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Silver:
From Decorative Jewelry to Infection Fighter to Andy Warhol to the Manhattan Project

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Editor's Note: Once again, well-regarded AESF/NASF contributor Jack Dini has provided us with another of his highly regarded and fascinating writings.

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The uses of silver plating are many. The decoration and protection of flatware, jewelry and art objects were the main uses for silver plating until 1970. Industrial and engineering uses have subsequently been increasing. Silver's electrical, mechanical and electrical properties, which include high electrical and thermal conductivity, high load carrying capacity, chemical resistance and nontoxic characteristics, are useful attributes for many applications. Expanding uses for silver plating for engineering applications, especially in the electrical and electronic industries, have resulted in increased attention to process and product innovations intended to improve physical properties, performance and reliability of plated components, and to meet specific functional requirements.[1]

Silver is the 66th most abundant element. Silver, like gold, is malleable and ductile. It can be beaten so thin as to be almost transparent, and one gram of the metal can be drawn into a wire nearly two kilometers long. It is stable to water and oxygen but is slowly attacked by sulfur compounds in the air to form a black sulfide layer, which is why silver objects need regular cleaning.

Uses

The major outlets for silver are photography, the electrical and electronic industries and for domestic use as cutlery, jewelry and mirrors. Tableware and trophies are made of the alloy sterling silver.

Pure silver has the highest electrical and thermal conductivity of all metals. It is the best conductor of heat and electricity of all the metals and hence is widely used for electrical and electronic devices.

Other uses of silver are: in dentistry as silver-tin-mercury or silver-tin-copper-mercury amalgams; as the oxide in high-capacity zinc long-life batteries and occasionally as the iodide for seeding clouds to promote rainfall.

Sterling Silver, Coins and Chloride, Arizona

Pure silver is too soft to be used as jewelry, so it is mixed with 7.5% copper to create sterling silver.

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Until 1965, dimes, quarters and half-dollars were made from 90% silver and 10% copper. If you hoarded every silver coin you could get your hands on in 1964, you would be rather wealthy. The value of the metal in one quarter is now $3.00.[2]

In Arizona on old Route 66, there's a town named Chloride. There isn't much there now, a ghost town that the ghosts abandoned. The question is - why would anyone bother to name a town in 1860 in the middle of nowhere just to mine salt? Because it's not sodium chloride that gave the town its name, it was named after silver chloride and there just happened to be a lot of it in the ground back then.[3]

Silver in the Environment, Body and Foodstuffs

Silver in the Environment

Earth's crust	70 ppb
Soils	~ 0.5 ppm
Sea Water	~ 0.1 ppt, at the surface, about 2 ppt in the depths
Atmosphere	Traces

Silver levels in soil are not usually high except in mineral rich areas, when they can sometimes be as much as 44 ppm. Plants can absorb silver and measured levels come in the range 0.03 to 0.5 ppm.[4]

Silver in the human body

Blood	3 ppb
Bone	varies between 10 and 40 ppb
Tissue	varies between 10 and 250 ppb
Total amount in body	approximately 2 milligrams

Silver has no biological role and indeed is especially toxic to lower organisms. Soluble silver salts irritate the skin and mucous membranes, and can cause death if ingested, although excess hydrochloric acid in the stomach protects the body by precipitating insoluble silver chloride.[4]

Silver in foodstuffs

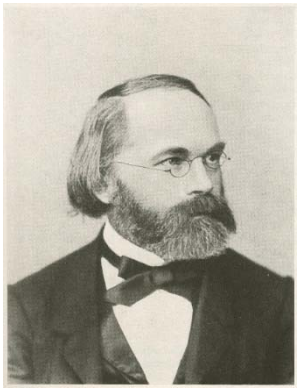
Foodstuffs contain measurable amounts of silver. For example, flour contains about 0.3 ppm and bran about three times this level. Milk has between 25 and 50 ppb; beef, pork and mutton around 40 ppb and fish can have as much as 10 ppm. Consequently, humans get an average daily intake of silver of between 20 and 80 micrograms, depending on the food they eat, but such tiny amounts pose no threat to health.[4]

Silver fights infections

Throughout much of our history, humankind hasn't paid a lot of attention to cleanliness. In earlier days improperly washed cutlery fostered the growth of disease-causing bacteria such as E. coli and salmonella. Silver spoons would have been less prone to this problem because of the metal's antibacterial effect. The rich could afford such cutlery and enjoyed the health

benefits it bestowed. All of this contributed to the saying that the children of the wealthy were born with silver spoons in their mouths. Some Russian peasants still place silver coins in cisterns and jugs to keep their water fresh.[5]

Silver's connection to health is thanks to the oligodynamic effect, discovered in 1893 by the Swiss botanist Karl Wilhelm von Nageli. This refers to the toxic effect of metal ions on living organisms such as bacteria, algae and fungi. A number of other metals also produce an antimicrobial effect, but the potential benefits have to be weighed against the metals' toxicity. Silver and copper are two that have low toxicity by comparison and can be effectively used to battle bacteria.[6]



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There are several anecdotes that indicate that silver has long been known to protect drinking water and may explain why silver coins were to be found at the bottom of many wells as far back as 425 BC. It requires only a little silver to sterilize water; 10 ppb, will suffice. Silver is still used to sterilize water and even footwear. Swimming pools can be made safe by adding silver salts to the water rather than by chlorination. Socks for athletes are available that haves silver fibers woven into them to prevent bacteria producing the sulfur molecules that cause smells.[4]

You do not have to be as rich as a maharaja to experience the oligodynamic effect of silver. The metal can be incorporated into urinary catheters and endotracheal breathing tubes to reduce infections, and fabrics can be formulated with small amounts of silver to control the bacteria responsible for churning out odorous compounds when they feast on sweat.

Silver ions inactivate enzymes that are essential to bacterial life. That's why bacteria are killed when contaminated water is stored in a silver container. The purity of the silver, the size of the container, and whether the water is shaken are each important determinants of the concentration of silver ions.[5]

Techniques have been worked out to produce just the right concentration of ions by immersing a pair of silver electrodes connected to a direct current into water that needs to be purified. This was the method used to produce drinking water aboard the Apollo space flights and is used in hospital plumbing systems to deactivate Legionella bacteria. Copper is often alloyed with silver in the electrodes to take advantage of its oligodynamic effect as well.[6]

Until fairly recently, how silver works has been a mystery. Now a team at Boston University in Massachusetts has described how silver can disrupt bacteria and shown that the ancient treatment could help deal with the thoroughly modern scourge of antibiotic resistance.[7]

The researchers found that silver, in the form of dissolved ions, attacks bacterial cells in two main ways: it makes the cell membrane more permeable, and it interferes with the cell's metabolism, leading to the overproduction of reactive, and often toxic, oxygen compounds. Both mechanisms could potentially be harnessed to make today's antibiotics more effective against resistant bacteria.[8]

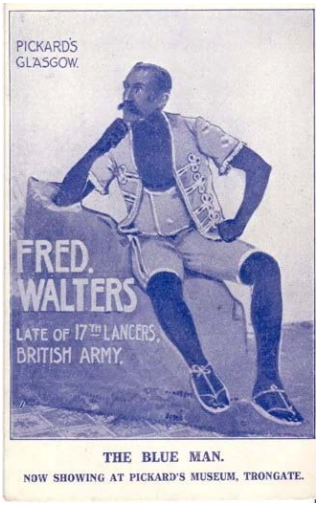
Colloidal silver

Have a medical problem? Colloidal silver is claimed to cure many afflictions. Manufacturers of colloidal silver supplements often promote their products by claiming that silver can boost the immune system, fight infection, treat cancer MRSA infections, destroy candida, fight flu, and purify water.[9]

However, supplements containing colloidal silver aren't considered safe or effective for any of the health claims manufacturers make. Silver has no known purpose in the body. It's not an essential mineral.[10]

No sound scientific studies evaluating these health claims have been published in reputable medical journals. In the US, the Food and Drug Administration and the Federal trade Commission have taken action against several companies for making unproven health claims.

When taken by the mouth, silver builds up in your body. Over months to years, this can result in a blue-gray discoloration of your skin, eyes, internal organs, nails and gums. Doctors call this argyria. It's usually permanent. In rare cases, high doses of colloidal silver can cause serious side effects, such as seizures, and organ damage.[11]



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The hallmark of excess silver is a gray-blue skin, a condition that is irreversible. One of the most famous cases was that of the Blue Man, who was a featured attraction in the Barnum and Bailey Circus in the early years of the twentieth century. He had apparently tried to cure his syphilis by ingesting silver nitrate but succeeded only in making himself blue.[6]

More recently, Stan Jones, an American Libertarian who twice ran unsuccessfully for the Senate and three times for Governor of Montana, did succeed in becoming blue. On the cusp of the year 2000, he was worried that computers would stop functioning and that this would somehow make antibiotics unavailable. He decided to take preventive action and started to take a colloidal silver preparation that he made himself by passing an electric current through a solution equipped with silver electrodes. Unfortunately, he didn't know what he was doing, he used too high a voltage, and his solution contained a great deal of silver. He turned blue. Regardless, he maintains that he is still healthy and still dopes himself with colloidal silver.

Nanosilver

Silver and silver nanoparticles exhibit antimicrobial properties against some bacteria, fungi and viruses. However, the ever increasing application of nanosilver in consumer products, water disinfection and healthcare settings, has raised concerns over the public health/environmental safety of this nanomaterial.

There are nearly 500 consumer products that claim to contain nanosilver. Ehsan Rezvani and colleagues review the toxicity of nanosized silver, drawing attention to the every-growing evidence of nanosilver toxicity to human and nature.[12]


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Andy Warhol's fascination with silver

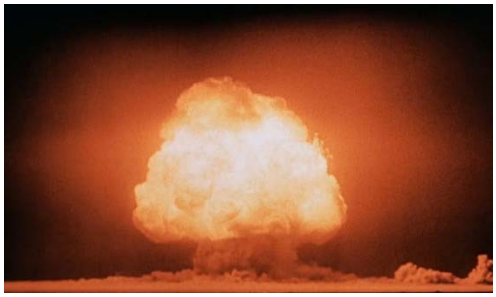
Andy Warhol effectively launched an artistic and cultural revolution in 1963 with the founding of his Factory on East 47th street in Midtown Manhattan. In keeping with the space race of the sixties, he developed a unique silver spaceship to launch his Pop Art - The Factory.

It was dubbed the 'Silver Factory' because Warhol wrapped the entire loft in silver foil, completely covering the walls and ceilings. Surrounded by silver, artists and Warhol superstars were in a place of worship, a house of art and a bed of creativity, a silver spaceship exploring new artistic galaxies.

"Silver was the future," Warhol proclaimed, and The Factory was the launching pad for future art. So, along with the space race to the moon, Warhol's The Factory was covered in silver because it was spacey - the astronauts wore silver suits - Shepherd, Grissom and Glenn had already been up in them, and their equipment was silver too."[13]

Further fascination with silver is Warhol's Silver Car Crash (Double Disaster), a 1963 serigraph that depicts a body twisted in the mangled interior of a silver car. In November 2013, it sold for $105 million at an auction in New York, setting a new highest price for a work by Warhol.

Manhattan Project



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The Manhattan Project was a research and development undertaking during World War II that produced the first nuclear weapons. It was led by the United States with the support of the United Kingdom and Canada.

Silver played a major role in this project. Massive amounts of copper would be needed for the Y-12 electromagnetic plant of the project but copper, used in shell casings, was a high priority commodity during the war. So a decision was made to use silver. Not having to divert mass amounts of copper was a huge boon for the project's secrecy.[14]

The magnets needed so much copper for windings that the Army had to borrow almost 15,000 tons of silver bullion from the United States Treasury to fabricate into strips and wind on to coils as a substitute for copper. Treasury silver was also used to manufacture the busbars that ran around the top of the racetracks at the Y-12 Plant.

One last item about silver and the Manhattan Project: The delivery program within the Air Force for the dropping of the bomb was codenamed Silverplate.[15]

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About the author

Jack Dini earned a Bachelor of Metallurgical Engineering degree from Cleveland State University and began his career in the 1950s with Cleveland Supply Co. (now Pavco). He spent a few years at Republic Steel's research center and Battelle Columbus Laboratories. In 1962, he joined Sandia Laboratories, Livermore, CA, where he was involved with electrodeposition projects for 18 years before moving to Lawrence Livermore (LLNL) in 1980. He was section leader, fabrication processes. Responsibilities included direction of activities in five groups: electroplating and metal finishing, vacuum processes, metal fabrication, plastics and optics.

Mr. Dini is a prolific scientist. He is the author or coauthor of some 180 technical papers and, while many researchers are content to specialize in one or two fields, he made significant contributions to more than half a dozen disciplines in surface finishing. He is the author of two books, *Electrodeposition- The Materials Science of Coatings and Substrates*, and *Challenging Environmental Mythology: Wrestling Zeus*. The scientific community is fortunate that he carefully documented his work, sharing it with others around the world. It includes plating uncommon metals, alloy plating, printed circuits, chemical milling, electrojoining and gathering electrochemical/property data.