

CATEGORY: 5.2	MATERIALS	TIN
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## INTRODUCTION

Pure tin is a silvery white metal, which is soft, ductile and malleable. It is one of the oldest metals known to man, but it does not occur naturally as a metal. By far the most important tin mineral is cassiterite, a naturally occurring oxide of tin, which in its purest form contains 78.6% tin. Tin is a relatively scarce metal compared to some other base metals like copper, lead and zinc, with an average abundance of about 2ppm in the Earth's crust.

## PROPERTIES OF TIN

Tin (Sn) is a member of Group IV of the Periodic Table, along with carbon, silicon, germanium and lead. As a metal, the most important properties of tin are its low melting point, its non-toxicity, its resistance to corrosion, its attractive appearance and the ability to readily form alloys with most metals to create useful materials.

Tin is rarely used in its pure form because of its softness, it is almost always used in combination with other metals, either as an alloying element or as a coating.

In compounds, tin can appear in two oxidation states, either +2 (stannous form) or +4 (stannic form), and it forms various industrially-important compounds of each type.

Property	Value and Units
Atomic No	50
Atomic mass	118.69 amu
Melting Point	232°C
Boiling Point	2625°C
Density	7280 kg/m <sup>3</sup>
Electrical resistivity at 20°C	12.6 μΩ cm
Young's Modulus at 20°C	49.9 GPa

## USES OF TIN

Tin possesses a unique combination of properties, which has led to its use in a wide range of applications. It finds many different applications as a metal, alloy or as a chemical compound. The two most significant uses of tin are in solders and tinfoil. The total world consumption of tin is around 310,000 tonnes per year.

## TIN ALLOYS

### **Solders**

Solders are the largest end-use for tin and find use in electronics, plumbing and general engineering. Traditionally the vast majority of solders were based on tin-lead. However, with legislation prohibiting the use of lead, lead-free solders are now becoming more important. The choice of lead-free solders is wide; most are based on tin with additions of silver, copper, bismuth, antimony, indium and zinc in various combinations.

### **Pewter**

Pewter is an alloy containing over 90% tin and is used for utensils, decorative items, costume jewellery and toys. The most significant alloying elements are antimony and copper.

***White Metal Alloys***

Primarily used in bearings applications. These alloys are considered to be light duty materials due to their limited fatigue resistance or the ability to withstand high loads (usually employed as a layer cast on a bronze, steel or cast iron backing). Tin-rich alloys typically contain antimony, copper and/or lead at levels up to 12%, balance tin. Lead-rich alloys contain between 1 and 10% tin.

***Bronzes***

Bronzes are alloys of copper and tin, with commercial grades usually containing between 3 and 8% tin for wrought products (formed into sheet, strip, tube, rod and wire and used in applications such as springs and instrument components) and up to 12% for cast products (used for gear wheels, plain bearings and traditional applications such as casting of bells and architectural monuments). Gunmetals are bronzes, which also contain zinc.

***Other Tin Containing Alloys***

Aluminium-tin alloys for bearings applications (Al<sub>6</sub>Sn, Al<sub>20</sub>Sn); zirconium-tin alloys (Zr<sub>2.5</sub>Sn) cladding for nuclear fuel; titanium-tin alloys ; niobium-tin alloys ; dental alloys (Ag<sub>3</sub>Sn Hg amalgam); Fusible alloys.

**COATINGS*****Tinplate***

Tinplate for packaging is the second largest end-use of tin. Tinplate is light gauge, cold reduced low-carbon steel strip coated on both faces with commercially pure tin (1 to 15.2g/m<sup>2</sup>).

***Tin Alloy Coatings***

A number of tin alloy coatings are used commercially; these include tin-nickel, tin-zinc, tin-copper, tin-lead and terneplate, and may be applied by hot-dipping or electroplating. Typical application areas include electronic, automotive, domestic and chemical processing equipment.

**TIN COMPOUNDS**

Inorganic and organic tin chemicals, (tin oxide, tin chloride, zinc stannate, dibutyltin dilaurate) are produced for a wide range of applications, such as, fire retardants, catalysts, ceramics, gas sensors, toothpaste, PVC stabilisers, biocides, glass coatings.

**(TIN) Internet Resources**

[Tin Technology Ltd](#) is the world's foremost authority on tin with access to 70 years experience and knowledge through its association with ITRI Ltd (formerly the International Tin Research Institute). It has a significant source of tin related information, and provides a focal point for a substantial network of industry contacts. Tin Technology consists of several divisions related to current tin applications, including materials, coatings and chemicals.

The [US Geological Survey](#) provides information on Tin and statistics relating to its consumption, production and stocks.