INTRODUCTION

Silver tarnishes readily in our atmosphere and needs to be cleaned and protected to maintain its bright polish and warm white color. Commercial silver polishes and cloths work quickly, but gradually wear away the silver over years of care. Historical Sheffield plate objects are often good examples of the this: the copper substrate is revealed at thin points (see below).

BACKGROUND

Silver sulfide, the mineral we know as silver tarnish, is a black rock. When it forms on a silver object, it begins in a very thin yellow or iridescent layer on the surface. Over time and as the layer thickens, the color shifts to orange, blue, brown, and finally black.

There are several methods for removing silver tarnish; this technical leaflet focuses on abrasive polishing with calcium carbonate. (For a description of other methods, see the MORE INFO section below.)

ABRASIVE POLISHING

Abrasive polishing uses a hard material, usually in the form of a powder or paste, to cut through the silver sulfide. The ideal polishing compound from a conservation perspective, is harder than the tarnish but softer than the silver. Anything harder than silver will scratch and cause wear to the surface.

Advantages

- Control over the level of polishing
- Non-toxic
- Can be used locally on mixed media items
- Easy to learn and teach

Disadvantages

- Slow

In spite of its slowness, abrasive polishing is by far the most widely utilized and preferred polishing technique in the conservation field.

Calcium carbonate, also known as chalk, whiting, calcite, and $CaCO_3$, is the optimal abrasive compound for silver polishing since it is hard enough to cut through the silver sulfide but soft enough that scratching to the original silver metal surface is minimized.

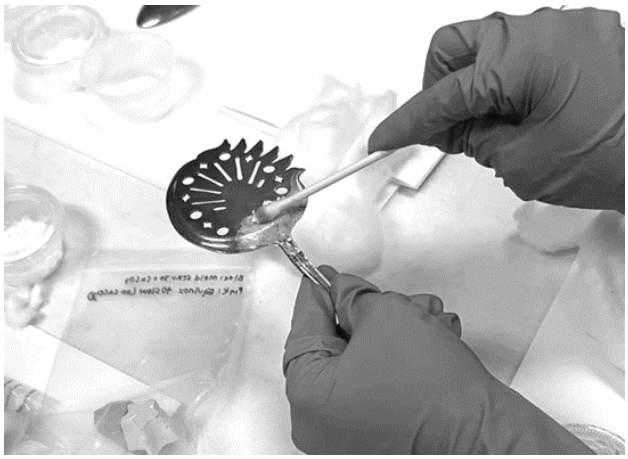
Note that pure silver is very soft and silver art objects and historic items can have varying amount of silver in them. Sterling silver is unlikely to be scratched by calcium carbonate, but other items may be. Test a small and unobtrusive area first to check for scratching.

MATERIALS NEEDED

- Calcium carbonate powder
- 1:1 Solution of distilled water and ethanol
- Cotton swabs and/or cotton cloth
- Acetone (optional—for drying)
- Undyed cotton velvet
- Toothbrush or other small, stiff brush
- Nitrile gloves

STEP BY STEP

1. Clean the silver with ethanol on cotton swabs or cloth. This removes surface dirt and grease, as well as loose silver sulfide, and accelerates polishing.
2. Dip cotton swabs into the water and ethanol solution until they are just moist, then dip into the calcium carbonate so that a small amount sticks to the damp swab. Apply to the silver in firm, gentle circles.



3. Allow the calcium carbonate to dry on the surface, and then brush it off with a stiff brush. Clear the remaining powder with the water and ethanol solution on cotton swabs. Make sure all polishing residue has been removed, especially from the crevices.
4. (Optional) Apply acetone on cotton swabs or cloth. This drives off water that may be remaining in the crevices.
5. Buff gently with cotton velvet.

Use gloves when handling metal objects. Especially once you have cleaned them!

POLISHING TIPS

- A toothbrush or similar stiff brush can work very well in the place of cotton swabs for delicate sections or intricate jewelry.

- Leave a small amount of tarnish in crevices to highlight incised decorations.

- Hold a white sheet of paper over the silver to cast a reflection after clearing the calcium carbonate. This will reveal areas of tarnish you may have missed.

STORAGE

Protecting silver from sulfur when it isn't being displayed or used will prevent tarnishing. *Pacific Silvercoth* is a product made especially for this purpose, and can also be used to line jewelry boxes or create storage bags.

Wrapping items in acid-free tissue or undyed cloth and placing them in a zip-lock bag can be an low-cost alternative to using *Pacific Silvercloth*.

WHERE TO BUY

Talas is a conservation supplier in New York that carries calcium carbonate.

University Products and **Gaylord Archival** are both large suppliers of a range of collections care materials, including *Pacific Silvercloth*.

Ethanol (sometimes called ethyl alcohol) and acetone are both sold in most hardware stores.

GEEK CORNER (ADDITIONAL INFO)

Mohs Hardness

Mohs Hardness is a scale used for measuring and comparing relative harness according to known common minerals. The scale is not linear, as can be seen by comparing the Mohs level to absolute hardness in the table opposite.

Other Polishing Compounds

Aluminum oxide, also known as alumina, corundum, and Al_2O_3, is a white powder similar to calcium carbonate. More abrasive, aluminum oxide can clean faster but carries a greatly increased risk of scratching. There are two mineral forms: alpha alumina (Mohs hardness of 9) is a hexagonal crysta, gamma alumina (Mohs hardness of 8) is a cubic crystal. In addition to alpha and gamma, alumna is available in different particle sizes. 0.05 µm and 0.3 µm have been used for silver polishing on harder silver alloys and/or very thick tarnish.

Mohs Hardness	Mineral	Absolute Hardness
1	Talc ($Mg_3Si_4O_{10}(OH)_2$)	1
2	Gypsum (CaSO4·2H2O)	2
3	Calcite ($CaCO_3$)	9
4	Fluorite (CaF_2)	21
5	Apatite ($Ca_5(PO_4)_3$(OH-, Cl-, F))	48
6	Orthoclase Feldspar ($KAlSi_3O_8$)	72
7	Quartz (SiO_2)	100
8	Topaz ($Al_2SiO_4(OH-,F-)_2$)	200
9	Corundum (Al_2O_3)	400
10	Diamond (C)	1500

Commercial polishes, including polishing cloths, contain alumina and are not recommended for most silver polishing situations.

Useful Mohs harnesses in the world of silver polishing:

Silver sulfide	2.5
Silver (Sterling)	3
Calcium carbonate (Calcite)	3
Gamma alumina	8
Alpha alumina (Corundum)	9

OTHER POLISHING METHODS

Thiourea Method

Also known as *silver dip,* thiourea is used to chemically clean silver when the surface is too fragile for abrasive polishing. In this method, the item is immersed in thiourea liquid, which chemically bonds to the silver component of silver sulfide, taking the mineral apart and allowing it to be rinsed away with water. The sulfur is released as a gas.

Advantages to Thiourea

- Fast
- Suitable for delicate surfaces

Disadvantages to Thiourea

- Carcinogenic
- Highly acidic and will etch the surface after two minutes of contact
- No control over the level of cleaning
- If not thoroughly rinsed will cause tarnish reversion that is very difficult to remove

Electrochemical Method

In this cleaning technique, hydrogen is produced at the interface between the corrosion and the metal surface, which causes the corrosion to pop off.

Advantages to Electrochemical Cleaning

- No risk of abrasion
- Faster than polishing

Disadvantages to Electrochemical Cleaning

- Requires an electric current
- Difficult to use locally
- Requires immersion of the item in a saltwater solution
- No control of the level of cleaning
- Not suitable for composite objects

ADDITIONAL BACKGROUND

Metals exist on earth in two forms: metallic and mineral.

The **metallic** form is dense, smooth, reflective, and it conducts both heat and electricity. Electrons are shared by all atoms and move freely across the surface.

Metallic solids consist of a single element or a physical mixture of metal elements, such as an alloy of copper and tin (aka bronze). Pure metals, those in which only a single element is present, are

quite soft.

Art objects are usually formed from alloys of two or more metals, because mixtures are stronger. Sterling silver is guaranteed to be 92.5% silver, with the rmaining 7.5% made up of copper, or copper mixed with tin, zinc, or other metals.

The **mineral** form of a metal takes the shape of a rock or crystal, but is often found commercially as a powder. Minerals are non-conductive. Electrons in the mineral form are used for bonding between dissimilar elements and cannot move across the surface freely.

Mineral solids consist of chemically bonded atoms of different elements. The simplest mineral will have two elements, but they can consist of many different ones. In two-element minerals, one element is a metal and one a non-metal.

Minerals—which can be brightly colored—are used in artwork most commonly as pigments. They also form on the surface of metallic objects, either intentionally as patina, or unintentionally as corrosion.

The mineral shown above is *acanthite*, aka silver sulfide. It forms from a reaction between metallic silver and sulfur impurities in the air following this chemical reaction:

$$2Ag + S = Ag_2S$$

This formula describe two atoms of silver (Ag, from the Latin “argentum”) combining with one atom of sulfer (S) to form one molecule of silver sulfide made of three total atoms.

All elements seek to find the most stable state for the environment they are in. Metals in the presence of oxygen and water (relative humidity) will eventually stabilize in the **mineral** form, and people must work hard to prevent this if they want the metal to stay **metallic**.

The Midwest Art Conservation Center is a non-profit organization for the preservation and conservation of art and artifacts, providing treatment, education, and training for museums, historical societies, libraries, other cultural institutions, artists, and the public.

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