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History of Tin in Dentistry

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Abstract

Tin has been a widely used dental material throughout history. It was primarily used to fill teeth in the form of alloys, such as dental amalgam or tin-mercury alloy.

Keywords: caries, filling, metal, alloys

About Tin in General

Among the earliest metals used by humanity, gold, and silver were the first to be known and utilized in ancient times. Following these noble metals, copper, tin, and iron gradually came into use. Human cultural eras were historically divided based on the materials used for essential tools, cooking utensils, and weapons. The earliest was the Stone Age, which lasted until approximately 4000 BC, when the discovery of copper initiated the Copper Age, lasting until around 3000 BC. As metallurgical knowledge expanded, more active metals were discovered—lead around 3500 BC and tin around 3000 BC. The mixture of tin and copper produced bronze, marking the beginning of the Bronze Age around 3000 BC. Iron, more reactive than copper, lead, and tin, was discovered around 800 BC, ushering in the Iron Age. Over 2,500 years later, during the French Revolution in 1790 AD, chromium was discovered. This led to the production of stainless steel, composed of 80% iron, 8% nickel, and 12% chromium.

The earliest documented use of tin dates back to around 3500 BC. Metalworkers in what is now Turkey learned to add tin to soft copper, producing a much stronger bronze alloy. This stronger material was used to create more durable tools and superior weapons. The Mycenaeans, who migrated from southern Russia and settled in Greece around 2000 BC, crafted some of the finest bronze weaponry. In the Far East, Thailand also developed bronze technologies.

Artifacts made from tin have been discovered in Egypt, dating back to approximately 1400 BC. By around 700 BC, Egyptian mummies were being wrapped in tin foil. Tin was a highly valued metal in the ancient world. The Phoenicians were already trading Cornish tin around 1000 BC.

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Authentic ancient bronze consisted of about 10% tin and 90% copper, both widely available in Britain then. Pliny the Elder describes metals extensively in his *Natural History*, beginning with gold and silver (Books IX–X) and continuing with copper, mercury, lead, tin, iron, and various alloys in Book XXXIV. (1) The Roman conquest of Britain was partly motivated by a desire to control tin mining operations. Agricola offered a detailed account of tin production in his treatise *De re metallica* (1556) (Fig. 2). (2)

Nomenclature

The ancient Greeks called tin *cassiteros*, derived from the principal tin ore, cassiterite. The term may originate from the Sanskrit word *kastir* or the Arabic *kasdir*. Britain was historically referred to as *Cassiterides*, likely a Celtic term. Herodotus first referenced this name around 550 BC. In comparison, Diodorus Siculus mentioned tin in his *Bibliotheca historica* (circa 56–36 BC) (Fig. 1). Tin was distinguished from lead in antiquity. However, Pliny referred to it as *plumbum candidum* or *plumbum album* (white lead), while lead was called *plumbum nigrum* (black lead). The Romans considered the two to be forms of the same metal. The Latin *stannum*, originally describing an alloy of silver and lead, later became the term for pure tin (Sn). *Stannum* is related to the Indo-European terms *stagnum* and *stag* (meaning "dripping"). The Germanic name *tina* translates to "shiny stick." Today, tin is represented by the symbol Sn and has an atomic number of 50 on the periodic table.

Properties of Tin

Tin has a low melting point and, while generally resistant to corrosion, it can deteriorate under extreme conditions involving strong acids or alkalis. It is an excellent electrical conductor, though not commonly used for this purpose. When exposed to high temperatures, tin oxidizes quickly, reducing its effectiveness.

Tin mining and processing can have significant environmental impacts. The extraction of cassiterite, tin's primary ore, often leads to ecosystem degradation, soil erosion, and deforestation. Tin mining can also pollute nearby water sources with heavy metals and chemicals, endangering aquatic life and rendering water unsafe for agriculture and human consumption. Atmospheric pollutants released during mining include sulfur dioxide and particulate matter, which harm air quality and contribute to respiratory illnesses and acid rain. Improper waste disposal from mining operations leads to soil contamination. Tin and associated heavy metals reduce soil fertility and are toxic to plants and microorganisms. Acid mine drainage, caused by sulfide mineral exposure to oxygen and water, results in sulfuric acid production and further environmental degradation.

Tin is a soft metal that can be easily rolled into foil. Historically, it was used for food wrapping and sealing milk bottles, though aluminum foil has since replaced it—though some still refer to it as "tinfoil." Tin exhibits two structural forms: a metallic phase stable above 13°C and a non-metallic phase that forms a gray powder at lower temperatures. When heated, the powder reverts to metallic tin. At sub-13°C temperatures, stored tin items may suffer from "tin plague," where the metal surface grays and crumbles. This transformation is most rapid around -50°C and is contagious among tin objects in close contact.

Tin is a vital component of many alloys prized for their low melting points and corrosion resistance. Alloys of tin with lead and cadmium have been widely produced. A mixture of antimony, lead, and tin was essential in early book printing. Tin plating is an ancient craft; Pliny reports that copper objects were tin-coated in

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the Gallic provinces, yielding surfaces resembling silver. This was achieved by immersing items in molten tin. During the Middle Ages, tin-plated steel sheets became common.

Tin's resistance to rust makes it valuable where other metals might corrode. Its low melting point (231.9°C) makes it helpful in creating workable alloys. Tin enhances malleability and can be formed, rolled, or drawn into sheets or wires. Due to its conductivity and biocompatibility, it is used in solders and coatings in the electrical and electronics industries. Tin compounds are used in paints, stabilizers, and catalysts. However, tin's mechanical weaknesses include low tensile and shear strength.

Dental Applications of Tin

Tin has been widely used in dentistry throughout history. Its silvery-white appearance and softness make it ideal for dental applications, especially in alloy form. Tin has primarily been used in amalgams, specifically tin-mercury alloys, for dental restoration. Tin enhances amalgam strength, corrosion resistance, and workability, making it easier to carve and polish. Tin-based alloys are valued for their durability in clinical use.

Various tin foils, categorized by weight (Nos. 4, 6, 8, 10), were historically used for dental fillings. Pierre Fauchard (1678–1761) discusses these formulations in his writings. (3) A 1988 study confirmed an 18th-century dental treatment on a 50-year-old male skeleton excavated in Saint-Amé, identified by scientists from the University of Lille. Six teeth had tin restorations, confirmed through panoramic and retro-alveolar radiography, X-ray fluorescence (XRF), and X-ray diffraction analysis. (4)

According to Fauchard, tin, lead, and gold were preferred materials for caries restoration. John Hunter (1728–1793) also supported tin restorations. (5) In the American Colonies, Townsend favored a silver-tin amalgam.

Henry L. Ambler (1843–1924) authored *Tin Foil and Its Combinations for Filling Teeth* in 1897, compiling expert opinions and case studies on tin fillings and foils. (6) Some of the quotations he included were:

- "In 1783, I stopped a considerable decay in a large double under tooth, on the outside of the crown or near the gums, with fine tin foil, which lasted for a good number of years." (7)
- "Fine tin foil or gold leaf may be injected into a cavity successfully and retained securely for many years." —Joseph Fox, Dover, England, 1802.
- "Tin is objectionable on account of rapid oxidation and being washed by the saliva into the stomach, as it may materially disorder it; the filling becomes so reduced that the cavity in which it has been inserted will no longer retain it, and acid fruits influence galvanic action." —*Every Man His Own Dentist*, Joseph Scott, London, 1833.
- "Tin is used in the form of little balls or tubes, but folds are better; introduce the metal gradually, taking care to pack it so that it will bear equally upon all points; the folds superimpose themselves one upon the other; thus we obtain a successive stratification much more exact and dense, and it is impossible there can be any void." (8)

Besides foil, fibrous tin—known as *fibrous tinn*—was also used for its cohesive and flexible properties. In 1903, Scheuer introduced the product *Zinn-Schwamm* ("tin sponge").

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The introduction of tin-gold combinations marked a new chapter in dental restorations. Gold and tin foils were layered, twisted, and folded to create a stronger, more durable filling material. According to Spring (9), the ideal mixture used one tin foil for every third gold foil; Luce recommended one tin foil for every fourth gold foil. This blend enhanced both strength and longevity in restorative dentistry.

Today, tin is not used as a restorative material like composite or ceramic, but it still plays a supporting role in amalgams (which are becoming less common) and alloys. However, with the move toward naturally looking, biocompatible, and mercury-free materials, tin's role has become more limited.

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Fig. 1. Diodori Siculi's Bibliothecae Historicae. Fig. 2. George Agricolae's De re metallica work, 1556.