Titanium and Titanium Alloys

- Atomic no =22
- Electronic configuration

  $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^6\ 4S^2\ 3d^2$
- Atomic mass 47.9
- Pure Titanium melts at 1670°C.
- It has a density of 4.45 g cm^{-3}.

Structure

- >882ºC is BCC (referred to as β)
- <882ºC is HCP (referred to as α)
- Has a dark grey color.

- **E=120 GPa**
- **Tensile strength=240MPa**
- **Electrical conductivity=3% IACS**
- **Useful temperature for structural applications is from 400 to 600^{o}C depending on its composition and alloys.**
- **(International Annealed Copper Standard).**

-A light metal with a better strength to weight ratio than any other metal at room temperature.

- Ideal for use in components which operate at elevated temperatures.

(where large strength to weight ratios are required)

- It is non- magnetic (NOTE: in MRI examinations any magnetic material will interfere with the radiations making it useful in making prosthetic parts.

-80% of all the titanium produced in the world is used in the aerospace industries.

- Because of its good corrosion resistance, it is widely used in chemical industries
- It's alloys are widely used in the medical field due to their biocompatibility.

- **Ti is flammable (can catch fire and cause severe damage) in circumstances where it rubs against other metals at elevated temperatures**
- **This limits its applications in the harsh environment of aero-engines to regions where the temperatures do not exceed 400°C**
- **Titanium is a very expensive metal**

Titanium can be:

-Wrought

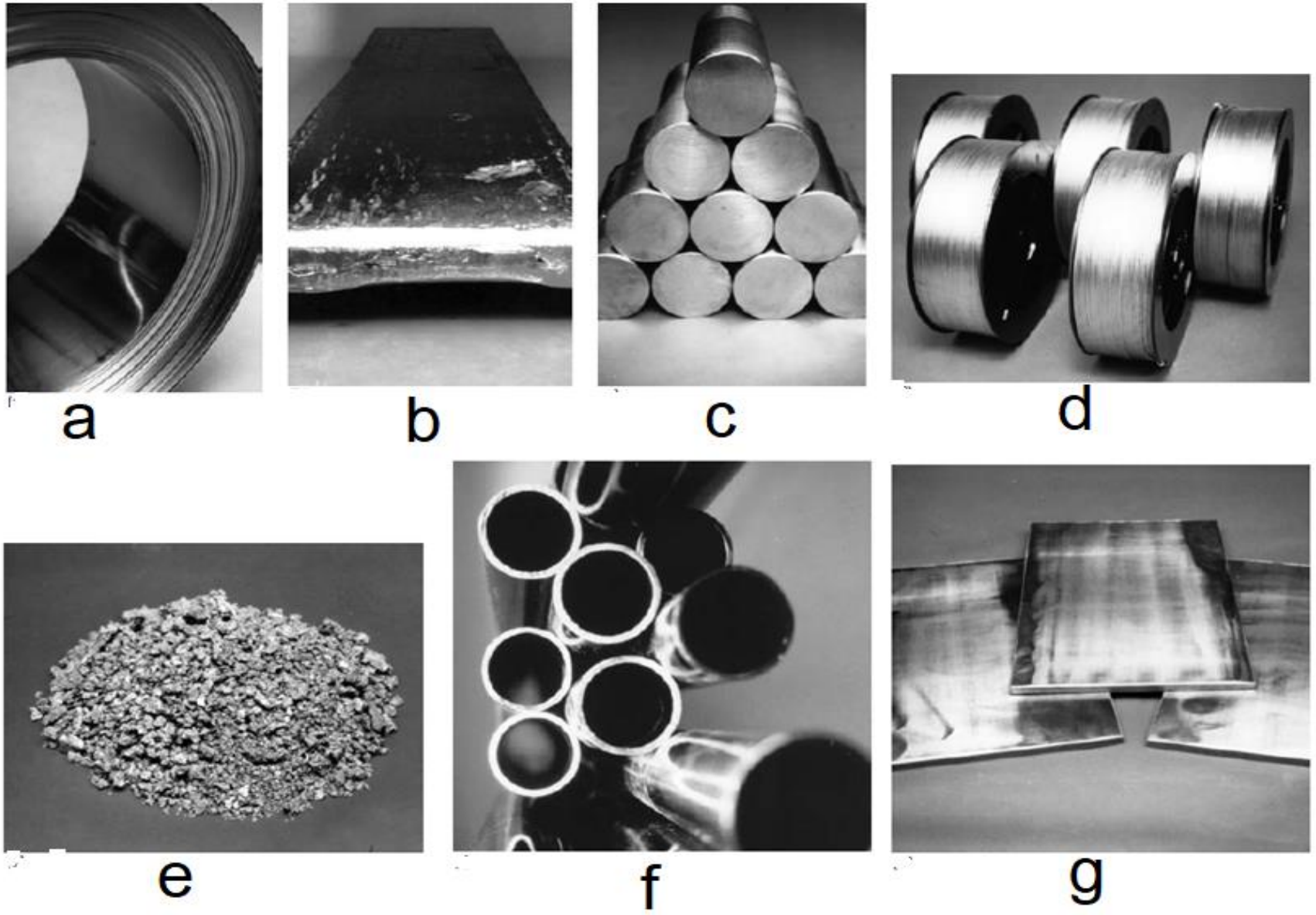
-Cast

-Made by PM technique.

Products made from Ti are:

-Ingots, Billets, Bars, Sheet, Strips, Tubes, Plates

-Common non mill products are: Ti Sponge and Ti-powder



a) Strip (b) Slab (c) Billet (d) Wire (e) Sponge f) Tube (g) Plate

-Large weights such as 1.4 tonnes of Ti parts are possible

-It forms a passive film and exhibits a high degree of immunity against attack by most mineral acids and chlorides

- Pure Ti is non-toxic
- Ti and Ti alloys are biologically compatible with human tissue and bones
- Used in petrochemical, chemical environments why? Because of good strength and excellent corrosion resistance

- **E for human bone is approx. =30GPa**
- **Human femoral cortical has a porosity of 5% to 15%, whereas the porosity of trabecular bone ranges from 40% to 95%.**
- **human femoral cortical bone**

E=18GPa

- **Tensile yield strain (%)=0.67**
- **Tensile ultimate stress (MPa)=135**
- **Compressive stress=115MPa**
- **E for steel =200GPa, Ti =110GPa TiZrNb alloy =70GPa.**

- **Ti is Used in aerospace structures because of high strength, stiffness and good toughness, Low ductility, good corrosion resistance and biocompatibility**

(These leads to high weight savings in aerospace structures and other high performance applications)

Typical Ti Alloys

- Ti-6Al-4V and Ti-3Al-8V-6Cr-4Mo-4Zr are used for **off- shore drilling**

Ti-6Al-4V, Ti-6Al-2Sn-4Zr-2Mo-Si among others

are used for **aircraft and gas turbine engines**

-Ti-6Al-4V and others are used for prosthetic devices due to their unique corrosion behavior, strength and corrosion resistance.

(Prosthetic means: artificial body part, such as limbs, heart, breast implant among others)

Summary of Uses of Titanium and its alloys

Aerospace

Gas turbine engines
Aircraft structures
Spacecraft
Helicopter rotors

Automotive

Body panels
Connecting rods
Valves and valve springs
Rocker arms

Power generation

Gas turbines
Steam turbines
Piping systems
Heat exchangers
Flue gas desulphurization systems

Chemical processing industries

Pressure and reaction vessels
Heat exchangers
Pipe and fittings
Liners
Tubing
Pumps
Condensers

Marine

Surface ship hulls
Deep-sea submersibles
Pleasure boat components
Racing yacht components
Shipboard cooling systems
Ship propellers
Service water systems
Ducting
Fire pumps
Water jet propulsion systems

Fashion and apparel

Eyeglasses
Jewelry

Oil, gas, and petroleum processing

Tubing and pipe
Liners
Springs
Valves
Risers

Biomedical

Artificial joint prostheses
Bone plates, intramedullary rods, etc.
Heart valves
Pacemakers
Dental implants
Attachment wire
Surgical instruments
Wheelchairs

Architectural

Roofing
Window frames
Eaves and gables
Railings
Ventilators

Sports

Golf clubs
Bicycle frames, gears, etc.
Lacrosse sticks
Racing wheelchairs
Horseshoes
Tennis rackets
Scuba gas cylinders
Skis
Pool cues

Miscellaneous

Shape memory alloys
Pollution control systems
Hand tools
Desalination systems
Military vehicle armor
Hunting knives
Backpack cookware

- https://www.youtube.com/watch?v=xb-Yb3gr3WI
- https://www.youtube.com/watch?v=XsdRo5jvnXo

THANK YOU FOR LISTENING