TITANIUM **FROM ORE TO BAR** MATERIAL

The processing of titanium mill products occurs in the following major steps: reduction of titanium ore into «sponge», metallic porous form; melting of sponge, or sponge plus master alloy to form an ingot; primary fabrication, where an ingot is forged into general mill products such as billets or slabs; and possibly rolled into semi-products such as plate, sheet, strip, bar/rod/wire or tube.

How is titanium made ?

- Ore to Metal
  - Rutile (TiO_2) to $TiCl_4$
  - $TiCl_4 + 2Mg = Ti + MgCl_2$
- Melting
  - VAR
  - Electron Beam Cold Hearth.
- Thermomechanical Processing
  - Forging
  - Rolling: Plate/Sheet/Bar
- Fabrication
  - Investment Casting
  - Forging/ Machining
  - Extrusion

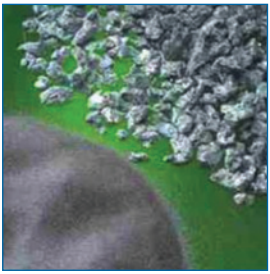


FIGURE 1: Rutile and titanium sponge

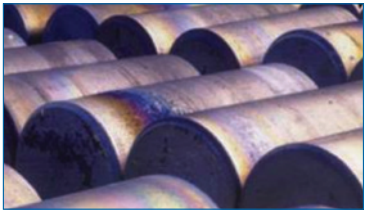
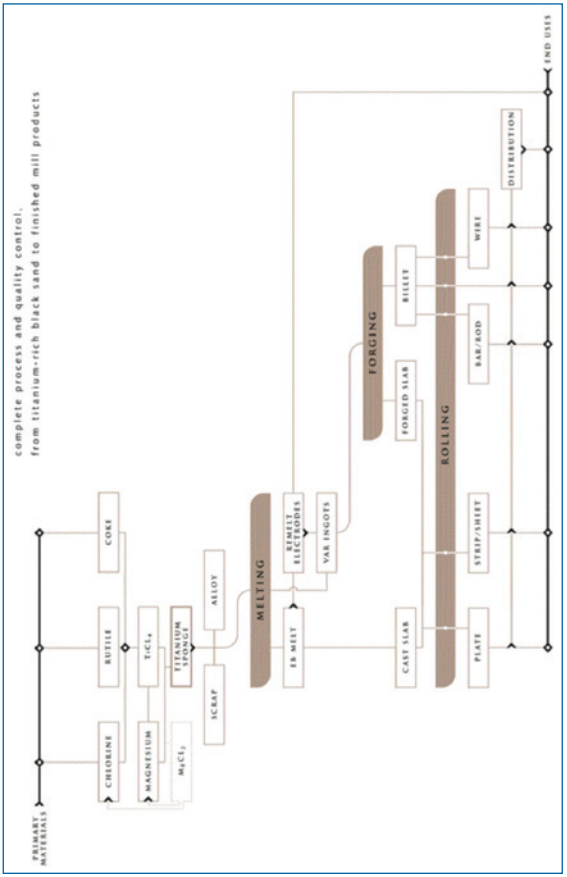


FIGURE 2:
Titanium Ingot & Slab



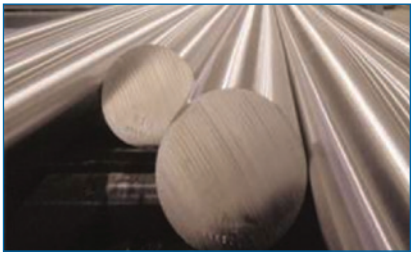


FIGURE 3: Titanium forged billets

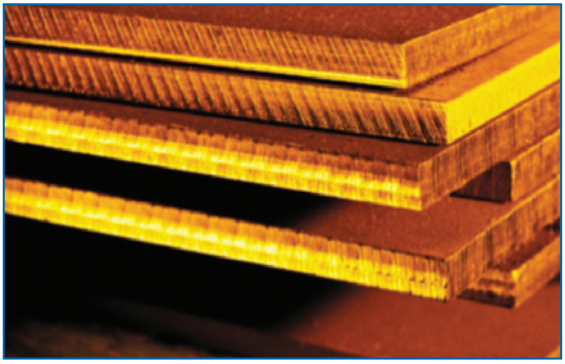


FIGURE 4: Titanium plates

Stock of titanium semi-products

The use of titanium in medical applications started in the 1950's and has been widely used every since due to its biocompatibility with the human body and many other advantages. Titanium's use in hip and knee prostheses are well known, but titanium and titanium alloys may allow for the future development of bioactive implants, external prostheses and instrumentation.

Advantages of titanium or titanium alloys for Bio / Medical Applications:

- Bio compatibility.
- Higher strength than bone [80 – 120 MPa], stainless steels and other implant materials.
- High fatigue strength [50% higher than cast Co-Cr alloy].
- High resistance to impact loading.
- Good corrosion resistance.
- Adequate resistance to fretting.
- Lower elastic modulus than steel or cobalt alloys.
- Low density.

Available grades for medical end-use:

	ASTM GRADES	STANDARDS		YIELD STRENGTH 0.2%	TENSILE STRENGTH	ELONGATION	YOUNG MODULUS	FATIGUE LIMIT	DENSITY	BETA TRANSUS +/-10°C	ADVANTAGES
		ASTM	ISO	MPa	MPa	%	GPa	% of TS	g/cm²		
TIMETAL® 35A	Gr. 1	F-67	5832-2	220	345	35	103	50	4.51	890	High Formability Machinability
TIMETAL® 50A	Gr. 2	F-67	5832-2	345	485	28	103	50	4.51	915	Formability Machinability
TIMETAL® 65A	Gr. 3	F-67	5832-2	450	585	25	103	50	4.51	920	Formability Improved mechanical properties
TIMETAL® 75A	Gr. 4	F-67	5832-2	560	680	23	103	50	4.51	950	Formability Improved mechanical properties
TIMETAL® 6-4ELI	Gr. 29	F-136	5832-3	885	985	15	113	55-60	5.43	980	Low crack growth Improved mechanical properties
TIMETAL® 367		F1295	5832-11	800	900	10	105-120	55-60	4.52	1015	High mechanical properties Excellent biocompatibility
TIMETAL® 6-4	Gr. 5	F1472	5832-3	885	985	15	105-120	55-60	4.42	995	High tensile properties and fatigue strength

Partner

TIMET is a fully integrated titanium producer and distributor, from sponge production to finished mill products. The company has developed a global industrial and commercial network including Service & Distribution facilities to serve customers locally. TIMET has worked with the medical industry for decades through strong partnerships with key players throughout the supply chain including forgers, machine shops, and wire drawing facilities. This has provided TIMET the ability to indirectly support activity in specialty titanium for implants as well as directly with implant designers and manufacturers. TIMET recently strengthened its position in the medical supply chain through an expansion of its Service & Distribution network to further improve service to customers.

TIMET accreditations: ISO9001, EN9100, ISO14001, NADCAP, and main aerospace end-users approvals.

Today, the global production capacity of titanium is greater than ever and continues to grow. TIMET has invested in Research & Development and in capacity to meet existing demand and new requirements in emerging applications. Through these efforts, TIMET can sustain growth of the medical market on a long term view.

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