



## Silver

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Silver (Ag, CAS no. 7440-22-4) is a rare element that occurs naturally in its pure form as a white, ductile metal and in ores.

### Usage and Exposure

Silver has been used for thousands of years to make valuable artifacts and jewelry and as a biocide in medicine and hygiene.

The use of silver increased significantly in the 20th century with the expansion of the photographic industry, but decreased considerably with the introduction of digital photography.

Silver is now used in a wide range of applications such as sanitation of drinking water, cooling towers, recreational waters, textiles, plastics, and sunscreens and other cosmetics antimicrobial surfaces and medical applications [SCENIHR].

Silver has many industrial uses:

- In recent years silver oxide batteries have begun to replace lithium batteries.
- Silver bearings are an essential component in many types of engines.
- Almost all electronics are configured with silver.
- Because of its unique chemical properties, silver is an important catalyst in the production of two major industrial chemicals: ethylene oxide and formaldehyde.
- Silver brazing alloys are used widely in many areas from air-conditioning and refrigeration to electric power distribution.
- Because of health concerns, the traditional tin/lead solder used to build electronic equipment is quickly being replaced by a combination of silver, tin, and copper solder. [The Silver Institute].

Nanoscale silver particles have been used in pigments, photographics, wound treatment, conductive/antistatic composites, catalysts, and as a biocide. Its biocidal applications are being studied extensively [The Silver Institute].

Workers can be exposed to silver in all stages of its use in industry - from ore extraction, melting/refining, product fabrication, use, disposal, and recycling. Published information on workers' exposure to silver is limited, but it indicates that when good risk management practices, such as engineering controls, are not followed, workplace airborne concentrations can exceed the occupational exposure limits [NIOSH].

The general population is exposed to silver primarily through the ingestion of drinking water and food and during application of silver containing medical devices.

### **Routes of Exposure**

The main route of occupational exposure to silver and its compounds is inhalation. Skin contact may also occur. Ingestion is the main route of exposure to silver among the general population.

### **Metabolism**

Ingested silver compounds are estimated to be absorbed by the body at a level of no more than 10%, with only 2–4% being retained in tissues. Normal concentrations of silver in human tissues are low. Even though silver does accumulate in some organs and tissues, very little data are available that indicate possible toxic effects.

Soluble silver compounds are more readily absorbed than metallic or insoluble silver and thus have the potential to produce adverse effects on the human body. The majority of occupational exposure reports involve soluble silver compounds, which seem to cause toxic effects at lower concentrations than metallic silver and insoluble silver compounds [Drake].

### **Health Hazards**

The most common health effects associated with prolonged exposure to silver are the development of a characteristic irreversible pigmentation of the skin known as argyria or of the eyes, known as argyrosis. Argyria and argyrosis are classified as either localized or generalized.

Localized argyria is caused by direct external contact with silver. Very small silver particles may enter the body through the exocrine sweat glands or through punctures. These deposits, which remain in the skin indefinitely, are light brown to dark blue and look like small round or oval patches. The most commonly affected areas are the hands, eyes, and mucous membranes. If fine particles of silver are rubbed into the eyes in occupational settings, localized argyrosis may develop over time [Drake].

Generalized argyria is recognized by a widespread pigmentation of the skin, eyes, and nails. Generalized argyria and argyrosis may result when silver compounds are applied to mucosal surfaces, inhaled, ingested, or injected into the body. After silver enters the body it is absorbed, carried by the bloodstream and deposited in various tissues throughout the body. Areas of the body most likely to become pigmented include eyes, internal organs, and sun-exposed areas such as the face, ears, forearms, hands, and nails. Generalized argyria was most often reported following the ingestion or application of silver-containing medicines, but it has also been reported after occupational exposure among silver nitrate makers [Drake]. Argyria of the respiratory tract has been described in two workers involved in the manufacture of silver nitrate. Their only symptom was mild chronic bronchitis [Zenz].

Pifer et al. performed a study of 27 silver reclamation workers exposed to insoluble silver compounds. The study used extensive health examinations including examination of skin biopsies, ophthalmologic studies, pulmonary function tests, chest radiography, and renal function. No cases of generalized argyria were found, and there was no evidence of any negative health effects apart from slight stunning of the bulbar conjunctiva, or argyrosis of the eye [Pifer].

Several silver salts are irritating to the mucous membranes and to the skin depending on concentration, the duration of contact of the liquid or solid, and the temperature. Silver nitrate can cause conjunctivitis, and even blindness [Zenz]. Acute symptoms of overexposure to silver nitrate are decreased blood pressure, diarrhea, stomach irritation and decreased respiration [Drake]. Skin and ocular burns caused by contact with silver nitrate, have been reported in workers [ATSDR].

Silver oxide ( $Ag_2O$ ) is also a strong oxidizer that is used in special battery making, for polishing and coloring glass, as a catalyst, for purifying drinking water, and as an ointment or in a solution for germicidal use. Contact and inhalation must be prevented [Zenz].

Abdominal pain has also been reported by workers exposed to silver nitrate and oxide in the workplace [ATSDR].

Occupational exposure to silver dusts can also lead to respiratory irritation. Rosenman et al. describes a group of 30 employees of a manufacturing facility involved in the production of silver nitrate and silver oxide. Twenty-five of the 30 workers complained of upper respiratory irritation (sneezing, stuffiness, and running nose or sore throat) at some time during their employment, with 20 out of 30 complaining of coughing, wheezing, or chest tightness. Chest radiograms and results of clinical examination of respiratory function were predominantly normal, with no demonstrated correlation between abnormalities and duration of employment [ATSDR].

## Carcinogenicity

There is no evidence of carcinogenicity of silver and its compounds.

U.S. Environmental Protection Agency (EPA) classified silver as class *D* - *not classified as to human carcinogenicity*".

## References:

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