CON 251
Non Ferrous Metals - Introduction

Nonferrous metals and their alloys do not contain iron as a principle ingredient, although they may contain small percentages. These include the radioactive metals uranium, thorium, and plutonium that are used as nuclear fuels.

Non Ferrous Metals - Introduction

Aluminum, beryllium, and titanium are used in structural applications. Light metals such as lithium, magnesium, potassium, and sodium also have important engineering applications. Nickel and lead have widespread applications as does copper which is often chosen for its high thermal and electrical conductivity. Cadmium, tin, and zinc are often used as coatings, electrical applications, and for bearing surfaces. Cobalt and manganese are common alloying elements in steels. Gold, silver, and platinum, the precious metals, are used in electrical applications and jewelry.

Non Ferrous Metals - Introduction

Finally, the refractory metals (those with melting points above 3600 degrees Fahrenheit [2000 degrees Celsius]), such as columbium, titanium, tungsten, vanadium, and zirconium, find use in applications requiring high strength, hardness, and thermal stability. For example, tool coatings, heat shielding, and other related uses.

Non Ferrous Metals - Properties

Nonferrous metals such as copper, brasses, bronzes, aluminum, magnesium, nickel, chromium, titanium, lead, tin, zinc, gold, silver, platinum, the refractory metals, and their alloys are used in a wide variety of applications; each requiring specific characteristics. Metals such as aluminum and magnesium, for example, tend to be high-strength, lightweight, and corrosion-resistant. They offer advantages over other metals in applications which depend on their unique properties.

Non Ferrous Metals - Properties

Refractory metals are chosen for their high heat resistance. They retain their properties at elevated temperatures. The precious metals are chosen for their luster in applications such as coinage and jewelry. Additionally, they may be used in electrical conductors, contacts, and biocompatible applications.

Some of these metals are chosen to plate other metals such as nickel, chromium, and zinc which are used to provide a resistant outer shell. Copper is an excellent conductor and used in application which require high conductivity. Its alloys, brasses and bronzes, are typically alloyed for specific purposes.

Aluminum

Aluminum is the third most abundant element in the earth's crust, behind silicon and oxygen. It is the most abundant metal. Aluminum is strong, lightweight, electrically- and thermally-conductive, and corrosion resistant. These properties can be enhanced through alloying. It is often anodized to help prevent corrosion.

Its electrical conductivity make it an excellent choice for electrical applications such as wiring and conductors. Its strength-to-weight ratio makes it attractive in structural applications as well as cast aluminum engine components, e.g. blocks, heads, and manifolds. Its high reflectivity of infrared and visible radiation makes it desirable in headlights, light fixtures, and many insulations. It is also used as a paint pigment.

Copper, Brass, and Bronze

Copper has been used in various applications for centuries. It generally finds applications requiring high thermal and electrical conductivity. For example, the thermal conductivity of copper is almost ten times greater than ordinary steel. Therefore, it finds use as kitchen products, wiring and electrical applications, piping and tubing, and other such uses.

Alloys of copper and zinc are termed brasses. Zinc is added to improve the strength and ductility of the alloy. There are many formulas for brasses which include other alloying elements than copper and zinc. Brass is used in decorative metal products, cartridge cases, piping and tubing, and many of the same application as copper.

Bronze

Bronze is an alloy of copper and any other metal. As with brasses, there are many formulas for bronzes, depending on the application. Aluminum bronzes, tin bronzes, phosphor bronzes, nickel bronzes, and silicon bronzes are all examples of varying alloys. The principle alloying element determines the nomenclature. Bronzes are used in applications such as bearings, some limited structural applications, decorative uses, and applications which require them not to spark when struck with another metal. This makes them useful in the transport and handling of items such as explosives, fuels, and flammable materials. Bronzes are often used in statues and can be seen to form the familiar green oxidized coating.

Magnesium

Magnesium is a light material, lighter than aluminum, derived primarily from seawater. Magnesium is a very active metal and, when burned, gives off an intense heat and light. It is used as an alloying element in steels and in applications which require high strength-to-weight ratios, such as extension ladders, aircraft, space vehicles, power tools, and similar applications.

Chromium

Chromium is often used in decorative and corrosion-resistant coatings. It is a major alloying element in many steels, especially stainless steels. It is used to provide a tough, wear-resistant, corrosion-resistant, decorative surface.

Nickel

Nickel is used as a plating material. It polishes to a high luster. It offers a wide working temperature range. It is also used as an alloying element for other materials, such as steels and bronzes. Nickel is also used in magnets, heating elements, thermocouples, and rechargeable batteries. Nickel and nickel silver are used in jewelry and coins.

Gold, Silver, Platinum

These are generally termed the precious metals due to their cost/value and use in coinage and jewelry. For example, the $20 gold piece at one time contained $20 worth of gold. Today, coins are used to represent the face value and are made from less expensive materials. Gold, silver, and platinum are used as plating materials. They offer good conductivity and corrosion resistance. Gold and silver are too soft to be used in a pure form and are often alloyed with copper, nickel, or platinum to increase their strength. Gold and silver have been used for dental caps, crowns, and fillings.

Silver

Silver also finds application in photographic films and papers. At one time, it was used to plate mirrors. It is now used in the manufacture of photochromatic lenses. Photochromatic lenses darken when exposed to ultraviolet light. Silver is also used in brazing alloys and long-life batteries. Silver fulminate (Ag2C2N2O2) is used as an explosive. Silver and silver compounds are found in many creams, ointments, and salves used for medicinal purposes. Silver iodide has been used to seed clouds to make rain.

Platinum

Platinum is found in a group of six metals extracted from nickel ores -- iridium, osmium, palladium, rhodium, ruthenium, and platinum. Of these, platinum has the most widespread application. It is used in corrosion-resistant coatings, as a catalyst for chemical reactions, high-resistance furnace wire, and in catalytic converters. A large percentage of platinum is used in laboratory equipment, medical instruments, and fine jewelry. Platinum is more expensive per pound than gold.

Refractory Metals

These metals have melting temperatures above 3600 degrees Fahrenheit (2000 degrees Celsius). Some of these approach 6200 degrees Fahrenheit (3500 degrees Celsius). They include such metals as iridium, osmium, and ruthenium, in addition to, chromium, columbium, hafnium, molybdenum, niobium, rhenium, tantalum, tungsten, and vanadium. They find application where high temperature stability is required. For example, furnace components, high speed tools, temperature-measuring devices and components, aircraft components and space vehicle shields. These metals also find application in electrical devices such as capacitors and rectifiers.

Titanium

Titanium is lightweight and strong. It is an important metal for the aerospace industry which requires high strength under extreme conditions. It is also used in the medical field for instruments and artificial joint replacements. Titanium is also used as a pigment in paints.

White Metals: Lead, Tin, and Zinc

White metals include antimony, bismuth, cadmium, lead, tin, and zinc. Of these, lead, tin, and zinc are of primary interest. Lead has been used for centuries for plumbing and plumbing-related uses, such as solders, pipe, and fittings. It is easily formed with low heat, corrosion resistant, and ductile. One primary use of lead in the past was as a pigment in lead-based paints. Another prior use for lead was as an octane booster in gasoline as tetraethyl lead. Modern paints and fuels do not contain lead. Lead has been identified as a health hazard and found to be toxic to animals and humans. Lead is used in storage batteries where the battery plates contain high percentages of lead. Due to its high density, it is also used as radiation shielding.

Tin

Tin is a major component of solders and pewter. It is also used as both an alloying element and plating material. Tin is a major alloy of many copper products. It is used to plate other metals due to its corrosion resistance.

Zinc

Zinc is commonly used as a plating material for steels. This product is termed galvanized steel. It is the familiar grayish coating seen on products such as nails and sheets. It is also used in die castings (such as die-cast children's toys, carburetor bodies, and pump housings) and as an alloying element in nonferrous metals. Zinc oxide is used in paints, glass, cements, and medicines.

Misc. Other Alloys

Finally, antimony, bismuth, and cadmium are included in "white" metals. Antimony is used in solders and as an alloying element in nonferrous metals. The same may be said for bismuth which has the lowest thermal conductivity of any metal except mercury. Cadmium is used as a plating material, as a component of rechargeable batteries (Nickel-cadmium batteries), and as a neutron absorber in control rods for nuclear power plants. Zirconium is also used in nuclear reactor structures and fuel shielding due to its low neutron absorption.