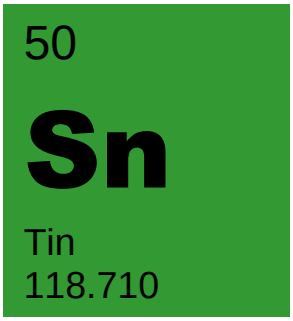
Tin



Chemical Structure

Tin is a soft, pliable, silvery-white metal that is not easily oxidized and resists corrosion. It possesses a highly crystalline structure and is classified as a transitional metal with other notable metals such as aluminium and lead. It has the advantageous combinations of a low melting point, malleability, resistance to corrosion and fatigue, and the ability to alloy with other metals.[1] Tin is a trace or micro mineral, and has an atomic number of 50 in the periodic table of elements. It is resistant to attack by sea, distilled, or soft tap water, but it will corrode in strong acids, alkalis, and acid salts and the presence of oxygen in a solution accelerates the rate of corrosion.[2]

Sources

Cassiterite (SnO_2) is by far the most important tin ore, although small amounts of tin are recovered from sulphide minerals such as stannite (Cu_2FeSnS_4).[3] Tin occurs in both primary and secondary deposits with the concentration of tin in soil and water is relatively low ranging from 1 – 4ppm (parts per million).[4]

The main sources of tin entering the human body tends to be from canned foods, cereal grains, dairy, meats, fruits, vegetables, seaweed, soil, water, environmental pollution, cosmetics, dental care products and toothpastes . Natural sources of tin can be found in various vegetables and fruits (amount contained may vary according to soil in region grown), herbal plants (liquorice, bilberry, milk thistle, juniper, valerian, nettle, couch grass, senna and others). Other main sources come from industry in the form of environmental pollution, food packaging and metallic coatings.

Absorption and Excretion

The estimated daily intake of tin from food and water (excluding canned food) is 1 – 4mg per day, mainly from organic forms.[5] Tin is not believed to be an essential mineral for nutrition and there is no established RDI (Recommended Daily Intake). The main cellular interactions with tin include; synergists: nickel, iodine, B1, Vit C and antagonists: iron, calcium, copper, chloride, B2, Vit E, zinc and bismuth. In humans, ingestion of tin has been shown to lower the net retention of zinc and can also alter the excretion of selenium.[6]

Tin is found in human tissues and in the greatest amounts in the supra-renal glands, lymph nodes, bone, liver, brain, spleen, kidneys and thyroid gland.[7] Target organs include: eyes, skin and respiratory system. Levels in humans show: Blood: 0.38 mg dm^{-3}, Bone: 1.4ppm, Liver: 0.23-2.4ppm, Muscle: 0.33-2.4ppm, Daily Dietary Intake: 0.2-3.5 mg, Total mass in an average 70kg human is approximately 20 mg.[8] The gastrointestinal absorption of tin is low, and the solubility and bioavailability of inorganic tin compounds varies and is dependent on the oxidation state.[9] The majority of ingested inorganic tin is excreted in the faeces (95-99%) with the remainder in urine.

Functions and Applications

One of the oldest and traditional uses of tin is in combination with copper to make bronze. There are many important uses for tin from industry. Most is used to produce tinplate, or steel coating with tin which is used for food packaging. Tin and tin alloys are used also for solder, especially in the electronics industry. It is commonly used as an alloy for bearing metal and as an alloy in metallic coatings. Another large application for tin is corrosion-resistant tin plating of steel. Because of its low toxicity, tin-plated metal is also used for food packaging, giving the name to tin cans, which are made mostly of steel. Electro-plating is also an important application of tin used in kitchen utensils, spray recipients and shaving foam, ink cans, electronic components, integrated circuits, clips, pins.

Inorganic compounds of tin are used in ceramics and glazes. Organic compounds of tin are used in plastics, wood preservatives, pesticides and in fire retardants. Some of the tin organic compounds have several applications as fungicides and insecticides for the agriculture and still as wood, textile and paper preservers.

Tin salts sprayed onto glass are used to produce electrically conductive coatings. Most window glass is made by floating molten glass on molten tin to produce a flat surface. The more important tin compound is the tin dioxide (SnO_2), used in electric resistors and dielectrics, and the tin monoxide that it is used in the production of tin salts for electroplating and as chemical reagents. The tin compounds that contain lead, barium, calcium and copper are indispensable in the production of electric capacitors. Tin fluoride also called stannous fluoride is used as an additive in commercial toothpastes.

There is no proven biological function for tin in the human body.[9] In animal studies, it has been shown that a deficiency of tin contributes to poor growth and hearing loss and may have cancer prevention properties.[10] In a two year study with humans, tin appeared to show some positive benefits for depression, fatigue, pain, skin problems, and digestion.[11]

Toxicity and Excess

Tin as organic compounds exhibit varying degrees of toxicity, with Triethyltin considered to be the most dangerous form for humans.[12] The effects of organic tin substances can vary depending on the kind of substance that is present and the level of exposure to the organism. Humans can absorb tin bonds through food, inhalation through breathing and through the skin.[13] The uptake of tin can cause acute and long term chronic effects. Acute effects may include; eye and skin irritations, headaches, gastrointestinal upsets (vomiting, diarrhoea, cramps), dizziness, severe sweating, breathlessness and urination problems.[14] Long term effects may include; depression, liver damage, immune dysfunction, cognitive dysfunction (anger, sleeping disorders, forgetfulness), shortage of red blood cells and chromosomal damage.[15]

Analysis in HTMA

Tin is measured as an additional element in a HTMA. As tin is biologically inert in the body, it does not serve any main biological function. Low levels of tin in a HTMA are considered to be 0.09 ppm or below and any reading above 0.09ppm up to 0.30ppm is considered to be in the high reference range and may be of more clinical significance. The levels in the body may correlate with previous exposure from various sources and may indicate residual build up over time if there has not been an acute exposure.