**Titanium and Titanium Alloys**

The use of titanium is widespread. It is used in many commercial enterprises and is in constant demand for such items as pumps, screens, and other tools and fixtures where corrosion attack is prevalent. In aircraft construction and repair, titanium is used for fuselage skins, engine shrouds, firewalls, longerons, frames, fittings, air ducts, and fasteners.
Titanium is used for making compressor disks, spacer rings, compressor blades and vanes, through bolts, turbine
housings and liners, and miscellaneous hardware for turbine engines.

Titanium, in appearance, is similar to stainless steel. One quick method used to identify titanium is the spark test. Titanium gives off a brilliant white trace ending in a brilliant white burst. Also, identification can be accomplished by moistening the titanium and using it to draw a line on a piece of glass. This will leave a dark line similar in appearance to a pencil mark.

Titanium falls between aluminium and stainless steel in terms of elasticity, density, and elevated temperature strength. It has a melting point of from 1500°C to 1735°C, low thermal conductivity, and a low coefficient of expansion. It is light, strong, and resistant to stress corrosion cracking. Titanium is approximately 60 percent heavier than aluminium and about 50 percent lighter than stainless steel.

Because of the high melting point of titanium, high temperature properties are disappointing. The ultimate yield strength of titanium drops rapidly above 425 °C. The absorption of oxygen and nitrogen from the air at temperatures above 540 °C makes the metal so brittle on long exposure that it soon becomes worthless. However, titanium does have some merit for short time exposure up to 1600 °C where strength is not important. Aircraft firewalls demand this requirement.

Titanium is nonmagnetic and has an electrical resistance comparable to that of stainless steel. Some of the base alloys of titanium are quite hard. Heat treating and alloying do not develop the hardness of titanium to the high levels of some of the heat-treated alloys of steel. It was only recently that a heat-treatable titanium alloy was developed. Prior to the development of this alloy, heating and rolling was the only method of forming that could be accomplished. However, it is possible to form the new alloy in the soft condition and heat treat it for hardness.

Iron, molybdenum, and chromium are used to stabilize titanium and produce alloys that will quench harden and age harden. The addition of these metals also adds ductility. The fatigue resistance of titanium is greater than that of aluminium or steel.
Titanium becomes softer as the degree of purity is increased. It is not practical to distinguish between the various grades of commercially pure or unalloyed titanium by chemical analysis; therefore, the grades are determined by mechanical properties.

**Titanium Designations**

The A-B-C classification of titanium alloys was established to provide a convenient and simple means of describing all titanium alloys. Titanium and titanium alloys possess three basic types of crystals: A (alpha), B (beta), and C (combined alpha and beta). Their characteristics are:

* A (alpha) — all around performance; good weldability; tough and strong both cold and hot, and resistant to oxidation.
* B (beta)—bendability; excellent bend ductility; strong both cold and hot, but vulnerable to contamination.
* C (combined alpha and beta for compromise performances) — strong when cold and warm, but weak when hot; good bendability; moderate contamination resistance; excellent forgeability.

Titanium is manufactured for commercial use in two basic compositions: commercially pure titanium and alloyed titanium. A-55 is an example of a commercially pure titanium. It has a yield strength of 420 MPa and is a general purpose grade for moderate to severe forming. It is sometimes used for non-structural aircraft parts and for all types of corrosion resistant applications, such as tubing. Type A-70 titanium is closely related to type A-55 but has a yield strength of 620 MPa . It is used where higher strength is required, and it is specified for many moderately stressed aircraft parts. For many corrosion applications, it is used interchangeably with type A-55. Both type A-55 and type A-70 are weldable.

One of the widely used titanium base alloys is designated as C-110M. It is used for primary structural members and aircraft skin, has 760 MPa minimum yield strength, and contains 8 percent manganese.

Type A-110AT is a titanium alloy which contains 5 percent aluminium and 2.5 percent tin. It also has a high minimum yield strength at elevated temperatures with the excellent welding characteristics inherent in alpha-type titanium alloys.