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"THE USE OF CATHODIC ELECTROPHORETIC LACQUER COATINGS FOR JEWELRY AND JEWELRY FINISHES"

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ABSTRACT

The use of Cathodic Electrophoretic Lacquer Coatings for Jewelry and Jewelry Finishes

Addressed will be the use of a durable, translucent electrophoretic lacquer coating that can be used on a variety of metals, both electroplated and polished jewelry items.

This process will provide a clear, resilient lacquer coating with uniform coverage.

The unbaked coating can also be dyed to produce a variety of lustrous colored finished, suitable for custom jewelry.

A comparison with other protective coatings presently in use within the jewelry industry will be made with health and environmental consideration.

KEY WORDS

Electro Phoretic Coatings, tarnishing, oxidation, discoloration, anti-tarnish, sulfur, chlorides, solvent based lacquers, water based lacquers, cathodic electrophoretic lacquer, electrolytically, activation, treatment, immersion, racking, curing, perspiration, conductivity, liver of sulfur, silver, silver plate, fine silver, sterling silver, gold, karat gold, gold filled, gold flash, filtration, ultrafiltration, De-ionized, electroclean, drag-out, post dip, rack coating, OHMAX, MSDS, SARA Title III.

INTRODUCTION

Tarnishing or oxidation of Jewelry has been an ongoing problem for Jewelry manufacturers, wholesalers and retailers alike. Discoloration of Sterling Silver, Gold Filled and sometimes even Karat Gold items are the reason for returns by the store.

The problem becomes especially annoying, when the discolored item is still in its original packaging and had never been used or worn.

The challenge of identifying the origin or reason for this dilemma has been an ongoing task for the Jewelry Industry, as long as it has been in existence. The problem of "tarnishing" is not limited to the custom jewelry manufacturer alone but also to the precious metal jewelry manufacturer as well.

Even though, the phenomena of "tarnished" jewelry has been looked at, examined and re-examined or researched, it still provides many manufacturers with costly rejects and rework and remains often a puzzle, especially when the problem surfaces only intermittently.

Jewelry manufacturers, over the years, have applied "Anti Tarnishes" or lacquer coatings to protect the finishes of the jewelry, with mixed results.

Selecting and adding one protective coating versus another depends on several issues such as: cost, equipment needs, environmental impact, safety related concerns, labor intensity, durability of the coating, final appearance of the finished product or the possibility of impairment of the functionality of the jewelry item such as the flexibility of jewelry chain.

The manufacturer must make a choice by selecting a coating that provides him or her with the most practical and cost effective coating that serves the purpose of protecting the finish while considering any possible trade-off associated with such a process.

WHAT IS TARNISHING ?

Tarnishing is caused by oxidation of certain metallic properties by exposure to unfavorable conditions or environment.

Silver for example will readily tarnish when exposed to sulfur or chlorides, even when present in small quantities.

Sterling silver with its addition of copper as alloy is quite sensitive to such exposure.

14 Kt and 10 Kt Gold, due to their alloys of silver, copper or nickel are also prone to "tarnishing" in strong adverse environmental conditions.

WHAT CAUSES JEWELRY TO TARNISH ?

There are many reasons why a finished piece of jewelry tarnishes. Let us look at some of the most common problems and their origin.

The XYZ Jewelry Company manufactures Sterling Silver Jewelry. The products consist of: Earrings, Brooches, Pins, Neckchains, Bracelets, Pendants, Belts and Buckles; all items are highly polished, cleaned, and air dried. No electroplating - no antitarnish applications.

The finished items are inspected, wrapped in "sulfur-free tissue" and placed into their specially designed "sulfur-free" packaging.

After arrival at the stores, some of the products are unpacked and put into display cases. Several days later a discoloration is noticed on the displayed items. After opening several packages and

examination of the items, additional pieces show an indication, that something is wrong!

Possible problems

1. **XYZ's rinsewater in the cleaning line used after polishing, had a very high chloride content. By air drying, some of the chloride residue remained on the items causing the problem.**

2. **Wrapping of the highly polished items should be done while workers wear jewelers cotton gloves which are periodically changed. Workers should not eat (touch food or fruit) or drink while performing this task.**

3. **The possibility exists, that one of the employees doing the wrapping may have been or is on medication, which can produce a problem when the items are touched without gloves or gloves saturated with secretions from the skin.**

4. **Purchasing has changed the supplier of the "sulfur-free tissue" or other packaging material.**

5. **Finished pieces were allowed to stay within the manufacturing area for an extended period (overnight) without being properly covered.**

6. **Silver metal used, was of poor quality - not 925 - or had metallic contamination or other impurities.**

7. **Oil used during the manufacturing process (stamping, chain-making etc.) used a sulfur containing oil or lubricant which was dragged into the cleaning cycle or allowed to remain on the piece during soldering or annealing operations.**

8. A new employee did not follow the manufacturing or process cycle. (Skipped rinses in the cleaning cycle for example).

9. Change or substitution in solder paste or compound.

10. Severe adverse environmental problems within the retail store can be the cause of the discoloration. (The problem here, would be isolated to a particular store only).

Discoloration of Karat Gold (10 Kt and 14 Kt)

The ABC Gold Jewelry Company manufactures a wide variety of Jewelry in 10 Kt and 14 Kt Gold.
Charms, Bangle Bracelets, Chains, Rings, Pendants, Earrings and Lockets.

Recently the company experiences an unusual amount of returns from customers and retailers of some of their 10 Kt and 14 Kt tailored chains and bracelets. Also polished items show some of the problem.

The items contain purple spots which are irregular in size and shape, but are located all over the piece.

The items, which are all soldered, are flashed with a decorative gold to provide uniformity in color between the findings and the rest of the item.

One Customer complained, that her "white garment has turned black where the 14 Kt Herring bone neckchain comes to rest".

Here we have two different issues which can be the cause of the problem:

A. The purple spots noticed on the jewelry are most likely caused during the plating cycle when the gold flash is applied.

The rinse tanks are fabricated from Stainless Steel, the water pipes leading into the rinse tanks should be made from PVC and not from copper.

If the work is allowed to hang in such a rinse tank for a prolonged period (during lunch time or break) the tank will plate a small amount of copper by galvanic action from the copper pipe or tubing directly onto the work. This holds especially true if this rinse tank follows an acid pickle.

The fact, that the rinse tank is made from a metal (stainless steel), the water pipe is made from copper, the pH of the water is acidic (drag-out from the acid pickle) the gold chain, allowed to hang in the rinse water, received small amounts of copper by galvanic action. This copper will adhere to the surface of the jewelry and eventually will turn a slight brown and then a purple color after having been exposed to the atmosphere. This discoloration process will be accelerated, if the work had not been properly dried. It also has been noted, that some plastic and fiberglass rinse tanks can produce the same condition, as long as the pH of the rinse water is low enough to sustain a galvanic action between the copper tubing and the jewelry.

B. The second problem, where the customer's white garment **turned black, can usually be traced to two factors:**

1. **The nature of the manufacturing process of a Herringbone Chain - may expose some of the low karat solder contained within, or on the surface of the gold wire used to manufacture the basic chain. A gold-flash (2 to 3 millionths (microinches) will give very little protection, if any, towards an adverse environment or severe condition; This can cause a reaction between the low melting metals used in the solder triggered by the perspiration from the wearer.**

2. **Chances are, that the customer's white garment, had been recently dry-cleaned and that a residue from a dirty solvent used in the dry-cleaning process remained within or on the surface of the fabric of the garment which in turn reacted adversely with the alloys of the gold chain.**

There are other reasons why a piece of gold jewelry may turn color:

1. **High alloy content (the item may be underkarated).**
2. **Low karat solder used in the manufacturing process.**
3. **Surface contamination in the finishing process.**
4. **Unsuitable packaging material used.**
5. **Unfavorable body chemistry of the wearer.**
6. **Medication taken by the wearer.**
7. **Exposure to reactive household chemicals.**
8. **Improper storage container (high sulfur content).**
9. **Heat and perspiration (tropical climates).**
10. **Surface dirt (which can be cleaned or removed readily).**

TARNISH PREVENTION

Tarnish prevention starts with the manufacturing process!

There are various basic questions we must ask and conditions we

should implement to prevent unnecessary problems. Problems that can be and must be controlled by the manufacturer.

Addressing foremost basic quality issues up front, in most cases will prevent costly rejects, time consuming repairs or rework and dis-satisfied customers caused by discoloration of the final finish.

After the fact remedies are counter-productive and add greatly to the manufacturing cost, which in turn reduces the competitive edge in a very competitive market.

Starting with the control of incoming raw material, may that be of the metal we make the product out of or the chemicals we use to produce the final finish, the question here is: "Do we get what we have specified in the order to the supplier?

And is the material of the quality we have paid for?

With other words, if 14 Kt gold was ordered, did we receive 14 Kt or 13 Kt material? If the solder we purchased is below the specified quality, we most likely will experience manufacturing problems.

Did the purchasing department notify us of any substitutions in the materials purchased?

Did we change supplier, because of cost savings?

Having obtained recycled packaging material, can we anticipate serious problems later on?

Very similar quality requirements exist during the in-process or manufacturing cycle where we must assure, that the manufacturing methods are followed and only approved manufacturing changes are made with the full acknowledgment of all involved with the manufacturing process.
Does production personnel report manufacturing problems in a timely fashion to their supervisor? Does the supervisor immediately

address the problem with all concerned?
Have maintenance related problems been reported as soon a possible, so that proper repairs can be initiated promptly?

These are some of the basic issues we must address first, before we do encounter serious problems later on.

All too often we are too busy to make corrections up front - or take the time to practice preventive maintenance; but strangely enough, we always seem to find the time to do things over, make emergency repairs or in a worse case scenario - reject and scrap the items entirely and make them over again.

We should therefore seek out the best solution available to prevent our products from tarnishing while still in the sample making stage.

Did you say "this is not possible"?

A well known, large manufacturer of silver plated tableware, uses no antitarnishes whatsoever, yet he has a minimal rate of rejects or customer returns.

What is his secret?

The answer is:

"No secret at all, just common sense and diligent research up front"

This manufacturer has no sulfur and no chlorides in their plating system or rinse waters.
He also uses strictly sulfur and chloride free packaging materials.
Employs good housekeeping practices and last but not least has implemented an excellent quality control program.

PROTECTIVE COATINGS FOR JEWELRY

Solvent based lacquers.

For many years the Jewelry Industry used clear or tinted solvent based lacquers.

While protecting the finish with a clear or slightly tinted coating this process was a proven but labor intensive protective coating which could be easily scratched or damaged.

Silver or silver plated items were placed onto wooden screens or hooked or strung with wire onto racks and then sprayed, using a spray gun hooked up to an aircompressor, with a mixture of lacquer and thinner at a specific viscosity.

The items were sprayed, first on one side, allowed to air dry and then turned over and sprayed on the other side.

The lacquered items then were placed into an hot air oven and baked.

Chain was immersed in hanks or bundles and the excess lacquer was expelled or "spun off" via centrifuge. The chain would then be placed into the oven for curing.

A light blue dye would sometimes be added to the clear lacquer to enhance the color and reflectivity of the translucent lacquer coating. Colored dye (black or brown) was sometimes added to the lacquer to achieve an antique look on custom jewelry.

Associated problems such as "blushing due to entrapped moisture" dust particles, water or oil in the air line and later on environmental and safety considerations combined with the added requirements by insurance companies due to the highly flammable nature of the material, this coating became too costly for most jewelry anufacturers to use.

Water based lacquers.

Water based lacquers are still in use in the jewelry industry today. Used mostly over brass and bronze plating on custom jewelry, this process was ideally used on automatic plating machines, where the rack with the plated pieces was submerged into the water based lacquer and then any excess lacquer allowed to drip off while still on the plating rack. The lacquered pieces were allowed to air dry or were moved through an oven equipped with heat lamps and baked.

This type of lacquer coating is not desirable over silver or silver plated jewelry due to its slightly yellow color and uneven finish.

Manufacturers of brass plated lighting fixtures and hardware products, locks, hinges, doorhandles etc. still use this process in their conveyerized or automated equipment.

Cathodic, Electrophoretic Lacquer Coatings.

Cathodic, Electrophoretic Lacquer Coating is a clear water-based durable acrylic coating which can be applied in various thickness on a variety of metals, which are textured or highly polished.

This process, first developed in Europe, is based on the process of "Paint Plating". Rather then using a paint, this process uses a colorless material (clear polymer resin) which is also plated on but appears as a white, milky colored coating which is cured in an oven.

It is this curing process which turns the plated coating to a clear hard, durable coating.
The uncured coating can also be immersed into a variety of colored dyes to produce colored finishes on custom jewelry such as goldtone, brass, antique brass, blue, green, red and gray.

There are also several related products on the market and in use by the jewelry manufacturing industry, which produce a specific coating thickness on sterling silver, fine silver, and silver electroplate. Some manufacturers have used this coating, or a version thereof for some time successfully on karat gold, gold filled, gold electroplated and other jewelry finishes.

This process requires precise control and maintenance; the manufacturers recommendations must be followed exactly as specified in their technical data sheet to consistently produce an acceptable coating.

Items must be racked so that they do not touch while the coating is being applied, or before they are cured for example. Should they accidentally touch, a mark will be made into the uncured coating which will probably cause the two pieces to be rejected.

The racks used for processing of the pieces to be coated, must be either uncoated or be coated with a coating that can withstand a temperature of 320° to 356° F (160° to 180° C) for 30 to 45 minutes.

The racks must be stripped after the work has been removed and the clear lacquer coating is cured, or before the racks are reloaded.

The clear lacquer will make the racks non-conductive and will prevent further processing (plating) of future items placed onto the racks.

Where electroplated work is being coated, the same racks can be utilized, providing the rack coating (OHMAX)can sustain the high temperature and the time period necessary for the curing process.

Re-racking may be an alternative here if necessary. Even though it requires additional labor, it may be the more cost effective approach to address the high temperature curing process.

Most plating rack-coating materials will not stand up for any length of time and at best, their life expectancy will be greatly reduced.

When we look at the technical data sheets provided by the supplier, we find, that this process must meet a specific equipment criteria. The equipment can be incorporated or added to an existing plating line; as long as the operation is segregated from other plating operations and the equipment is strictly used for the application of the cathodic electrophoretic coating. Sharing the precleaning or rinse cycle for other plating operations is unacceptable and will render this somewhat costly process inoperable in a very short period.

The equipment required for this process is as follows:

Tanks:	Acid resistant polypropylene or lined steel tanks. Tanks should be equipped with an overflow weir at the side of the tank.
Heaters:	Teflon coated electric immersion heaters w/accurate thermostatic control - (20° - 35° C) are required. A heating capacity of 2 KW/1000 litters is sufficient. Note: Overheating may impair the solution.
Pumps & Filters:	The solution should be recirculated through a 5 micron polypro or corrugated paper filter cartridge. A pump capable of recirculating the solution (up to 500 liters) 5 to 6 times the bath volume per hour. Larger tanks 2 to 3 times the bath volume per hour.
Ultra-filtration	For the removal of dissolved impurities ultrafiltration is essential for the successful operation of the bath.
Power:	A continuously variable voltage controlled rectifier is recommended. Max. voltage required is 40 Volts.
Anodes:	316 type stainless steel at a ratio of 1:4 at 20 cm minimum distance between anode and cathode.

Let us look at some of the technical data normally supplied by the vendors of this process.

OPERATING CONDITIONS:

Concentrated Solution:	**20%**
Operating Solids:	**6 - 8 %**
Filtration:	**continuous / 5 micron**
Ultrafiltration	**required**
Temperature:	**20° - 30° C**
pH:	**5.7 +/- 0.3**
Conductivity:	**> 700 micro siemens**
Plating time:	**30 - 180 seconds**
Plating Voltage:	**up to 30 volts**
Anode Material:	**316 Stainless Steel**
Anode/Cathode Ratio:	**1:2 - 1:4**
Baking Temperature	**130° - 150° C**
Baking Time:	**20 minutes**

PROCESS CYCLE:

1. **Alkaline Soak/Electroclean**
2. **Water rinse**
3. **Passivation - (Optional)**
4. **Two (2) DI water rinses**
5. **Pre-dip/conditioner at room temperature for 1 minute**
6. **Cathodic Electrophoretic Coating**
   a. **soak for 30 seconds**
   b. **plate at 20 volts for 30 seconds to 1 minute at 78° F**
7. **Drag-out/post dip at room temperature with or without optical brightener**
8. **Three (3) separate DI water rinses**
9. **Brief air dry**
10. **Bake at 266° - 300° F for 20 minutes**

Additional Requirements

1. Use only De-Ionized water for this process - including rinses.
2. A variable range conductivity meter is required up to 1000 micro siemens.
3. Curing Oven, a ventilated electric or indirect gas-fired air-circulating oven which can maintain a minimum metal temp. of at least 150° C for 20 minutes is needed.

Environmental and Safety Concerns

The Cathodic Electrophoretic Coating solution as such is considered an irritant to eyes and skin. Appropriate safety equipment must be worn when handling this material.

The solution temperature should be kept under 95° F (34° C) when stored.

Disposal requirements for the solution itself must be addressed in accordance with federal and local regulations conforming to toxic chemicals. This product is regulated under section 313 of SARA Title III, and 40 CFR, Part 372.

The solution, pre-dip/conditioner, drag-out and post dip may contain
Propolyne Glycol Monoethyl Ether CAS# 112-25-4 and
Diethylene Glycol Monobutyl Ether CAS# 112-34-5

While small amounts mixed with large amounts of the solution, will reduce the danger of combustion. The material, while concentrated, will be combustible and considered toxic via ingestion.

All safety precautions must be observed when working with this material and personal protective clothing and equipment should be worn to prevent personal injury.

The cleaner and the strip solution contain sodium hydroxide. Caution must be taken when working with this material in either dry or liquid form. Appropriate personal protective equipment must be worn when handling this material.

As with all chemicals, consult the Material Safety Data Sheet supplied by the vendor for important safety information when using this material.

Solutions containing sodium hydroxide can normally be incorporated into the wastewater treatment system as long as they are free of solvents or other hazardous materials which are not compatible with your treatment system.

When in doubt as to the proper procedure for disposal of a chemical consult the Material Safety Data Sheet (MSDS) section for waste disposal or call your supplier for specific information at the telephone number listed at the top section of the MSDS.

In case of a major spill, call the 24 hour emergency telephone number for Chem-Trec: 1-800-424-9300

Federal and local regulations require, that you must also notify state emergency agencies as outlined in your hazardous material emergency or contingency plan.

ANTI-TARNISH SOLUTIONS

There are various products on the market to provide the jewelry manufacturer with protective coatings over silver, gold-filled, brass bronze and copper metal products or electroplated finishes.

The coatings are applied electyrolytically, that is plated on, or by immersion.

Some of these coatings contain volatile solvents, or contain products from the chromate family, while others are based on tin metal.

Non of these coatings are able to produce a heavy, protective coating that guarantees extended wearability, but are designed to provide temporary or limited protection or shelf-life of the jewelry treated with such coatings.

Many of these coatings are subject to environmental regulations and require specific treatment and/or disposal applications specific for such products.

Anti-Tarnish Finish for Silver, Copper and Gold - Chromate Type

The first product we discuss, is a two-step operation.

Both solutions contain chromates.

This process applies a very thin invisible coating on all silver, silver-alloy, copper, brass, bronze and gold surfaces.

It protects the surface against tarnish while in open trays, in storage and during shipment.

It is not abrasion resistant and may be removed by rubbing or prolonged handling.

The treated surfaces can be easily soldered, but the protective film will be removed by rosin flux and soldering heat without any special treatment.

The application of this anti-tarnish process is made in two steps. First a room temperature cathodic treatment in an aqueous bath, followed by a rinse and a simple immersion into a second room temperature solution. The cost of the application is minimal.

The operating cycle is as follows:

Electroclean
Double rinse (counterflow)
Mild acid pickle
Double rinse (counterflow)
Antitarnish # 1 at 3 Volts 2 minutes minimum
room temperature
specific gravity 11 - 14° Be'
Cold water rinse

Antitarnish # 2 immersion
room temperature
specific gravity 10 - 12° Be'

Cold water rinse (counterflow)

Air dry in oven or centrifugal unit. (do not rub dry in sawdust)

Environmental and safety considerations:

The materials used in this antitarnish process are:

Anti-Tarnish # 1 Sodium Hydroxide/ Sodium Chromate

Anti-Tarnish # 2 Sodium Dichromate

Both chromate solutions are chrome^{6} and must be converted to chrome^{3} before it can be precipitated in a conventional wastewater treatment system. A solution consisting of sodium hydroxide and sodium borohydride, utilized as in-line treatment, can accomplish the conversion from chrome^{6} to chrome^{3} effectively.

For safety precautions for any chemical process you must consult the MSDS (Material Safety Data Sheet) supplied by your vendor.

A single step chromate based anti-tarnish system is also available. The process here is applied electrolytically in a heated (150° F) chromate solution of 6° Be' for 1- 3 minutes at 6 volts

The process cycle as outlined in the two-step chromate anti-tarnish system is identical.

Environmental and safety consideration are also identical.

Anti-Tarnish Finishes - Solvent Type

Solvent-based anti-tarnishes for silver and gold marketed as chromate-free, many times are solvent based.

They are, as a rule, not quite as durable as the chromate based types especially those that are applied electrolytically.

When we apply the solvent based antitarnishes by immersion, the solvent evaporates into the atmosphere and leaves a very thin protective coating behind which can be removed by mere handling of the product. This means, that in the process of packaging of the coated item, some or most of this protective coating can be inadvertently removed.

This product can also be purchased in aerosol spray cans and has found their use in protecting pipeorgans and musical instruments.

The process cycle for this product is as follow:

Clean items to be coated in a conventional cleaning line.
Cold water rinse
Dip in 1- 3 % Nitric Acid at room temperature
Counterflow cold water rinse
Immerse in anti-tarnish for 5 - 10 minutes at 70 - 120° F
Rinse in warm water 70- 80° F
Air dry (do not dry by rubbing in saw dust).

Environmental and safety considerations

This product contains the following chemicals:

Butyl Carbitol	**CAS # 112-34-5**
Perchloroethylene	**CAS # 127-18-4**
Butyl Cellosolve	**CAS# 111-76-2**
Lactic Acid	**CAS # 50-21-5**

Federal, State and Local disposal regulations apply.

Consult the MSDS (Material Safety Data Sheet) supplied by the vendor when using this product for personal protection and safety concerns.

Anti-Tarnish Products - Chromate and Solvent - free

Due to environmental considerations and health and safety concerns the chemical industry has developed "less hazardous" and more "environmentally friendly" products.

This does not mean, that these products are 100% safe and can be used without precautions.

Chemicals, as any material, substance, medications, food, clothing etc. can cause allergic reactions during short or long periods of exposure, ingestion, inhalation or contact can trigger or aggravate a medical condition.

This anti-tarnish can be applied over silver or silver plated items directly after the plating process. Sterling silver jewelry, must be first cleaned as one would in the preparation for plating.

The items, old silver, sterling silver, fine silver or silver electroplate should be processed as follows:

Activation cycle

Dip in a 1% solution of dishwashing detergent (Joy)
Rinse well in cold running water (counterflow rinse)
Dip in 1 - 3% nitric acid at room temperature
Rinse in cold running water (counterflow rinse).

Treatment cycle

Immerse into Anti	**- Tarnish for one to two minutes at 80 - 120° F (two minutes will give maximum protection)**
Cold water rinse	
Hot water rinse	**Temperature should be below (150° F)**
Dry (warm air)	**Do not tumble dry or rub in sawdust.**

Environmental considerations

This anti-tarnish is a tin based product. Follow recommended disposal procedures listed on the MSDS or regulatory mandates.

Stannous Chloride (anhydrous) CAS # 7772-99-8

Health and Safety precautions:

Follow recommendations listed in the supplier's MSDS (Material Safety Data Sheet) for this product.

TARNISH REMOVAL PRODUCTS

One of the problems the jewelry manufacturer encounters, is addressing merchandise that has tarnished on the premises or at the retail store.

In order to restore the finish, any discoloration must be removed first, before the re-work can take place.

There are products available, that will accomplish this, as long as the discoloration is not caused by extreme heat, impurities in the metal or severe oxidation caused by chemical reaction.

At times a quick cleaning through the pre-cleaning cycle in the plating line will remedy the problem, if the discoloration is not too severe; in such cases we encounter basic surface dirt which has accumulated, when the product had been stored too long or was improperly stored or packaged.

If the products need special treatment, a "Tarnish-Remover" can be the "first aid" remedy to correct the problem.

Treatment Cycle

Immerse the items into the tarnish remover for 15 seconds to two minutes at room temperature.

Rinse in room temperature or slightly warmer water

Dry or immediately

Clean and apply an anti-tarnish coating

Environmental considerations

This product is regulated under Federal, State and Local regulations.

This product contains the following materials:

Thiourea	**CAS #**	**62-65-6**
Saffrole	**CAS #**	**94-59-7**
Sulfuric Acid	**CAS #**	**7664-93-9**

Health and Safety precautions must be followed as recommended in the MSDS supplied with this product by the vendor.

How to assure coverage with anti-tarnish on jewelry products

There are several simple methods to test the effectiveness of an antitarnish coating.

1. **Conductivity**

   By using a conductivity meter and holding both leads + and - onto the coated item in various places.

   Most antitarnish coatings will make the covered item non-conductive.

2. **Expose the coated items to the vapors of a heated liver of sulfur solution.**

3. **Immerse the coated items into a solution of artificial perspiration.**

4. **Place coated items in an adverse environment (plating room).**

5. **Wear-test the coated jewelry items under ordinary conditions.**

6. **Without electrocleaning or using strong alkaline or acidic solutions - just rinsing - attempt to flash a gold color over silver or silver over gold jewelry items.**
   Anti-tarnish coatings are mostly non-conductive and therefore should not plate.

The solutions, procedures and other technical information presented in this paper, are taken from actual processes the author has worked with or evaluated.

It is not the intent to recommend or promote them in any way, but only to demonstrate the variety and types of products available on the market today. There are several US manufacturers who provide excellent technical service, literature and general information on their anti-tarnish products for the jewelry manufacturer.

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