys	R_m MPa	Feed, mm/rev	Cutting speed, v_c m/min				
α, near α and α+β alloys, annealed	950	0.1	85	80	75	65	65
0.2		70					
0.3		55	65	60	55	55	
0.5			55	50	45	45	
α+βalloys in aged conditions, βalloys, annealed or aged	1050	0.1	80	80	70	65	65
0.2		60					
0.3		50	60	55	50	50	
0.5			50	45	40	40	

Parting and Grooving

Corocut family (CoroCut and T-Max Q-Cut)®
The recommendations are valid for use with cutting fluid.
Note!(For internal grooving , face grooving and undercutting, the speed should be reduced by 30-40%)

Carbide tool (insert) SANDVIK COROMANT REFERENCES	H10	H13A	GC4125			
Titanium alloys	Specific cutting force kc , 0.4 MPa	R_m MPa	Feed, mm/rev	Cutting speed, v_c m/min		
α, near αandα+β alloys, annealed	1675	950	0.05	80	70	70
0.3			65	80	38	
α+β alloys in aged conditions, β alloys, annealed or aged	1690	1050	0.05	70	85	65
0.3			65	55	33	

Threading

Cutting speed recommendations

Carbide tool (insert) - SANDVIK COROMANT REFERENCES	GC1020	GC4125	H13A	
Titanium alloys	R_m MPa	Cutting speed, v_c, m/min		
α, near a and α+βalloys, annealed	950	60	65	50
α, near a and α+βalloys in aged conditions, βalloys, annealed or aged alloys, annealed	1050	50	55	40

Drilling - Solid carbide

CoroDrill® Delta-C for drill diameters 3 -20 mm

Titanium alloys	R_m MPa	Grades	Cutting speed, v_c, m/min	Drill diameter, mm			
3.00 - 6.00	6.01 - 10.00	10.01 - 14.00	14.01 - 20.00				
Feed, fn, mm/rev							
α, near αand α+β alloys, annealed	850	1220	20 - 60	0.06 - 0.12	0.08 - 0.20	0.14 - 0.28	0.16 - 0.30
α+βalloys in aged conditions, βalloys, annealed or aged alloys, annealed	1050	1220	20 - 60	0.06 - 0.12	0.08 - 0.20	0.14 - 0.28	0.16 - 0.30

Corodrill® Delta-C R840 for drill diameters 0.30 - 2.90 mm

Titanium alloys	Rm MPa	Grade	Cutting speed v_c, m/min	Drill diameter, mm			
0.30 - 1.40 Feed, fn, mm/rev	Grade	Cutting speed v_c m/min	1.50 - 2.90 Feed, fn, mm/r				
α, nearα and α+β alloys, annealed	850	H10F	4 - 17	0.0023 - 0.01	1020	30 - 40	0.02 - 0.04
α+β alloys in aged conditions, βalloys, annealed or aged alloys, annealed	1050	H10F	3 - 13	0.0015 - 0.007	1020	30 - 40	0.02 - 0.04

Milling - Solid carbide
Coromill® plura
Grade : GC1620
Recommendations for roughing condition :
Speed : 55 - 70 m/min
Feed : 0.05 - 0.12
Milling - Carbide tools (insert)
Specific cutting force kc 1 = 1400 MPa
mc = 0.23
Carbide tool (insert) - SANDVIK COROMANT REFERENCES

Carbide tool (insert) - SANDVIK COROMANT REFERENCES	GC1025	GC1030	H13A	H10F	GC2030	GC2040		
Titanium alloys	R_m MPa	Max chip thickness h_{ex}, mm	Cutting speed, v_c m/min					
α, near α and α+β alloys, annealed	950	0.05		80			75	75
0.1		80		75	65			
0.15		75	75	70	65	70	70	
0.2		75	75	70	65	70		
0.25							70	
α+βalloys in aged conditions	1050	0.05		65			60	60
0.1		65		60	55			
0.15		60	60	60	55	60	60	
0.2		60	60	60	55	55		
0.25							55	

APPLICATIONS

Sandvik Bioline Ti6Al4V ELI is a preferred grade for medical/dental applications because of highly favourable combinattion of biocompatibility, excellent corrosion resistance, high strength and low modulus of elasticity.

Typical applications are joint replacement (hip, knee, shoulder), bone fixation devices, surgical clips, cryogenic vessels, surgical tools

DISCLAIMER:
Sandvik is not providing any products or services that are intended or may be construed to be recommending or otherwise advising on, in any manner, the design, suitability, appropriateness or effectiveness, from a medical/biological/safety perspective, of any medical material, instrument and/or medical device.