



Titanium Alloy “Ti-6Al-4V ELI”

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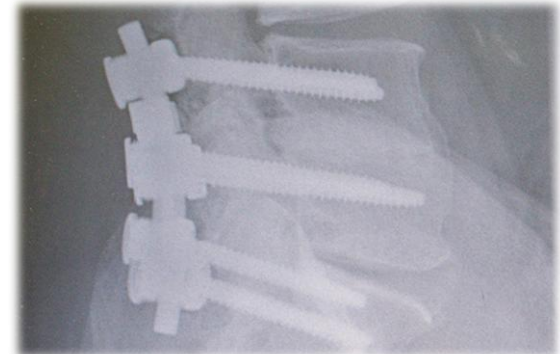


Product

Titanium screws used in Medical applications.

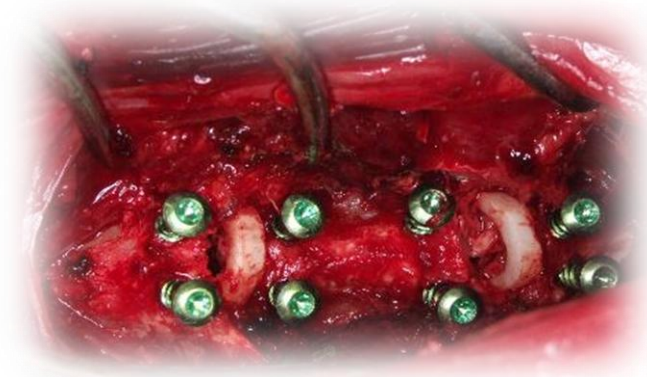
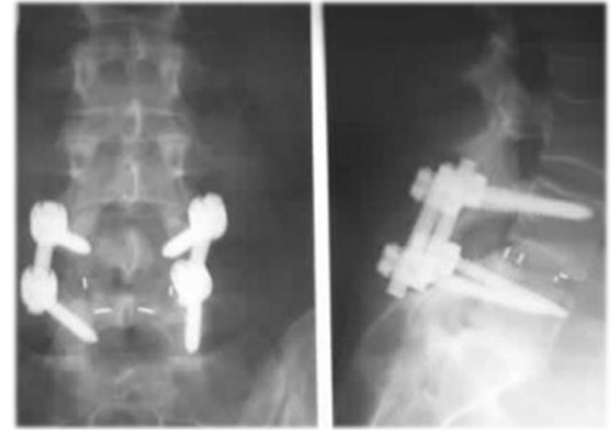


- A screw used in back surgery
- Used for various back surgeries , and permanently fixes the problem.
- Mostly considered in biomedical applications and Implantable components
- Used because of it strong corrosion resistance, and strength.
- Also used in Aircraft, and for high temperature applications.

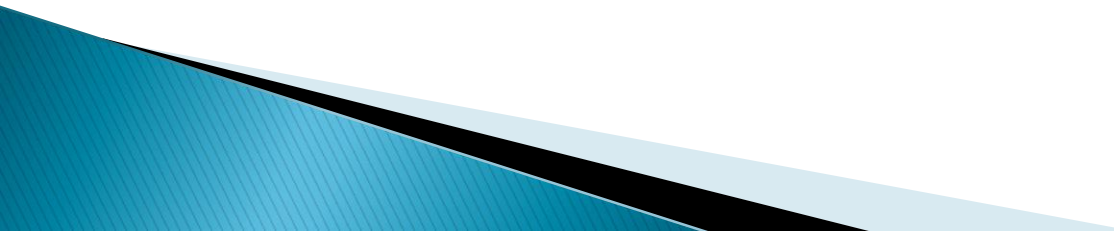


Mechanical Properties

- Tensile strength is 120 ksi
- Modulus of Elasticity is 15.2×10^3 ksi
- Magnetic Attraction—none
- Ultimate Bearing strength is 200–300 ksi
- Compressive Yield Strength 120–130 ksi
- Ultimate Shear Strength 70–100 ksi
- Density – $4.43\text{g}/\text{cm}^3$



Corrosion Resistance

- ▶ Ti-6Al-4V EII forms stable oxide film when exposed to oxygen, which means better Toughness and corrosion resistance.
 - ▶ Combination of oxide corrosion resistance and low elastic modulus makes product bone like
 - ▶ Extensive use in orthopedics
 - ▶ Highly resistant to general corrosion.
 - ▶ Cracking associated with exposure to halide ion (remember from chemistry)
 - ▶ General practice to avoid chlorinated solvents and processing titanium
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Hardness values

- ▶ Brinell – 334
- ▶ Knoop – 363
- ▶ R_a – 68.5
- ▶ R_c – 36

Rockwell Hardness



Brinell hardness



Chemical Composition

- ▶ Percent Composition

Titanium 91.0%
Main ingredient/ Solvent

Aluminum 6.75%
Represents the 6Al in Ti-6Al-4V ELI
ELI- Extra Low Interstitial
To give strength and provide alpha stabilizers

Vanadium 4.5%
The 4.5% represents the 4V in Ti-6Al-4V ELI
Added so that product is more wear resistant
Gives toughness and improved formability



Chemical Composition

- ▶ Percent composition

Impurities – Not Wanted

Carbon 0.08% Max

Hydrogen 0.015% Max

Iron 0.4% Max

Nitrogen 0.3% Max

Oxygen 0.2% Max



Alpha, Beta, and Alpha/Beta

- ▶ Alpha
 - Include aluminum, tin, oxygen
 - All-Alpha Alloys
 - Not heat treatable
 - Only strengthened by cold working
 - Near-Alpha Alloys
 - Useful for aircraft skins
 - Have small trace amounts of Beta stabilizers

Alpha, Beta, and Alpha/Beta

- ▶ Beta
 - Includes
 - All-Beta Alloys
 - Generally high strength, toughness, and formability
 - Heat treatable to high strengths
 - Used in aircraft frames, fasteners, springs, and pipes.
- ▶ Alpha/Beta
 - Contains 10 – 50% of beta phase stabilizers
 - Can be heat treated
 - Two types: Lean and Rich
 - Lean: moderately heat treatable and easy to weld
 - Rich: most difficult to weld, great harden ability
 - Ti-6Al-4V ELI classified under Alpha/Beta Rich

Heat Treat

- Used in either mill annealed, beta annealed/re-crystallization annealed condition
- Used to maximize strength for applications such as joint replacements
- Beta annealed results in a completely transformed structure, used to maximize damage tolerance.
- Intermediate/final annealing of Ti -6Al-4V ELI is performed in vacuum/inert gas atmosphere to avoid alpha case formation.



Manufacturing Processes

- ▶ <http://youtu.be/XsdRo5jvnXo>