



## High purity metals / High-tech metals



Click the name of the item below to read more.

- Aluminum (high purity)
- Antimony (high purity)
- Beryllium (high purity)
- Bismuth
- Cadmium powder (99.99%)
- Cesium Metal (99.99%)
- Cerium Metal (99.999%)
- Cobalt
- Dysprosium (highly pure)
- Germanium Powder (99.999%)
- Gold
- Holmium Powder (99.9%)
- Indium
- Copper / Copper Powder / Copper Ingot
- Nickel

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## High-purity Aluminum:

Aluminum is available as metal and compounds with purities ranging from 99% to 99,9999% (ACS grade to ultra-high purity) in the form of films, sputtering targets, and nanopowders.

Elemental or metallic forms include pellets, rods, wires, and granules for evaporation purposes. High purity (99,999%) alumina (Al<sub>2</sub>O<sub>3</sub>) powder is available in the form of powders and dense pellets for applications such as optical coatings and thin films.

High purity (99,9999%) aluminum (Al) sputtering targets are available in soluble forms, including chlorides, nitrates and acetates. These compounds are also prepared as solutions at certain stoichiometries.

Aluminum can be synthesized in ultrahigh purity (99,999 +%) for laboratory standards, advanced electronic thin film deposition using sputtering targets and evaporation materials, metallurgical and optical materials and other high technology applications.

Organometallic aluminum compounds are soluble in organic or nonaqueous solvents.



Aluminum ingot

The purest aluminum with a purity of > 99,999% is produced with the help of three-layer electrolysis. In order to clarify the technical effort, we have included the original description of the patent DE4329732C1 below. This process is to be used for the ingot as well as for the fine wire products.

The invention relates to a method and apparatus for refining aluminum in a three-layer melt-flow electrolysis cell, wherein the addition of the metal to be refined takes place via a forehearth containing a liquid anode alloy.

Usually, in the three-layer electrolysis, a furnace with a forehearth is used. This serves to charge the electrolysis cell, wherein the supply of the pure aluminum to be refined takes place in liquid form over the preform formed as a siphon into the lower layer of the electrolytic metal, the so-called anode metal. About 30% of copper is added to the anode metal to increase the density, and because of the constant supply of fresh aluminum material, an uneven alloy distribution in the electrolytic furnace is observed.

In addition to the anode metal, the three-layer electrolysis consists of a middle layer of a molten electrolyte and the product "pure aluminum" above that, which is the top layer in contact with the graphite cathodes.



The electrolysis is operated with direct current, with the anodic power supply at the bottom of the furnace and the cathodic supply via graphite electrodes. Due to the electrochemical Potentialverhältnisse essentially only aluminum is anodically dissolved or cathodically deposited. Due to the low diffusion rate, there is no automatic mixing of the supplied liquid pure aluminum with the anode alloy, so that has been mechanically pumped to achieve a concentration balance between the various components of the anode metal.

By a manual or mechanical pumping there is a risk that waves occur at the interfaces of the three layers, leading in extreme cases by local short circuits to contamination of the cathode with the anode metal. Furthermore, it is disadvantageous that hitherto, in order to improve the miscibility, the pure aluminum to be refined has been melted in a separate furnace and then mixed with the anode metal via the forehearth. The known procedure could also be carried out only intermittently, since it always had to wait until the added pure aluminum was distributed by mechanical pumping in the forehearth.

Object of the present invention is to avoid the disadvantages mentioned and to provide a method and apparatus that allow a continuous supply of pure aluminum in particulate form in the Elektrolysemetall, shorts are avoided and impurities are removed continuously.

This object is achieved by the features specified in the main claim. Further preferred embodiments of the invention can be taken from the features of claims 2 to 15.

The essential idea of the invention is that a portion of the electrolysis is passed through the forehearth in the anode metal. This results in the combination of the current flow with the magnetic field of the furnace, a force that leads to a metal movement in the forehearth. This movement is sufficient with a corresponding flow of current to cause melting and mixing of the introduced in the forehearth pure aluminum.

The current supplied to the forehearth via the 9 electrode is about 1 to 20%; preferably 10 to 15%, of the total flow of the electrolytic cell. From numerous experiments it has been found that a current from 1,5 to 7,5 kA can be introduced into the forehearth via the 9 electrode, preferably 3 to 6 kA being sufficient to allow good dissolution also of lumpy aluminum in the forehearth.

The adjustment of the current flowing through the electrode 9 can be carried out, for example, by the following parameters:

- 1. Change in the conductivity of the nipple material, the ramming mass or the carbon electrode
- 2. Change of the cross-section of the 9 electrodes or the surface-active in the anode metal
- 3. Turn on or off the individual power supply to the cathode or anode
- 4. Change of material combination graphite/copper / synthetic resin binder.
- 5. Change in the thickness of the ramming compound 19.
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On the basis of experiments, it has proven to be particularly effective to use the material of the 9 electrodes made of double-impregnated electrographite. However, it is also possible with graphite or carbon to introduce sufficient power into the anode metal.

The limits for the current supplied via the 9 electrodes are defined by the following boundary conditions:

At less than 1%, the anode metal effective force is insufficient to achieve sufficient mixing. At more than 20% of the total current densities occur, which must be limited in terms of a sufficient life upwards.

In a preferred embodiment, the 9 electrode has a protective cover intended to prevent burnup. It consists of a ceramic material which is gas-tight and resistant to an aluminum-copper-anode alloy; For example, nitride-bonded silicon carbide can be used. A mixture of silicon carbide and silicon powder, which has been annealed under nitrogen, has proved to be particularly favorable.



From time to time, it is important that the underside of the 9 electrode be cleaned of dross from the charred aluminum pieces. The electrode 9 should therefore protrude from the bottom of the protective cover, whereby a vertical adjustment relative to the protective cover allows stripping or cleaning. Furthermore, the conductivity of the electrode 9 must be adjustable in order to effect the desired stirring or mixing in the anode metal.

Due to the inventive design of the three-layer electrolysis, it is possible that an automatic addition of pure aluminum takes place in lumpy form, the operation can proceed fully automatically by simple control engineering measures.

On the previously required mechanical stirrer can be omitted; Due to the materials used and the structural design of the 9 electrode, a long service life is guaranteed. As a result, the operating times of the electrode according to the invention have been significantly extended.

In the 10 electrolytic cell, a lining of magnesite 1 and an anode bottom of carbon 2 can be seen. The power supply is anodic via the anode rail 3 steel and cathodic graphite cathode 7, which are suspended from a corresponding cathode rail. Inside the electrolysis cell is the refining aluminum or 4 anode metal, which is covered at the top by a molten electrolyte 5.

The anode metal 4 extends into the forehearth 8, which is attached to improve the flow conditions obliquely to the electrolytic furnace.

Anode 3 is connected to the 11 anodes and the 9 electrodes. Lateral aluminum in the direction of the 9 can be added to the side of the 12 electrodes.

The purified aluminum settles as ultrapure aluminum at the electrolyte/cathode interface. From the cathode compartment, it can be withdrawn in a known manner.

With the method according to the invention can be kept constant in an advantageous manner, the bath level in the three-layer electrolysis cell, with such great accuracy that even small fluctuations by continuous addition of pure aluminum, preferably in particulate form, can be compensated. This has the surprising advantage that the degree of purity in the method according to the invention can be substantially improved since no impurities are absorbed by the lining of the electrolytic cell. In the case of three-layer electrolysis, this is particularly important because the impurities of the respective layer are deposited on the walls of the cell so that, when the bath level fluctuates, there is a risk that the impurity will be absorbed again into the already cleaned aluminum layers.

In Fig. 2 the inventive structure of an electrode 9 is shown in more detail. One recognizes the electrode material 13 and the cladding 14, which is separated from the electrode material 17 by a gap 13, which contributes to the isolation of the cladding.

The 9 electrode also consists of the electrode nipple 18 and a thin ramming layer 19, which surrounds the electrode nipple 18 inside the sleeve-shaped electrode.

At the electrode nipple 18 in the upper part of the further 14 cladding is attached, which is pressed over a screw 20 and a cover 21 against an annular disc 22. Between the envelope 14 and the nipple 18 is a sealing material 23, so that a gas-tight termination of the electrode is secured to the ambient air out. The washer 22 presses against the stop blocks 24 of the nipple 18.

To improve the bearing surface on the forehearth 8 a wall support 25 is provided. At the same time, it also fulfills sealing functions and serves as a fastener for the overlay of the 21 cover.

In order to minimize the resistance in the 9 electrodes, the distance between the low point 15 of the 9 electrodes and the lower edge 16 of the 14 cladding must be kept within certain limits. An adjustment possibility is given by the mechanical connection of the nipple 18 over the screws 26, 27, and 28 with the electrode rod 29. Preferably, the distance between the lower edge 16 and the low point 15 is between 20 and 30 cm.



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## High purity Antimony:

For thousands of years, humans have used antimony in many and often radically different ways. Already at 3100 v. It was made from the mineral stibnite (antimony trisulfide) cabbage, which favored pitch-black eye make-up by the ancient Egyptians, and a bright yellow pigment of antimony trioxide and lead was used in glassware and paints. To the 14. In the century BC, a possibly apocryphal legend was born, as the Babylonian king, Nebuchadnezzar slowly went mad because he was exposed to the painted walls of his palace. But this pigment, which eventually became known as the "Naples Yellow", reached the 18. Century the height of its popularity. The writings of the Greek philosopher Pliny d. Ä. from the first century AD contains an indication of the medical use of stibnite, from which the element lead (with falsely identified antimony) could be obtained by heating. The first authors who described a means for the isolation of metallic antimony were the Italian metallurgist Vannoccio Biringuccio in the year 1540 u. Z. and Georgius Agricola in the year 1556; The French chemist Nicolas L  mery was the first to examine the element and its compounds and published its results in the year 1707.



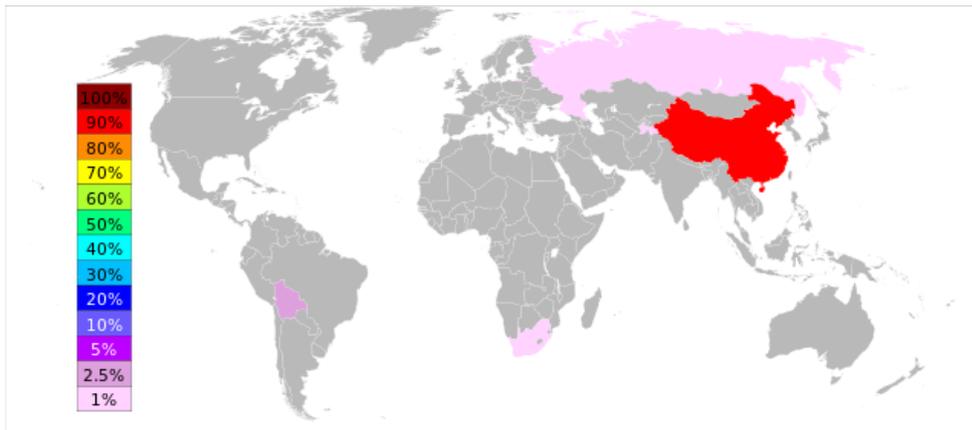
Antimony oxides

The medieval alchemists recognized antimony as a "profane element" associated with femininity and gave the element its own symbol (of which a version continues to symbolize the woman). Antimony compounds have been used medicinally since the ancient Greeks prescribed certain powders to treat skin diseases. However, they were in the years following the death of the Swiss-German alchemist and physicist Paracelsus in the 16. Century as a medicine, so-called "antimony drugs", more popular. In particular, Paracelsus strongly favored the use of antimony agents as a laxative; His therapies were adopted by many in Europe over the next two centuries, notably in the form of emetics and laxatives, the remarkable effectiveness of which was largely due to their toxicity. Although arsenic is far more deadly, antimony poisoning has similar symptoms, and almost all forms can have profound toxic effects over time, including liver damage or cancer. Elemental antimony is more toxic than its salts, and compounds containing antimony in its trivalent oxidation state are generally ten times more toxic than those containing pentavalent antimony. Stibin ( $\text{SbH}_3$ ) and Stibnite ( $\text{Sb}_2\text{S}_3$ ) are extremely toxic antimony compounds. Exposure to more than 50 mg / m<sup>3</sup> is considered an imminent threat to life and health.



Antimony Ingot 16 Kg

Like other elements, including boron, silicon, germanium, arsenic, and tellurium, antimony is classified as a metalloid that has properties intermediate between metals and nonmetals. Although its chemical structure resembles that of real metals, it is less thermally and electrically conductive and has the unusual property of having lower electrical conductivity than solid as a liquid. As with phosphorus and arsenic, there are several allotrope forms of antimony: a stable form, which is a silver-white metal, and three metastable forms: black, yellow, and explosive. Elemental antimony is acid resistant and stable in the air, although it is flammable when heated. It is one of five elements with the unusual property of expanding in volume upon solidification (silicon, germanium, gallium and bismuth are the other four). When molten antimony is allowed to cool, its surface receives a thin crystalline film with a characteristic crystalline fern or star pattern.



Worldwide antimony production

In the medical field, there are still some niche applications for antimony-based compounds. Antimony potassium tartrate or potassium antimony (III) tartrate, better known as tartar emetic, is slowly being withdrawn, but compounds such as meglumine antimonite, sodium stibogluconate, and lithium antimony thiomalate have been used to treat difficult to treat parasitic diseases such as skin diseases fight leishmaniasis. However, slow recognition of the risks associated with the element has resulted in a general shift of applications towards mainly industrial and high technology applications. Antimony oxides and sodium antimonite are widely used as flame retardants in plastics, textiles, leather, and PVC because in a fire, unstable compounds are released that rapidly combine with atmospheric oxygen to choke the flames. Flame retardants are one of the most important industrial applications for antimony. In addition, the security matches contain a combination of antimony trisulfide and an oxidizing agent such as potassium chlorate with red phosphor tips, which must be beaten on the respective matchbox surface for firing. Various antimony compounds are used as components of pigments, mordants, pyrotechnics, fining agents for removing gas bubbles in glass, and in the production of high quality transparent glass used in computer monitors and television screens. In laboratory chemistry, fluorantimonic acid is obtained by reacting antimony pentafluoride with hydrogen. Fluoride is the strongest known superacid.



Recent antimony applications have focused on advanced semiconductor technologies. Particularly important are the antimony compounds with indium, gallium, germanium and tellurium, which produce compounds such as InSb, Ge<sub>3</sub>Sb<sub>3</sub>, GaSb, and Sb<sub>2</sub>Te<sub>3</sub>. These semiconductive compounds are used as components and substrates for the high-tech electrical materials in laser diodes, integrated circuits, infrared detectors, Hall-effect devices, and memory storage devices for data storage. In addition, it has been suggested that antimony semiconductors are critically important for the development of the next generation of metal oxide semiconductor field-effect transistors (MOSFETs) and tunnel field-effect transistors (TFETs) that could supply fast and efficient computers for use in sensors and microelectronics. High purity antimony (99,999 +%) serves as an n-type dopant in silicon wafers, and indium tin oxide (ITO) nanoparticles doped with varying concentrations of antimony have been shown to improve laser reflectance performance. Sever-antimony compounds function as topological insulators, hybrid materials that are electrical insulators in their interior but are conductors on their surface. Silver antimony telluride crystals have been used to develop modeling tools for the development of new thermoelectric devices. and various antimony-based materials such as copper antimonide and monodisperse antimony nanocrystals have been studied as a highly efficient electrode and electrolyte materials in next-generation batteries.

Antimony derived its element symbol Sb from stibium, the Latin name for stibnite. The origin of the name “antimony” is less clear. Suggestions include Latin antimonium, which appears for the first time in a Latin translation of Ceber's work, the Arabic term Mesdemet, and the Greek words anti and monos, which mean “not alone,” as the element occurs mainly in compound form or with others heavier metals. The most common mineral springs are the aforementioned stibnite (also known as antimony gaze) found in hydrothermally formed veins, valentinite (antimony trioxide, a by-product of the decomposition of stibnite), and tetrahedrite. However, the element also occurs in over a hundred different minerals: cervantite or kermesite, senarmonite, nadorite, and more. Antimony is mainly extracted from stibnite in the production of silver, gold, and copper and can also be recovered from the recycling of lead-acid batteries.

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## High purity Beryllium:



Beryllium metal

Beryllium is a fairly soft metal that is brittle yet solid.

It is used as a coating for X-ray tubes because it is transparent to X-rays. It also has military and nuclear industrial applications.

High purity (99,999%) beryllium (Be) sputtering target Beryllium is available as metal and compounds with purities ranging from 99% to 99,999% (ACS grade to ultra-high purity).



High purity (99,999%) beryllium oxide (BeO) powder or metallic forms include pellets, rods, wires, and granules for sources of evaporation.

Beryllium Oxide is an insoluble beryllium source available in powder and dense pellet form for applications such as optical coatings and thin-film applications. Beryllium fluoride is another insoluble form for applications where oxygen is undesirable, such as metallurgy, chemical and physical vapor deposition, and some optical coatings. Beryllium is also available in soluble forms including chlorides, nitrates, and acetates. These compounds can be prepared as solutions at certain stoichiometries.

## Bismuth:



Bismuth crystals, unoxidized

Bismuth expands upon solidification. Because of this property, bismuth alloys are particularly suitable for producing sharp castings which can be damaged by high temperatures. Bismuth forms low-melting alloys with other metals such as tin, cadmium, etc., which are often used for safety devices in fire detection and extinguishing systems. Bismuth is also used in the production of malleable iron and is used as a catalyst for the production of acrylic fibers.

High purity (99,9999%) sputum target from bismuth (Bi)

When bismuth is heated in the air, it burns with a blue flame and forms yellow oxide vapors. The metal is also used as a thermocouple material and has been used as a carrier for  $^{235}\text{U}$  or  $^{233}\text{U}$  fuel in nuclear reactors application. Its soluble salts are characterized by the formation of insoluble basic salts with the addition of water, a property sometimes used in detection. Bismuth oxychloride is widely used in cosmetics. Elemental or metallic forms of bismuth include pellets, rods, wires, and granules for evaporation source material purposes. Bismuth oxide is available in the form of powders and dense pellets for applications such as optical coatings and thin-film applications. Oxides tend to be insoluble. Bismuth fluorides are another insoluble form for applications where oxygen is undesirable, such as metallurgy, chemical and physical vapor deposition, and in some optical coatings. Bismuth is also available in soluble forms including chlorides, nitrates and acetates. These compounds are prepared as solutions at certain stoichiometries.

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## Cadmium / Cadmium powder:



Cadmium Metal Cadmium

Cadmium is most commonly found in nature as a minor component of zinc ores. This fact led 1817 to its discovery by Samuel Leberecht Hermann and Friedrich Stromeyer, who studied impurities in a sample of the zinc carbonate mineral Calamin (or Cadmia in Latin), from which the name of the element was later derived.

Cadmium found a variety of applications soon after its discovery. The first noteworthy uses of cadmium were red, orange, and yellow cadmium sulfide-selenated pigments, already in the forties of the 19. Century were used on a small scale. Cadmium pigments are valued for their liveliness and durability, and at the time of their introduction, there were few options for stable pigments in this color range. As the production of cadmium metal on an industrial scale in the early 20. Century began, cadmium pigments became more popular and other applications followed. Because cadmium is resistant to corrosion, it can be electrodeposited to serve as a protective coating for lightly corrosive metals such as steel. Nickel-cadmium (NiCd) batteries were first invented by 1899, but were generally manufactured in the middle of the 40 years. For the next fifty years, they were the primary rechargeable batteries for consumer electronics. Cadmium may also be a component of silver-based solder alloys which are versatile, have high strength and uniquely low melting point. Cadmium compounds can be used to stabilize PVC plastics, significantly increasing their resistance to heat and general wear.

Unfortunately, the use of cadmium has had a major disadvantage for all of these applications: cadmium and many of its compounds are extremely toxic. The poisoning by metal fumes or cadmium dust is often acute and causes severe flu-like symptoms, respiratory problems and damage to the liver and kidneys within hours of exposure. Acute organ damage can also be caused by ingesting large amounts of cadmium compounds. Long-term low-level exposure, however, can also lead to insidious damage, leading to progressive kidney disease, gout and dangerously weak bones, leading to severe pain and fractures. Cadmium in industrial waste, landfills and mines easily enter the groundwater and can be used in drinking water or collected in crops. All plants can pick up some cadmium from the soil, but some tend to concentrate the metal, which sometimes leads to tragic mass poisoning.

Concerns over the toxicity of cadmium have led to workplace safety regulations, battery recycling programs and a significant decline in traditional uses of the metal. Alternative pigments such as cerium sulphide and azo pigments are now available for many applications, although some paints still contain cadmium. For most applications of corrosion resistant thin films, a zinc or aluminum coating can serve the same purpose as a cadmium coating. Few soldering formulas still contain cadmium, and alternative stabilizers have been developed for the manufacture of PVC products. Finally, nickel-metal hydride (NiMH) and lithium-ion batteries for rechargeable batteries in consumer electronics are becoming economically and functionally comparable alternatives to Ni-Cd, although Ni-Cd batteries still have the benefits they provide for some specialty applications recommend.

A relatively new application of cadmium in compound semiconductors is becoming increasingly important. Cadmium can form II-VI class semiconductor compounds with selenium, tellurium and sulfur, as well as being part of several ternary



semiconductors. Currently, the largest use of cadmium semiconductors is in cadmium telluride thin-film photovoltaics, but also in radiation detectors, electro-optic modulators, optical windows and lenses, photoresistors, and lasers. In addition, ongoing research on nanoscale cadmium semiconductor crystals such as cadmium selenide quantum dots has yielded promising results for a variety of applications, including more efficient LED illumination.

Cadmium is relatively rare and there are no common cadmium ores. Therefore, the element is still commercially obtained today as a by-product of zinc mining. Cadmium sulfide is the most abundant compound in zinc ores. Because it is easy to insulate and clean, it is the main source of cadmium for industrial applications.



Cadmium Powder

Cadmium Powder 99,99%

Highly pure cadmium powder with the smallest possible average grain sizes is used for the production of pressed and bonded sputtering targets as well as for chemical vapor deposition (CVD) and physical vapor deposition (PVD) processes, including thermal and electron beam processes (e-beam) evaporation, organic evaporation at low temperature, atomic Layer Deposition (ALD), organometallic and chemical vapor deposition (MOCVD). Powders are also suitable for all applications where large surface areas are desired, e.g. B. for water treatment as well as for fuel cell and solar applications. Nanoparticles also produce very high surfaces. Standard powder particle sizes averages in the range of -325 mesh, -100 mesh, 10-50 microns, and submicron (<1 micron). Materials in the nano range can also be created. There are standard grades including Mil Spec (military grade); ACS, reagent and technical grade; Food, agricultural and pharmaceutical quality; Optical quality, USP and EP / BP (European Pharmacopoeia / British Pharmacopoeia) and follows the applicable ASTM test standards. Cadmium is also manufactured in rods, ingots, pieces, pellets, discs, granules, wire and in composite forms such as oxide.

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## Cesium Metal (99,99%):



Cesium metal

### Cesium

With an electron in the sixth and outermost shell, cesium is the most electropositive of all stable elements in the periodic table: the metal is extremely pyrophoric, ignites spontaneously when in contact with air, and explodes violently in water or ice at any temperature above  $-116^{\circ}\text{C}$ . Although cesium is only mildly toxic, it is considered hazardous because of its high reactivity and is usually packaged in glass ampoules in vacuo or under an inert gas such as argon. The heaviest of the stable alkali metals, cesium, has a silvery-golden appearance, is ductile and, with 0,2 on the Mohs scale, the softest element in the periodic table. Cesium melts at  $28^{\circ}\text{C}$ , making it one of three elements (the others are gallium and mercury) that are liquid at or near room temperature. Mercury is the only element with a lower melting point. Only one of the known isotopes of cesium is stable ( $^{133}\text{Cs}$ ), but with its 39 isotopes it is associated with xenon, the two elements with the largest amount of known isotopes. Cesium was also the first spectroscopically discovered element of the German scientists Robert Bunsen and Gustav Kirchhoff, who had invented the technology last year. Bunsen and Kirchhoff gave the new element a name based on the Latin word *Caesius* (sky or celestial blue) for the two bright blue lines in its spectrum.

Cesium is the most abundant element on earth and is found in the minerals pollucite, avogadrite, pezzottaite, londonite, rhodocite, beryl and some potassium ores. The primary commercial source of metallic cesium is the mining of pollucite, while cesium radioisotopes are produced from waste from nuclear reactors. Oxygen-free metallic cesium can also be produced by the thermal decomposition of cesium azide ( $\text{CsN}_3$ ). Laboratories use cesium compounds for various functions in organic chemistry, such as the hydrogenation of organic compounds or, in the case of cesium fluoride, as a source of the fluorine anion. The radioactive isotope cesium-137 is often used in X-ray irradiation for cancer treatment. In commercial and industrial applications, cesium salts can serve as catalyst promoters, glass amplifiers, components of photoelectric cells, crystals in scintillation counters, and "getters" in vacuum tubes; Cesium formate brine is commonly used in oil drilling to lubricate bits and maintain pressure. Thermionic energy converters use a vapor of cesium ions to determine the work function of the electrodes. Early ion propulsion motors for space exploration used cesium as a propellant until xenon became the standard. The most accurate commercially available atomic clocks measure time using the oscillation of the 137 MHz hyperfine transition frequency of the cesium-133 atom. This frequency, known as the "cesium standard", is the primary time standard for defining the second and is critical to the data transmission infrastructure of cellular networks, GPS and the Internet.

### Cesium Metal 99,99%

Metallic cesium ingots with the highest possible density. Ingots are generally the least expensive metal form and are suitable for general applications. A standard bar size is nominal 2-3 cm x 3-8 cm x 6-12 cm. Materials are made using crystallization, solid state, and other ultrahigh-cleaning methods such as sublimation. Manufacturing is mostly done on custom



compositions for commercial and research applications, as well as new proprietary technologies. It can Also, metallic cesium can be produced in forms such as lumps and sputtering targets and in composite forms such as cesium oxide.

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## Cerium / Cerium Metal / Cerium Oxides (99,999%):



Cerium oxide

Cerium,

Cerium was discovered by Jons Jacob Berzelius in 1803 and named after the newly discovered dwarf planet Ceres. Like most of its rare earth counterparts, of which it is the most abundant, cerium was originally identified in the form of its oxide, known as cerium oxide, and was only extracted as a pure metal decades after its first discovery. Nonetheless, both salts and metal mixtures containing cerium quickly found industrial use. Cerium salts were found to have antiemetic properties and soon found their way into cough tinctures and antibacterial treatments. Around the same time, Carl Auer von Welsbach, an Austrian scientist who knows how to commercialize his discoveries, successfully developed two products that required the use of cerium: gas jackets and lighters. Auer's gas coats were simple devices - cotton fabrics soaked in a mixture of salt - but the glow they gave off when heated enabled brighter, whiter light to be emitted from gas lamps. In the early days of artificial lighting, cerium found a third use in carbon arc lamps, particularly prized in movie studios for their extreme brightness, which enabled them to mimic the appearance of natural sunlight.

With the exception of cerium nitrate, which is still available as an antiseptic and anti-inflammatory topical treatment for burns, cerium compounds find little use in modern medicine, but the use of cerium in lighting applications has been continued and expanded: cerium, lantern coats and celiac lighters are becoming ever more popular still manufactured, but nowadays cerium-containing phosphors are also indispensable for the production of screens and fluorescent lamps.

The optical properties of cerium make it an important component of non-toxic alternatives to cadmium-based pigments and an important additive in glassmaking, where it provides a golden coloration and allows the selective blocking of UV light. Cerium also adds valuable properties to various alloys when added in small amounts: it makes aluminum more corrosion resistant, magnesium more heat resistant, and helps to reduce the sulfur and oxygen content of steel. The largest volume of cerium in terms of volume is the cerium (IV) oxide abrasive used for precision optical components and for polishing silicon



wafers used in microchips. Cerium oxides are also useful as catalysts and are used for this purpose in automotive catalytic converters, petroleum refineries, and solid oxide fuel cells.

Like other rare earth elements, cerium never occurs in its pure form in nature. It can only be obtained from rare earths that contain minerals such as xenotime, monazite and bastnasite, or from ion adsorption.

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## Cobalt / Cobalt Metal / Cobalt chips:



Kobalt chips

Cobalt,

Like cupernickel, the devil's copper, so named because what is believed to be a cobalt ore is not copper. This was frustrating for miners. Not only did they provide useful metals, they also produced toxic arsenic oxide when smelted. Therefore, the ores were named after the goblins, who were often blamed in mining accidents by German miners. When Swedish chemist Georg Brandt succeeded in isolating cobalt metal around 1825, he named the newly discovered element his ore.

In addition to the discovery of cobalt, Brandt was able to prove that cobalt compounds were used in an unknown way to color smalt, a blue glass since medieval times. In the late eighteenth and early nineteenth centuries, green, blue cobalt-based pigments were widely used to paint ceramics, jewelry, and paints. These applications for cobalt still apply today, although today cobalt is most commonly used in its metallic form.

Most of the cobalt consumed in the US is used to make superalloys. These are in areas where resistance to the most common conditions is required, for example; B. in components of jet engines or high-speed drills. Superalloys are also sometimes used in biomedical implants such as hip replacements, but these implants need to be monitored for damage, as metal nanoparticles produced by wear can be easily absorbed and distributed throughout the body. Cobalt in cobalamin, also known as vitamin B12, is an essential nutrient, but excess free cobalt ions in the body have toxic effects.

Cobalt is also used in other alloy applications. It is found in alnico and samarium cobalt magnets, both of which are widely used in industry. Cobalt is also found with primary electrode metals in lithium-ion, nickel cadmium, and nickel metal hydride batteries. Thanks to its attractive appearance, extreme hardness and oxidation resistance, cobalt can be used as a metal in plating other materials, alone or as a base for other coatings such as porcelain enamel. Platinum used in jewelry contains 5 percent cobalt because this makes it an alloy suitable for highly detailed casting.



There are two other major uses of cobalt in the industry. The first acts as a catalyst: cobalt compounds are used industrially to make polymer precursors to remove sulfur-containing impurities in petroleum and to improve the adhesion of rubber to steel for the manufacture of steel-belted tires. Additionally, cobalt catalysts are added as drying agents for paints and lacquers and are used in a variety of other chemical processes, both at industrial and laboratory scale. The second main application is the use as a binder in hard metals and the use of very hard materials, processing metals such as steel.

Finally, cobalt radioisotopes perform some important functions. Cobalt-60 is a radioactive isotope used in the sterilization of food and medical supplies and to produce gamma rays for use in both medical radiotherapy and industrial X-ray imaging. Cobalt-57 is used as a tracer in medical imaging, particularly to monitor vitamin B12 intake.

The most important cobalt ores are cobaltite, erythritol, glaucodot and skutterudite, all of which are commercially exploited. However, a significant portion of the metal is also recovered by processing the by-products of copper and nickel mining. Cobalt catalysts and cobalt alloy waste can also be recycled to recover high purity cobalt.

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## Dysprosium (highly pure):



Dysprosium Metal highly pure

Dysprosium metal,

French chemist Paul Emile Lecoq de Boisbaudran isolated 1886 dysprosium oxide from an impure sample of holmium oxide. He had great difficulty deriving the metal itself from the oxide, calling it "hard to get". It is not surprising that the metal was so difficult to isolate, as significant amounts of pure rare earth elements could only be obtained when ion exchange techniques were developed in the 1950 years.

A number of compounds containing dysprosium emit light under defined conditions, making them useful for a number of applications. Dysprosium-doped calcium sulfate or calcium fluoride crystals luminesce when exposed to radiation and are therefore used in dosimeters to measure exposure to radiation. Dysprosium iodide and bromide are used in metal halide lamps that produce extremely bright white light, which is appreciated in the film industry. In addition, dysprosium compounds can be used to generate infrared light and are often used in infrared lasers.



Dysprosium oxides

Dysprosium and its compounds are also valued for their magnetic properties. Readily magnetizable dysprosium compounds can be used in data storage applications such as hard drives, and dysprosium is often used to replace part of the neodymium in neodymium-iron-boron magnets. Replacing these high performance magnets with dysprosium increases their corrosion resistance and coercive force. Neodymium magnets are indispensable for electric motors, magnetic storage devices such as hard drives and many other modern electronic devices. Dysprosium-containing garnets with magnetic properties are used in magnetic refrigerators, which can be reached extremely low temperatures. Finally, Terfenol-D is an alloy of terbium, iron and dysprosium that is magnetostrictive: it contracts or expands when exposed to magnetic fields. This property allows a direct conversion between electrical and mechanical performance, and the alloy is used in sensors, actuators, and sonic and ultrasonic transducers and active noise and vibration suppression devices.

Dysprosium effectively absorbs neutrons and is therefore used in control rods for nuclear reactors. It can also be used to make nanofibers with high strength and natural corrosion resistance, which can be used as reinforcement in ceramic materials for high temperature applications.

Dysprosium, like other rare earth elements in nature, never occurs in pure form. It can only be obtained from rare earths that contain minerals such as xenotime, monazite and bastnasite, or from ion adsorption.

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## Germanium Powder (99,999%)



Germanium powder



Germanium powder 99,999%,

When Mendeleev 1869 published his first periodic table of elements, it contained several elements that were still undiscovered. He gave everyone a temporary name and predicted his qualities based on the surrounding elements. One of them was called ekasilicon, and Mendeleev almost perfectly predicted the properties of the actual element that 1886 discovered by Clemens Winkler and named after his native Germany: germanium.

Germanium is a semiconducting metalloid with silicon-like properties, and its use in electronic devices predated the use of the more familiar element. The first transistors were made 1947 in Bell Labs from germanium. Finally, the available technologies for use with silicon and the abundance of silicon have led to many other silicon semiconductor applications, including standard computer chips, and germanium has played a limited role in semiconductor devices for many years. Today, however, new technologies make Germanium a key material for electronic applications. Germanium is preferable to silicon in some types of photovoltaic cells used to generate solar energy and is used as an important substrate in the manufacture of high brightness LEDs for flashlights, taillights, cameras, traffic signals, and displays. Germanium, as an LED component, is sometimes preferable to the alternative gallium arsenide because it breaks less frequently and poses fewer disposal problems. In addition, microchip designs with germanium-on-insulator or silicon-germanium technology are increasingly being used.

Another important use of germanium is the favorable optical properties of germanium and some of its compounds. Germanium oxide has a high refractive index and low optical scattering, making it suitable for use in wide-angle lenses and some microscopes. Germanium oxide also confers some of these properties when used as a dopant in fused silica, and is used as such in the core of optical fibers. An additional useful optical property is that germanium glass is transparent to infrared radiation. It is therefore used in thermal imaging cameras, night vision systems and sensitive infrared detectors. Another use of germanium in optical systems is the material germanium antimony tellurium or GeSbTe, a phase change material used in rewritable optical discs (CD-RW, DVD-RW) and other phase change storage devices.

In addition to its electronic and optical applications, germanium is also used in several other key areas. Germanium oxide is used as a catalyst in the production of many plastics. Adding germanium in small quantities to sterling silver reduces fire and tarnishing and makes the final metal harder. In contrast to earlier ideas, germanium has been shown to have no medical function and is considered potentially dangerous when consumed. Nevertheless, some dietary supplements contain the element.



Germanium metal

Although germanium is not particularly rare, it is not contained in any mineral in a percentage sufficient to specifically degrade germanium. Instead, germanium is derived from concentrates obtained as by-products from the extraction of other metals, particularly zinc, and additionally from the fly ash of some coal-fired power plants.

Highly pure germanium powder is produced in the smallest possible average grain sizes for the production of pressed and bonded sputtering targets as well as for chemical deposition processes (CVD) and physical deposition processes (PVD),



including thermal and electron beam evaporation (e-beam), low temperature organic evaporation, atomic layer deposition (ALD), organometallic and chemical vapor deposition (MOCVD). Powders are also suitable for all applications where large surface areas are desired, e.g. B. for water treatment as well as for fuel cell and solar applications. Nanoparticles also produce very high surface areas. Standard powder particle sizes average in the range of -325 mesh, -100 mesh, 10-50 microns, and submicrons (<1 micron). Germanium is also produced in rods, ingots, pieces, pellets, discs, granules, wire and in composite forms such as oxide.

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## Gold:



Gold Ingot

Gold,

The remarkable properties of pure metallic gold are as follows: It is the most ductile and ductile metal and an unusual color for elements of this class. It is largely non-reactive, conducts electricity well and is extremely dense. The density of the gold contributed to its relative rarity, since gold, which was present at the origin of the earth, had mostly sunk into the core of the planet. It is therefore believed that virtually all gold discovered by humans was deposited much later by meteorites containing the element. The low reactivity of gold explains why the metal was known in ancient societies despite its rarity: unlike most metals, it mainly occurs in its elemental form.

The rarity of gold combined with the ease with which it can be worked, its optical distinctiveness and its resistance to chemical corrosion made it an extremely unusual material and an object of great fascination. It was therefore a natural choice to use it as a symbol of ornamental status and currency unit. The oldest known gold artefacts come from the 4. Millennium BC And the first gold coins (actually made of electrum, a natural gold-silver alloy) were used in today's Turkey around 600 v. Chr. Stamped. Gold remained in the 20 for much of the world. It was an important component of the monetary system in the 19th century, as most developed countries used a gold standard to support their currencies, even as gold coins became rarer. During the First World War gold standards began to give up, and over time all modern industrialized nations switched to Fiat currency systems.



The biggest gold nugget found

Despite gold's decline from an official monetary function, it is still widely regarded as valuable and used as an investment metal or a means of storing wealth. Many hoard it as a hedge against inflation, and gold continues to be a common metal in fine jewelry. These functions still consume most of the gold produced, despite a large number of other uses for the metal. Gold and mercury amalgams have long been used in restorative dentistry for fillings and crowns. However, concerns about mercury toxicity and the increasing availability of suitable composite materials as substitutes have resulted in a decline in demand. Gold also has many uses in electronics, where its high conductivity makes it attractive for wiring or as a coating for more easily corrosive metals. Circuit boards often have such thin gold protective layers. Thin gold films are useful for a variety of other functions as well. Gold can be made so thin that it appears transparent, so it can be used in windows - for example in aircraft windshields - which can then be de-iced by passing electricity through the conductive film. Gold films are also excellent reflectors for electromagnetic radiation, including infrared light and radio waves, and are therefore used in infrared mirrors, heat shields, and protective coatings on satellites and other equipment.

Despite its low reactivity, it has long been recognized that gold can be dissolved in nitro-hydrochloric acid (aqua regia) and forms some compounds, including gold chlorides, gold oxides and thiosulfates (such as gold sodium thiosulfate), and many gold applications relate to these less familiar forms. Gold chloride solutions made by dissolving gold in aqua regia have been used to make cranberry glass, the bright red color of which is known to be due to glass-dispersed nanoscale gold particles.



Gold as a jewelry and status symbol

Suspensions of such gold particles in liquids, also referred to as colloidal gold, are of great interest because of their unique optical and electrical properties as well as their potential for useful interactions with biological systems. The electromagnetic



absorption of gold colloid solutions can be adjusted based on the particle size. This is a useful feature with the side effect of creating solutions that range in color from red to blue. Such solutions can be used in printable conductive inks for electronics, for the manufacture of sensors and photovoltaics and for the production of microscopy samples.

In modern biology, there is a significant history in which minute gold particles are bound to a variety of biological probes that are commonly used in electron microscopy. The High Electron Density of Gold Particles Facilitates Visualization This type of gold nanoparticle is used in medicine to target specific tissues or cell types, including cancer cells. As a result, they can be used to detect cancer cell sites and site-specific delivery of drugs and other therapeutic agents (including small RNA molecules being studied for use as gene therapy). In addition, gold nanostave structures absorb near-infrared light that easily penetrates through many human tissues. This fact has been exploited in cancer treatment: the heat generated by absorbing light in the near infrared from the rods kills the cells that contain them, leaving the surrounding cells largely intact.

Gold is most commonly found as a standalone metal or as a natural gold-silver alloy. Most of the gold is recovered in this form from either Lode or Placer deposits, and a small amount is produced as a by-product of base metal processing. In addition, gold is often recycled from scrap, and many financial institutions still have significant gold reserves.

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## Holmium, Holmium Powder, High-Purity Holmium (99,9%)



Holmium Powder

Holmium (Ho) is an element of the lanthanides with atomic number 67. Holmium is a soft, bright, silvery-white rare earth metal that is malleable and ductile. Isolated holmium is stable in dry air at room temperature, but readily reacts with water and easily corrodes. In addition, holmium burns on heating the air temperature to form holmium oxide (Ho<sub>2</sub>O<sub>3</sub>). In most compounds, holmium is in its trivalent state. Holmium reacts with all halogens.

Holmium is the element with the greatest magnetic properties. Holmium is used to create artificial magnetic fields. In medical technology, ophthalmology and dentistry devices based on microwave technology are created using holmium. Holmium is used as a yellow and red dye in glass and ceramic production. In the production of zirconia (synthetic diamonds) it is used for the yellowish luster. Holmium is used as a combustible poison to regulate nuclear reactors because it can absorb nuclear fission neutrons. Holmium, one of its isotopes, which is Ho-166m1, is used to calibrate gamma ray spectrophotometers.

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## Indium:

Chemists Ferdinand Reich and Hieronymus Theodor Richter spent 1863 spectroscopically examining different ores in hopes of finding the element thallium. Thallium did not have the characteristic green emission lines but instead a light blue spectral line was observed. Since there are no elements known to produce such a line, they correctly assumed that their sample contained a new element. They called the hypothetical new element indium of his spectral line indigo, and Richter isolated the pure indium metal the following year.



Indium metal

Indium has followed a very slow path from its initial discovery to commercial relevance. For the first seventy years after its discovery, it was above all a curiosity. A sample of the metal was presented at the World's Fair in 1867, but there was no major indium degradation by the late 1920s. These processes were only started because some chemists were interested in using indium as a hardening surface treatment for ferrous metals and had to develop a metal source themselves to experiment with the idea. The first large-scale application of the metal was the lining of bearings in aircraft high-performance engines. However, these and some niche alloys were the only drivers in demand for the metal from 1952 until it was used in semiconductor technology. After that time, production continued to increase as applications for the metal continued to evolve in both alloys and compound semiconductors.

Since 1992, a single semiconductor compound has made the largest contribution to the demand for indium indium tin oxide. When applied to a surface in a thin film, ITO produces an optically transparent conductive coating that makes it possible to act as a transparent electrode in electronic devices. Transparent electrodes are essential for the design of liquid crystal displays (LCDs), plasma displays, and touchscreen devices. ITO is also used to coat aircraft windshields, which can readily dissolve when a current flows through conductive foil, and is also shielded against electromagnetic interference in organic LEDs, solar cells, sodium vapor lamps, antistatic coatings, thin-film tension gauges, and the like.

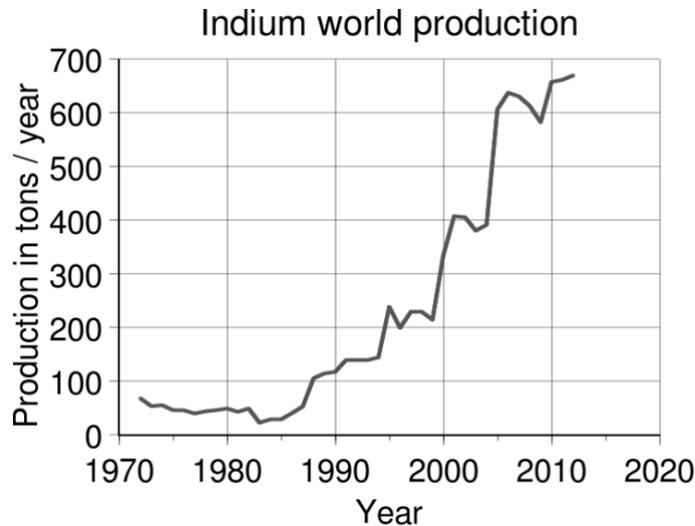
Some other indium-based semiconductors, although not used in high ITO volume, have important applications. Most indium semiconductors, including indium arsenide, Indium phosphide, Indium nitride, Indium antimonide and many alloys with other semiconductor compounds, are characterized by high electron mobility and are therefore found in high frequency electronics such as high frequency transistors. In addition, these materials often have direct band gaps, making them suitable for optoelectronic devices such as LEDs, lasers, thin-film solar cells, radiation detectors, and integrated optical circuits.

Compound semiconductor copper-indium-gallium selenide (CIGS) is one of the few materials currently used commercially for the manufacture of thin-film photovoltaic devices. Additionally, many indium semiconductors are being explored for their potential uses in new nanotechnologically engineered forms such as quantum dots and nanowires.

Except for use in semiconductors, indium is primarily found as a metal, either alone or in alloys, often in applications where a low melting point is used. Indium can be used to make alloys such as galistan that is liquid at room temperature and can replace mercury in applications such as thermometers. Indium alloys are commonly used in gaskets for cryogenic applications because they remain malleable and flexible at low temperatures. Indium-containing solders have gained prominence due to increasingly stringent restrictions on the use of lead, another low melting point metal that was once found in the lowest temperature solders. Additionally, it can be found in indium casting alloys and thermal interface materials.



Two niche uses of indium are also noteworthy. Indium leukocyte imaging uses an indium radioisotope to track white blood cells in the body and identify sources of infection. Indium is also part of the control rods used in nuclear reactors, where it absorbs excess neutrons, in addition to silver and cadmium.



World production of indium

Indium is not particularly rare—about as common as mercury—but it is not an economically important indium ore mineral. The metal must therefore be mined from other metal ores, where it can be found in trace amounts and is most commonly extracted today as a byproduct of zinc mining. Increasingly, indium is extracted from waste generated by the ITO sputtering process and even directly from scrap LCD panels. These recycling efforts vary depending on the efficiency of the process and current metal prices in economic feasibility, so their use varies widely from country to country and from year to year. Concerns about the world's depletion of indium resources have sparked significant interest in the development of alternative transparent electrode materials to replace ITO in electronics.

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## Copper / Copper Powder / Copper Ingot:



copper Nugget



Copper is a soft, ductile, and highly conductive metal that has been used in human society since ancient times. Gold and meteoric iron were the only metals that existed prior to the discovery of copper around 9000 BC. have been proven. This early use was facilitated by the presence of native copper deposits that could be cold worked due to the softness of the metal. However, native copper is not particularly common and eventually the smelting of copper from ore was developed, which in turn led to the inadvertent discovery of alloys.

Adding another metal to copper increases hardness and facilitates casting, which makes the metal much more useful. This was initially done by smelting copper ores containing small amounts of other metals, often arsenic and silicon, to produce a natural bronze. Later it was discovered that bronze could be purposely made by adding tin to molten copper. This advance occurred between 4500 v. Chr. And 600 v. Chr. In various regions of the world. Today, bronze production is considered to be one of the most important technological achievements, so that the period between this discovery and the development of molten iron is often referred to as "Bronze Age" in any society.

The introduction of bronze allowed the protection of harder and more durable metal tools and weapons. Bronze was so important to the civilizations of the time that the story was shaped by the trade in the relatively rare tin ore needed to make it. Although copper was easier to obtain, its sources were also relevant to ancient societies and indeed led to the naming of the element. In the Roman Empire, copper was most commonly mined on the island of Cyprus, and the modern name of the metal derives from the Latin cuprum, which itself derives from Cyprium and means "metal of Cyprus".

Although alloys have many preferred uses over pure copper metal, architecture has used elemental copper since ancient times. The patina that develops the metal over time provides a natural coating that makes it extremely durable and low-maintenance, and its malleability can be molded into the shapes you want. Today, copper is most commonly used in architecture in roofs, lightning, gutters and downspouts

Other metals than tin were later used for alloying with copper, especially nickel and zinc. Brass, an alloy of zinc and copper, is more malleable than any single metal, easier to cast and has excellent acoustic properties. Initially, brass has been used in coins and decorative purposes, while today it is widely used in brass musical instruments, plumbing and electrical applications, and in applications such as locks where low metal-to-metal friction is required. Copper nickel alloys, including ancient Chinese pactong and European nickel silver, were originally used in a variety of applications and are still used in the manufacture of coins, fittings and musical instruments. Copper is also included in some gold alloys and in sterling silver.



Copper Ingot (Dory Bar)

In addition to the widespread use of copper and copper alloys for tools, instruments, money and building materials, ancient societies used copper for its antimicrobial properties. Although the ancient Egyptians did not understand that copper prevented the growth of microscopic organisms, they found that water stored in copper vessels was less likely to heal fouled and copper-treated wounds. Today, copper is still used in this capacity in a variety of environments, particularly in hospitals where copper coatings on frequently contacted surfaces help limit the spread of pathogenic organisms.



Current applications for copper often use one of its properties that has not been of much interest to most of our history: electrical conductivity. Copper can easily be pulled into wires and is the preferred electrical conductor for most wiring applications. About half of the total copper mined is used in this way. Not only is copper highly conductive, it also has high tensile strength and low thermal expansion and resists corrosion and creep. These properties together lead to a reliable circuit arrangement. The high conductivity of copper also increases the energy efficiency of electric motors. Copper is also found in electronic devices such as electromagnets, vacuum tubes, magnetrons and microwaves. Copper is sometimes used in heat sinks and heat exchangers of electronic equipment because it dissipates heat faster than the most common alternative, aluminum.

Copper compounds also have many notable uses. Copper oxides and carbonates are used in pigment and glass making, and copper sulfate can be used as a herbicide, fungicide and pesticide, as well as a chemical reagent in organic synthesis. Several copper compounds are semiconductors, including copper (I) oxide, one of the materials in which many semiconductor applications have been studied for the first time. Copper semiconductors are today usually used in thin-film solar cells. Copper can also be part of high-temperature superconductors, copper is often used as a catalyst in organic synthesis.



Copper Mine - Bingham Canyon Mine

Naturally occurring metallic copper has at times played a significant role in the commercial delivery of the metal, but most of the copper is contained in sulfide, carbonate and oxide minerals. Copper sulfides are the main copper ore, and after separation of iron and other undesirable material, they are roasted to produce the oxide. Copper oxide is then converted to blister copper by heating and further purified by electrorefining. Copper is also recyclable without loss of quality and, after iron and aluminum, the third most recycled metal.

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## Nickel:



Nickel Wire

Nickel occurs in nature mainly as oxides, sulfides and silicates. Nickel is the fifth most abundant element of the earth with the highest concentrations in the nucleus and the lowest concentrations in the earth's crust. Nickel ores are mined in 33 countries on all continents and are processed or refined in 30 countries.

Primary nickel is produced and used in the form of ferro-nickel, nickel oxides, NPI, nickel sulfate and other chemicals as well as more or less pure nickel metal. Nickel is easily recycled in many of its uses and large amounts of secondary or "scrap" nickel are used to supplement newly mined ores.

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