Jewellers Technical Guide

To chemical processing.

Including
Anodising
Cleaning metals
Colouring metals
Electroplating,
Electro Forming
Electro polishing,
Media polishing.
Pickling

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The world of chemical finishing is often portrayed as a high technology subject, seemingly too complex for non chemists. With modern processes this is no longer true, this booklet sets out to impart the basic knowledge to non-technical people to enable them to achieve results they would not consider possible.
Certain fundamentals to finishing hold true across most of the chemical processes, they are:
Plated finishes generally reproduce the base finish, except Copper and Nickel plate, so if you require brightness, polish the work first. If you want matt finishes, scratch-brushing or shot blasting is recommended. Finishing solutions rarely go wrong on their own, it is usually caused by contamination or over heating.
Clean water is the best asset the finisher has, always wash in clean water between any different process. If in doubt, douse in water, it can never do any harm.
The best processes in the world will not work in inferior situations, so use decent equipment, keep it clean and follow the process information accurately.
Most processes are toxic, so should be treated with respect. Wash affected area with water.
If taken internally, consult a doctor without delay.

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This is the second edition of the Guide, first published in 1980 and updated 2015 to reflect modern needs and developments.

Users of chemical processes do so at their own risk and no liability can be accepted by the author or distributor. This guide is for basic information and does not constitute a definitive method of working. Various health and safety regulations should be considered as should various legal and employee responsibilities be followed.

ACID PICKLING

SULPHURIC ACID

Function - To remove surplus flux, heat discolouration and oxidation from gold, silver, copper, copper alloys including brass and "gilding metal" from articles that have been soldered or excessively heated.

Container - Polypropylene, PVC, Glass, Copper or Lead.
Temperature- Cold to 65ºC
Time - 1 – 60 minutes.
Heater - PTFE clad, lead clad, glass, indirect (water-jacket). Gas or electric hot plates may be used with copper and lead containers but this method is dangerous.
Agitation - None to occasional
Availability - Obtainable in various sizes from industrial chemical suppliers. Commercial grade (R.O.V.), Sulphuric Acid performs adequately for pickling. Pure Sulphuric Acid can be used, but is more costly. Car battery acid can be used.
Make-up - Use at a strength of 5% - 20% by volume of acid with water. (7 to 30% if using battery acid)
Add the required amount of acid to COLD water very slowly.
TAKE CARE—Heat is generated by mixing acid and water, so always add acid to water, never the reverse. Wear protective clothing and glasses for safety.
When mixed, heat solution to required temperature.
Operation - Hang articles by copper or plastic hooks or place in polypropylene basket and immerse in The solution for the necessary time. Gold articles normally come out of the solution a 'coppery' colour whilst silver comes out a grey colour.
Wash articles well in water before handling.

CAUTION - SULPHURIC ACID IN A CONCENTRATED AND A DILUTE FORM ARE HIGHLY CORROSIVE, INGESTION MAY CAUSE DEATH.
PROTECT YOUR EYES.
Heated acids give off corrosive fumes so ventilation is recommended

PICKLING, SAFETY PICKLE

Function - As Sulphuric Acid pickling. Specification of plant and use is also the same as sulphuric acid pickling. This process, although slower, is safer and preferable where inexperienced or young people are present. Safety pickle is still a toxic substance, but much less corrosive than sulphuric acid. Supplied in dry salt form, it removes the handling problems that wet acids have.
Availability - From most chemical suppliers in 500g, 1 Kg sizes.
Brand names- "Vitex", "Safety Pickle"
Make-up - Add to cold water at the rate of 50 – 200 grams of salt per litre of water. Stir and heat to required temperature.
Operation - As Sulphuric Acid pickling.

Heated acids give off corrosive fumes so ventilation is recommended

HYDROCHLORIC ACID

Function - To remove rust (Iron Oxide), scale, steel welding residue, heat discolouration and oxidation from Iron, Steel and some stainless steels.

Container - Polypropylene, PVC, Glass,
Temperature- Cold to 65ºC (Extensive fumes are produced at the higher temperatures)
Time - 1 – 20 minutes.
Heater - Glass, indirect (water-jacket). Gas or electric hot plates may be used with Pyrex containers but this method is dangerous.
Agitation - None to slight occasionally
Availability - Obtainable in various sizes from industrial chemical suppliers. Commercial grade "Muriatic acid" performs adequately for pickling. Pure Hydrochloric Acid can be used, but is more costly.
Make-up - Use at a strength of 20% - 50% by volume of acid with water.
Add the required amount of acid to COLD water very slowly.
TAKE CARE— dangerous fumes are produced from Hydrochloric acid, always use an extracted enclosure when making up the solution and whilst processing.
Wear protective clothing and glasses for safety.
When mixed, heat solution to required temperature.
Operation - Hang articles by plastic covered hooks or place in polypropylene basket and immerse in The solution for the necessary time.
Wash articles well in water before handling.
After process- Corrosion can quickly re-occur on pickled surfaces, to prevent this, immerse the items in a weak Sodium Carbonate (50 grams per litre) and wash in clean water.
5% Sodium Hydroxide (Caustic Soda) can also be used but is more dangerous.

CAUTION - HYDROCHLORIC ACID IN A CONCENTRATED OR A DILUTE FORM IS HIGHLY CORROSIVE, INGESTION MAY CAUSE DEATH. PROTECT YOUR EYES & SKIN.
HYDROCHLORIC acid gives off DANGEROUS fumes so ventilation is ESSENTIAL.

NITRIC ACID & AQUA FORTIS

Function - To remove surface discolouration and to brighten copper and its alloys including Brass a, Bronze and "Gilding metal".

Container - Polypropylene, PVC, Glass, high grade stainless steel.
Temperature- Cold to 40ºC (Extensive fumes are produced at the higher temperatures)
Time - 5 – 20 seconds.
Heater - Normally no heating is required as the process heats up quickly when in contact with the items being processed.
Agitation - Vigorous movement of the items to obtain an even result.
Availability - Obtainable in various sizes from industrial chemical suppliers. Commercial grade "Aqua-Regia acid", which is a mixture of Sulphuric and Nitric acids plus Sodium Chloride performs better for "bright dipping".
Make-up - Use at a strength of 20% to 100% by volume of acid with water.
Operation - Hang articles by plastic coated hooks or place in polypropylene basket and immerse in solution with vigorous movement until brown fumes are produced, remove and quickly wash articles well in water before handling.

CAUTION - NITRIC ACID & AQUAFORTIS ACIDS IN A CONCENTRATED OR A DILUTE FORM ARE HIGHLY CORROSIVE, INGESTION MAY CAUSE DEATH.
PROTECT YOUR EYES & SKIN.
NITRIC AND AQUA-FORTIS acids give off DANGEROUS fumes so ventilation is ESSENTIAL.

HYDROFLUORIC ACID

Function - This acid is used in a variety of applications, including
To remove surface discolouration/etch Titanium
To etch glass
To remove silicon based materials ie casting plaster.

Container - Polypropylene, PVC, **NOT Glass**,
Temperature- Cold to 40ºC (Extensive fumes are produced at the higher temperatures)
Time - Variable depending on surfaces..
Heater - Indirect water jacket, PTFE clad or Polypropylene heated by external contact band heaters.
Agitation - Vigorous movement of the items to obtain an even result.
Availability - Obtainable in various sizes from selective chemical suppliers. Commercial grade Hydrofluoric Acid is 70% strength.
Make-up - Use at various strengths depending on the process.
Operation - Hang articles by plastic coated hooks or place in polypropylene basket and immerse in solution with vigorous movement until brown fumes are produced, remove and quickly wash articles well in water before handling.

EXTREME CAUTION - HYDROFLUORIC ACID IN CONCENTRATED OR DILUTE FORMS ARE HIGHLY CORROSIVE AND PRODUCE VERY TOXIC FUMES.
INGESTION WILL CAUSE DEATH.
PROTECT YOUR EYES & SKIN AT ALL TIMES.
CONTACT WITH THE BODY CAUSES SEVERE TISSUE ATTACK AND AMPUTATION MAY BE THE ONLY TREATMENT AVAILABLE.

THIS MATERIAL MUST ONLY BE USED IN A PROPERLY EQUIPPED FACILITY IN A REMOTELY OPERATED EXTRACTED ENCLOSURE WHERE NO BODY CONTACT IS POSSIBLE.
THE POURING OF THE FULL STENGTH ACID IS PARTICULARLY DANGEROUS AND FULL BODY PROTECTION IS VITAL.

ACID PICKLING STAINLESS STEEL

Function - This acid is used in a variety of applications, including removal of welding slag and heat discolouration due to annealing, often used as a pre-treatment to electro polishing. Solutions are usually mixtures of various strong mineral acids and must be treated with care. Fume extraction is essential. Because there are many types of pickling liquids available from suppliers, only general guidelines are quoted in this guide.

Container - Polypropylene, PVC, **NOT Glass**,
Temperature- Cold to 40ºC (Extensive fumes are produced at the higher temperatures)
Time - Variable depending on surfaces, 1 to 30 minutes.
Heater - Indirect water jacket, PTFE clad or Polypropylene heated by external contact band heaters.
Agitation - Occasional movement of the items to obtain an even result.
Availability - Obtainable in various sizes from specialist chemical suppliers.
Make-up - Use at various strengths depending on the products being processed.
Operation - Hang articles by plastic coated hooks or place in polypropylene basket and immerse in solution, remove and quickly wash articles well in water before handling.

CAUTION - PICKLING ACIDS IN A CONCENTRATED AND DILUTE FORM ARE HIGHLY CORROSIVE, INGESTION MAY CAUSE DEATH.
PROTECT YOUR EYES.
Heated acids give off corrosive fumes so ventilation is recommended.

ACID PICKLING TITANIUM, NIOBIUM AND TANTALUM (Ti, Nb, & Ta)

Function— To clean and etch the surface of the Refractory metals Ti, Nb, and Ta.
Operation is the same as for stainless steel using either mixtures on Hydrofluoric and other acids (very dangerous) or using the slower salt based products as Microetch™ (USA) or VITEX ™ (UK) Process sequence is as pickling Stainless steel.

ANODISING

ALUMINIUM

There are many variations on solutions used for anodising aluminium and the quoted type below is the most commonly found where just protection is used or there is a need to colour dye the anodised film. It is suggested that more detailed information is researched when the requirements are more complex.

Function - To produce a protective layer over Aluminium and its alloys to create a protective layer against corrosion.
Container - Polypropylene, PVC, plastic or lead lined.
Cathodes - Lead sheets, connect to negative output of DC supply.
Temperature- 18 - 25ºC
DC Voltage - 12 – 25 volts.
DC Amperage- 1 – 1.5 amps per dm^2 / 0.01— 0.016 amps per cm^2 / 0.07 = 0.10 amps per $inch^2$.
Deposition rate- 1 micron in 2.4 minutes in a 15% solution, 1 micron in 3.6 minutes in a 10% solution
Time - As required, 10 minutes minimum.
Heater - PTFE, Lead coated, Glass or Quartz
Agitation - Vigorous air from an oil free source.
Availability - The most common make up is 10% Sulphuric Acid in demineralised water, 15% Sulphuric acid produces a more open structure and is preferred when the use of colour dyes are used as the colour intensity is better.
Colours - Most colours of the spectrum are available including black and many shades of grey.
Make-up - Add the acid to water and allow to cool to under 25°C before use.

Operation -

1. Hang articles on copper, brass, titanium or Aluminium wire, jigs or racks. Connect to Positive output of DC supply.
2. Clean in a suitable non aggressive electrolytic or soak cleaner, rinse in water.
3. Etch (Option for some alloys and if the items are castings) in 25% Sodium Hydroxide, rinse.
4. De-smut in 7% Nitric acid if the etch stage has been used, rinse
5. Anodise at required time and current, rinse. Note that it is usual for the amps to fall and the voltage to rise as the anodic film is formed. Low amp readings usually indicate the process is complete.
6. If colouring is required, immerse in suitable dye tank, rinse.
7. Seal surface in 95—99°C demineralised water for up to 20 minutes.

Maintenance- Occasional analysis for sulphuric acid and aluminium contents
Disposal - Because of the high level of toxic material, this solution must not be discharged untreated.

CAUTION - THIS SOLUTION CONTAINS SULPHURIC ACID AND IS HIGHLY TOXIC. INGESTION WILL CAUSE DEATH.

ANODISING, continued

TITANIUM, NIOBIUM AND TANTALUM

There are many variations on solutions used for anodising these metals and the quoted type below is the most commonly used.
It is suggested that more detailed information is researched when the requirements are more complex.

Function - To produce a coloured layer of the metal oxide. Used in medical implants, jewellery and for the identification of machine parts. This is a conversion coating and as such is an integral part of the metal used and cannot detach from the base material.

Container - Polypropylene, PVC or glass.
Cathodes - Titanium mesh or sheet, this should be kept small, connect to negative output of DC supply.
Temperature- 18 - 25ºC
DC Voltage - 9—120 volts dc.
DC Amperage- Not applicable
Deposition rate- Not applicable as only thin conversion coatings can be formed.
Time - 2 to 10 seconds.
Heater - PTFE, Glass or Quartz, normally not necessary as room temperature is suitable.
Agitation - Not necessary
Availability - From specialist distributors, in salt form.
Make-up - Add the salts to demineralised water and dissolve. 50 to 100 grams per litre salts to water.

Operation - The colour required is very sensitive to the voltage applied, changes of as little as 0.1 volt may affect the colour. The use of a digital meter is essential to establish the correct voltage for the machine and product being processed. Carry out a series of tests with the voltage being increased gradually until the correct colour is achieved. Making a reference board of samples at various voltages enable the reproduction of the specific colours
in the future.

1. Hang articles on Titanium or stainless steel wire, jigs, racks or Titanium surgical tweezers. Connect to Positive output of DC supply.
2. Clean in a suitable cathodic electrolytic (preferred for an even colouration) or soak cleaner, rinse in water.
3. Etch in a suitable chemical eg Microetch™ (USA) or VITEX ™ (UK). Rinse
4. Anodise for the required time. Rinse and dry.

Maintenance- Replace the solution when dirty or the process becomes erratic.

WARNING—THE DC VOLTAGES APPLIED ARE HIGH ENOUGH TO BE DANGEROUS, USE RUBBER GLOVES AND ENSURE THE DEVICES FOR HOLDING THE PRODUCTS ARE INSULATED WHERE THEY ARE HANDLED. ENSURE YOU DO NOT COME INTO CONTACT WITH EITHER CATHODE OR WORKPIECES WHEN THE HIGHER VOLTAGES ARE USED.

BARREL BURNISHING

Grinding and polishing of metals using various media is a very wide subject so only the basic theory and methods can be part of this guide. There are many specialist companies who can advise on specific requirements. This section covers the use of rotating barrels. Larger items are often processed using Vibratory systems and other more complex methods.

Function - To serve as a final finish on many small pieces and as a pre-polish prior to hand polishing of other items. Also used as a de-burring process in certain cases.

Availability - A rotating drum made from polypropylene, PVC, wood, glass or rubber lined steel. Drum diameter should be between 150mm and 300mm revolving at between 20 and 60rpm. The cross section of the drum should be 6 or 8 sided for best results.
The ideal operational details for burnishing pieces up to 15 grams in copper, brass, tin/lead, silver and gold are as follows:

Barrel shape and size, 6 sided x 275 long x 80mm diameter, Speed, 35rpm.
Shot / shapes 6 Kg. Non metallic media (Plastic and ceramic) 3 Kg .

For a very small scale production, round barrels with inner surface profiles and a diameter of 100mm work quite well but are very slow and can take 4 times longer to process than 6 sided barrels.

Availability - There are many versions of the rotating barrel available, generally it is better to process different metals in separate barrel enclosures as metals may transfer from one operation to another. This is particularly true when Gold is processed after Silver, where a white to pale Gold film appears on the surface due to traces of silver migrating onto the Gold surface.

Thorough cleaning can alleviate this problem but it can be unreliable. The gasket material on the barrel lid is a source of cross contamination so it is suggested that a thin wall polythene sheet from a polythene bag be placed under the lid to isolate the gasket from the barrel contents.

Operation - Based on a Rotabarrel Machine with a 6 litre barrel body. All new shot should be run In the barrel for a minimum of 1 hour with 25 grams of Barrelbrite BB63 per 1kg of steel shot and shapes to remove any traces of protective oil.
After the shot and barrel have been cleaned the machine is ready for operation.

For deburring, grinding and sateen effects.

Load each compartment with approximately 3kgs of Media.
Add cold water until barrel is ½ full of water.
Add 50 grams of Cutting powder “PB” powder per compartment.
Add work to be done. Maximum volume of work per compartment should not exceed 500cc. Efficiency of the barrel is more dependent on the ratio of volume of work to shot than the weight ratio. Measure the work using a measuring jug.
Close barrel securely. Switch on and run for 1 – 4 hours depending on the quality of the work being put in, and the finish required.
Empty barrel, sieve work and shot to separate, wash well in running water.

The degree of abrasive properties of the barrel can be reduced by the addition of both the Cutting powder and some polishing powder, e.g. BB63.
Starting at a 50/50 ratio is a good start, increasing or decreasing the 2 components proportionately whilst maintaining the total weight of power the same.

For polishing.

Load each compartment with approximately 6kgs of mixed shot.
Add cold water until barrel is ½ full of water.
Add 50 grams of Barrelbrite BB63 powder per compartment.
Add work to be done. Maximum volume of work per compartment should not exceed 500cc. Measure the work using a measuring jug.
Close barrel securely. Switch on and run for 1 – 4 hours depending on the quality of the work being put in, and the finish required.
Empty barrel, sieve work and shot to separate, wash well in running water.

BARREL BURNISHING continued

Maintenance - To achieve consistently good results the following points must be observed. Cleanliness is very important, keep inside of barrel clear of grease, deposits of lime and barrelling powder build up.

Shot must be kept clean and never allowed to oxidise or rust. Always keep shot under a solution of water and polishing powder e.g. (BB63), as these powders have rust inhibiting properties.
For prolonged periods of not using the shot / shapes, add 25cc of ammonia to the polishing solution.
Badly rusted shot is useless and should be replaced. Stainless steel shot and shapes are difficult to obtain and very expensive. The quality of finish between well kept steel shot and stainless steel shot is identical

Do not overload the work content of the barrel, damage to the products may occur. It is preferable to keep separate barrel compartments and shot for Gold, Silver and base metal goods. Many unsatisfactory loads are caused by one type of metal being burnished into a different metal.

In the event of faulty loads being produced even after cleaning the barrel and shot, the following can be carried out.
Go through the operation procedures 1 to 6 with the exception of adding the work, instead add about 8 walnut sized hard pebbles.
Barrel for 2 hours and then discard the stones, followed by running the barrel with shot and polishing powder/ water mix but with no work pieces for a further 4 hours to retrieve the polish on the shot.

Wash shot and barrel interior well and use as normal.

BRASS PLATING

Function - To deposit a layer of copper and zinc alloy in thin deposits to simulate a brass made product..

This is a cyanide based solution, use primarily as a thin overcoat to other finishes.
This type of solution plates easily over most metals and is particularly useful when refinishing antique pieces.

BRASS Solution operation.

Container	-	Polypropylene, Glass or Stainless Steel.
Anodes	-	Brass or Stainless Steel may be used on small solutions. Connect anodes to the positive dc supply
Temperature	-	35 – 45ºC
DC Voltage	-	4 – 6 volts.
DC Amperage	-	0.03 – 0.05 amps per cm^2 (0.2 – 0.3 amps/$inch^2$).
Time	-	15 – 60 seconds.
Heater	-	Stainless Steel, glass or indirect (water jacket).
Agitation	-	Gentle movement.
Availability	-	From leading suppliers
Make up	-	Normally supplied as a ready made solution but can be available in salt form. Dissolve in Demineralised water.

Control of colour.

Brass solutions co-deposit copper and zinc and as such greater attention must be made to the operational conditions. In particular to solution temperature and dc voltage applied.

CLEANING METHODS FOR METALS AND CERAMICS

ABRASIVE CLEANING

Function - Used predominantly on surfaces to produce a matt to semi bright finish.
Often used in conjunction with polishing mops at slow speeds to work on metal and glass enamel surfaces.
Availability - Pumice powder, from leading trade suppliers.
Operation - By hand, lightly rub with damp cloth or sponge, wash well in water when clean.

By mop, ensure speed is below 500 rpm and the sisal mop is enclosed within a waterproof cowl and base. Mix the pumice powder with water to a paste and apply to the mop carefully. Using a gloved hand hold some of the paste in the palm of the hand and allow it to feed onto the mop whilst holding the item for cleaning onto the mop.

Warning.
This procedure allows the pumice to abrade the surface but should be carried out only by experienced polishing mop operators as the technique could be dangerous in inexperienced hands. Take particular care when working with assembled products that are linked, as the product could become entangled with the mop with dangerous results. Use of a wooden board to hold linked items against is used when enamel polishing Chains of Office.
Never try this method on a normal speed polishing wheels as the method will not work and the risks are very high that injury will result.

ELECTROLYTIC CLEANING

The most important step in electro-plating. This is the only method that produces a chemically clean surface. All other methods will produce a physically clean surface that is not good enough to ensure good adhesion when electroplating .
A suitable test that proves that electrolytic cleaning is superior to any other method is to take a piece of polished metal and clean it by electrolytic means and another piece by any other method. Immediately after cleaning, wash in water and examine the surfaces, one will have no water break, the electrolytically cleaned sample, the other will have a globules of water on the surface, like rain on a waxed car.

Function - To remove traces of oil, grease and tarnish.
Container - Glass, Polypropylene, PVC or Stainless Steel.
Anodes - Stainless Steel, connect to positive output of DC supply for non ferrous metals and to the negative for all steels.
Temperature - Cold to 65ºC
DC Voltage - 5 – 7 volts. (not critical)
DC Amperage - .02 - .04 amps per cm^2 (0.12 – 0.25 amps/$inch^2$). Not critical.
Time - 10 – 30 seconds.
Heater - Glass, Stainless Steel or indirect (water-jacket).
Agitation - Not necessary.
Availability - In various pack sizes.
Make-up - Add required amount of salts to cold water, stir and heat if required.
Operation - Hang articles by hooks and jigs made of either copper or a plastic coated jig with metal contacts
Maintenance - Use solution until it appears dirty or foaming during use, ceases or if grease and oil are floating on the surface.
Never risk any electro-plating if the electro-cleaning does not produce an unbroken water effect on the surface of the work.

CAUTION - THIS SOLUTION CONTAINS STRONG ALKALII. INGESTION MAY CAUSE DEATH.

ULTRASONIC CLEANING

Function	-	To remove bulk polishing composition and loose fragments. It is not adequate to go from ultrasonic cleaning to electroplating. Electrolytic cleaning must also be used.
Container	-	Stainless Steel.
Anodes	-	None.
Temperature	-	Cold to 80ºC
DC Voltage	-	None.
DC Amperage	-	None.
Time	-	30 seconds to 3 minutes.
Heater	-	Usually integral, immersion heaters in glass, silica and stainless steel may be used when ultrasonic power is off.
Agitation	-	None.
Availability	-	Wide range available.
Ultrasonic Cleaning	-	Concentrate. 1, 5 & 25 litre available. Ammoniated and ammonia free types.
Make-up	-	Dilute concentrate with warm water in the ratio of 1 part concentrate to 15 parts water.
Operation	-	Hang articles by hooks and jigs made of plastic.
Maintenance	-	Use until dirty, discard using plenty of clean water.

Notes on Ultrasonic cleaning fluids.

The preference for using either fluids with ammonia or without are mostly affected by the following parameters.

Vapours—Ammonia fumes are classified as hazardous so a well ventilated or extracted area to use them in is recommended.

Products to be cleaned—all high copper content alloys or copper products must not be cleaned in ammonia containing fluids as this will cause the “Cuprammonium effect” where the ammonia reacts with the copper to produce a tarnished colour on the product surface.

Steel items must be cleaned in an alkaline solution (ammoniated or pH higher than 7.0) as iron oxide / rust will quickly form on removal from the bath.

Some other materials may also react with this fluid. Test a sample first.

Whilst ammoniated products generally attack greases and oils quicker than non ammoniated types the above considerations should be observed.

WATER BLAST CLEANING,

Function	-	To remove bulk material from the surface of both lost wax cast and 3D printed products. Used also to clean recesses and surfaces on manufactured products where other methods are not suitable.
Method	-	Pressurised water to 70 –120 bar is directed at the surface to be cleaned via fixed and movable nozzles inside an enclosure. At these pressures the enclosures have to be designed so that direct contact with the operator is avoided and that the screen is made from toughened glass.
Temperature	-	Room temperature.
Availability	-	From Casting equipment and 3D printing supply companies.

DRYING

Function - To remove the final rinse water to leave a clean stain free surface.
Types - a. Sawdust (media)
b. Hot Air
C. Solvent

Sawdust (Media Dryers)

Using resin free sawdust, crushed maize or corn granules in containers manufactured of aluminium, copper or galvanised steel.
Heating is usually provided by electric, gas or water jacket heaters.

Operation - The media is placed in the heated dryer and allowed to heat to approximately 40-50ºC. The wet work is placed in the media either loose or in a perforated tray. With gently agitation of the work the water becomes absorbed into the media leaving the work dry. Good results can be obtained by this method providing the media is not contaminated by dirty water or is allowed to become very wet through high volumes of work.

Availability - Various sizes from trade suppliers from , 200mm diameter to large vibratory / separator models.

Hot Air Dryers

Normally using electrically heated air, often blown by a fan. Domestic fan heaters fitted into a small enclosure are used but are dangerous as there is a risk of water entering the heaters, causing a fire hazard.. The life of heating elements tends to be short due to overheating.

Hot Air Dryers are useful when drying large parts where the use of media is unwise. i.e. clock parts or pieces with very deep recesses.

With highly polished pieces it can be very difficult to avoid drying stains and some experimentation with holding the parts is necessary to allow water to run off easily.
Always use demineralised water as a final rinse to avoid hard water salt staining.

Operation - After washing the parts in clean cold water place the articles in the warm air stream of the dryer. A hot water wash may be used after the cold water, but ensure that this is very clean, i.e. in de-ionised or distilled water.

Availability - From bench top units to large industrial systems.

Solvent dryers

With the restrictions of the use of Trichloroethylene and derivatives due to their carcinogenic properties, the only safe methods of using solvent systems are by using totally enclosed systems which separate the operator from contact with the solvent.

These are specialist machines available from trade manufacturers and are outside the scope of this guide.

ELECTRO POLISHING STAINLESS STEEL

Function	-	To remove the top surface and polish stainless steel and other Chrome-Nickel-Iron alloys. Solutions are usually Sulphuric and Phosphoric Acid based and have a specific gravity in excess of 1.7 (Water = 1.00)
Container	-	Polypropylene, lined steel tanks, PVC or glass.
Heaters	-	PTFE, PDVF, Glass / Silica, or heated indirectly in a heated water jacket.
Cathodes	-	Stainless Steel, connect to negative output of DC Supply.
Temperature	-	55—85ºC
DC current	-	10—40 amps per sq. decimetre, 0.1—0.4 amps per cm², (0.6—2.4 amps/inch²).
Voltage	-	15 – 20 volts dc
Time	-	5 seconds – 20 minutes, depending on the degree of metal removal..
Agitation	-	Gentle horizontal or vertical movement or air agitation from an oil free source.
Availability	-	From specialist metal finishing suppliers.
Make-up	-	The solution is generally supplied ready made in liquid form.

Operation
Hang articles on coated copper or brass wire, jigs or racks with either replaceable stainless steel or copper alloy contact points or made with Titanium contact points that do not need replacing.
Electrical contacts need to be tight and able to carry high dc currents. Connect to the positive output of the DC supply.

Items that are contaminated with oils and greases must be degreased prior to process, using preferably electrolytic cleaning or adequate soak or ultrasonic cleaning.
If the items have welding scale on them it is often necessary to pickle them in a specialised acid mix.
See the section on Pickling—Stainless steels

Immerse the items in solution and apply the pre-calculated current. If the correct current exceeds the output of the rectifier either reduce the load size or connect to a larger output rectifier.
It is initially important to establish the correct time of process due to the many uses of electro polishing stainless steels. Times as low as 5 seconds have been used for light polishing of surgical devices and up to 20 minutes for heavy industrial items.

After the elapsed time, remove the items from the bath and rinse well, the electro polishing solution is very viscous and requires good water rinsing to remove traces of the electrolyte.

It is possible to neutralise the electrolyte to prevent later staining of the surface due to residues of electrolyte seeping out from deep cracks and recesses by immersion in a 10% solution of Sodium Carbonate in water, followed by another rinse in water. Hot water immersion can also help in the prevention of staining and as an aid to drying.

CAUTION - THIS SOLUTION CONTAINS STRONG ACIDS AND IS HIGHLY TOXIC. INGESTION WILL CAUSE DEATH. PROTECT EYES AND SKIN FROM CONTACT, WASH WITH WATER AND SEEK MEDICAL ATTENTION IF CONTACT IS MADE.

ELECTRO POLISHING PRECIOUS METALS

Function	-	To remove the top surface and to brighten & polish Gold. Not suitable for Silver, or Platinum group metals.
Container	-	Polypropylene, lined steel tanks, PVC or glass.
Heaters	-	PTFE, PDVF, Glass / Silica, or heated indirectly in a heated water jacket.
Cathodes	-	Stainless Steel, connect to negative output of DC Supply.
Temperature	-	65—75ºC
DC current	-	100—300 amps per sq. decimetre, 1—3 amps per cm², (6—18 amps/inch²).
Voltage	-	15 – 20 volts dc
Time	-	5 seconds – 60 seconds, depending on the degree of polish required.
Agitation	-	None or gentle horizontal or vertical movement.
Availability	-	From specialist metal finishing suppliers.
Make-up	-	The solution is generally supplied in a salt form, pre-packed 10 litres size requiring the complete container to be dissolved in 10 litres of water and heated to operational temperature. Packs should not be divided in the salt form, only once dissolved up.

Operation
Hang articles on coated copper or brass wire, jigs or racks with either replaceable copper alloy contact points. Copper hooks can also be used but they need to be thick enough to carry the current without overheating. Stainless steel can be used but care must be taken that the contact is tight otherwise "arc erosion" may occur on the gold item due to sparking under the solution. Titanium cannot be used as the contact points will become quickly anodised and restrict electrical connection.
Connect to the positive output of the DC supply.

Items that are contaminated with oils and greases must be degreased prior to process, using preferably electrolytic cleaning or adequate soak or ultrasonic cleaning.
If the items have soldering scale or discolouration from soldering on them it is often necessary to pickle them in a dilute Sulphuric acid / water acid mix.
See the section on Pickling—Sulphuric acid

Immerse the items in solution and apply the correct voltage, 15 volts dc for small items, up to 20 volts for larger items. If the correct current exceeds the output of the rectifier either reduce the load size or connect to a larger output rectifier.
It is initially important to establish the correct time of process due to the many uses of electro polishing. Times as low as 10 seconds for delicate items and up to 60 seconds for larger pieces.

After the elapsed time, remove the items from the bath and rinse well, they need good water rinsing to remove traces of the electrolyte.

It is possible to neutralise the electrolyte to prevent later staining of the surface due to residues of electrolyte seeping out from deep cracks and recesses by immersion in a 10% solution of Citric Acid or vinegar (Acetic acid) in water, followed by another rinse in water. Hot water immersion can also help in the prevention of staining and as an aid to drying.

Maintenance- During all periods that electro polishing solutions are heated they consume Potassium Cyanide. An efficient method of determining if there is sufficient Potassium Cyanide present in the process is to carry out the following test.
Heat solution to 65ºC.
Place a component of Silver or Gold into the solution connected to the positive output of the DC supply.
Turn DC supply up to 15 volts without agitation, leave work in for 15 seconds.
On removing the work, the surface should be clean white or gold. If the surface Is black, the Potassium Cyanide content is low.
Add Potassium Cyanide at the rate of 25 grams per litre of solution and repeat above stages until the surface is clean.

Disposal - Because of the high level of toxic material, this solution must not be discharged untreated. Solutions should be safely bottled and sent for re-processing to a registered treatment company. Many solutions contain gold and silver in economically recoverable amounts.

CAUTION - THIS SOLUTION CONTAINS CYANIDES AND IS HIGHLY TOXIC.
INGESTION WILL CAUSE DEATH.
PROTECT EYES AND SKIN FROM CONTACT, WASH WITH WATER AND SEEK MEDICAL ATTENTION IF CONTACT IS MADE.
FUME EXTRACTION IS RECOMMENDED.

ELECTRO-STRIPPING (FIRE REMOVAL)

Function	-	To remove the top 'skin' of contaminated gold and silver, where any form of heating has been used in manufacture, leaving the surface clean and semi-bright ready for final finishing.
Container	-	Glass, Polypropylene, Stainless Steel (inferior).
Anodes	-	Stainless Steel, connect to negative output of DC supply.
Temperature	-	60ºC – 75ºC
DC Voltage	-	6 – 9 volts.
DC Amperage	-	1 – 2.5 amps per cm2 (6-16 amps per inch2).
Time	-	10 – 40 seconds.
Heater	-	Stainless Steel.
Agitation	-	Gentle horizontal movement.
Availablity	-	5 litre packs from distributors. Do not divide packs, dissolve in water and then divide up if necessary.
Make-up	-	Add required amount of salt to cold water, add 10cc of Ammonia. (.880 or household type) per litre of solution. Stir and heat to recommended temperature.
Operation	-	Hang articles on copper, brass or stainless steel wire, jigs or racks. Connect to positive output of DC supply.
Maintenance	-	During all periods that electro stripping solutions are heated they consume Potassium Cyanide. An efficient method of determining if there is sufficient Potassium Cyanide present in the process is to carry out the following test. Heat solution to 65ºC. Place a component of Silver or Gold into the solution connected to the positive output of the DC supply. Turn DC supply up to 7 volts without agitation, leave work in for 15 seconds. On removing the work, the surface should be clean white or gold. If the surface is black, the Potassium Cyanide content is low. Add Potassium Cyanide at the rate of 75 grams per litre of solution and repeat above stages until the surface is clean.
Disposal	-	Because of the high level of toxic material, this solution must not be discharged untreated. Solutions should be safely bottled and sent for re-processing to a registered treatment company. Many solutions contain gold and silver in economically recoverable amounts.
CAUTION	-	**THIS SOLUTION CONTAINS POTASSIUM CYANIDE AND IS HIGHLY TOXIC. INGESTION WILL CAUSE DEATH.**

GOLD ELECTROPLATING

The depositing of gold falls into several categories and it is important to decide the requirements of the finish required, in particular,

1. The thickness of the deposit, is it for a decorative finish or does it need wear resistance?
2. Is a specific thickness required, these can be from 0.01microns to 10 microns normally, depending on the product to be plated.
3. The colour of the deposit, this can range from 9K to 24K.
4. The equipment you will use the solution in, some solutions require very accurate criteria, others are more flexible.

When these criteria are decided, the following sections will provide more detailed information.

GILDING (thin gold plating)Yellow gold colours

Function	-	To deposit a thin layer of coloured gold (9k, 14, 18k, 22k & 24K etc) to the surface of an article. This converts the finish of the article to a uniform colour and reduces oxidation of the surface. Used extensively on low carat golds to improve the finished colour and on some base metals, also used on some silver articles.
Container	-	Glass, Polypropylene, PVC
Anodes	-	Stainless Steel, connect to positive output of DC supply.
Temperature	-	60ºC – 65ºC
DC Voltage	-	6 – 8 volts. DC Amperage— Not relevant
Time	-	7 – 20 seconds.
Heater	-	Stainless Steel, PTFE, Glass or indirect (water-jacket).
Agitation	-	None or very gently horizontal agitation if articles lie together.
Make-up	-	Dissolve salts in required amount of water, stir and heat to recommended temperature.
Operation	-	Hang articles on copper, brass or stainless steel wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended in the CLEANING SECTION . Wash in water and gild as recommended above. Connect work to the negative output of your DC supply. Replenishment should be done on a visual basis when deposit changes colour from the original colour. Replenisher in small solutions under 2 litres is not recommended, replace the solution. Larger solutions can be replenished using the suppliers additives.

CAUTION - GILDING SOLUTIONS ARE TOXIC. INGESTION MAY CAUSE DEATH.

GILDING (Thin Gold plating) Red, Rose, Green, Brown, Black gold colours

Function	-	To deposit a thin layer of coloured gold to the surface of an article. This converts the finish of the article to a uniform colour. Because the deposit is made up from an alloy of Gold and other metals it is necessary to observe a closer control over the operating temperature and voltage applied. This is because different metals electroplate at different voltages and affect the colour and composition of the alloy. It is recommended that trial items are processed initially to achieve the finish you require which will depend on your equipment and the voltage applied. As very small voltages can affect the colour it is recommended that a digital meter is used to record the applied voltage. Most suppliers can supply an adaptor to convert analogue metered machines to digital.
Container	-	Glass, Polypropylene, PVC
Anodes	-	Stainless Steel, connect to positive output of DC supply.
Temperature	-	Dependant on the supplied solution from your distributor, read the individual data sheet.
DC Voltage	-	See data sheet. Time— See data sheet.
Heater	-	See data sheet
Agitation	-	None or very gently horizontal agitation if articles lie together.
Make-up	-	May be supplied in either liquid or salt form, read specific data sheet.
Operation	-	As Gilding yellow colours, use specific data sheet instructions. Replenisher in small solutions under 2 litres is not recommended, replace the solution. Larger solutions can be replenished using the suppliers additives.

CAUTION - GILDING SOLUTIONS ARE TOXIC. INGESTION MAY CAUSE DEATH.

GOLD PLATING Thick deposits.

There is a wide range of processes available, these operational conditions apply to most of the available types, but it is recommended to read through the specific data sheet from your supplier.

Function - To deposit a layer of coloured gold (9K, 14K, 18K, 22K, 24K yellow gold), in thickness of between 0.5 microns and 20 microns. The gold plate presents a durable surface with all the appearance of solid carat gold. Used extensively on silver articles of jewellery, badges, tableware, household fittings and many base metal products including watch bracelets and costume jewellery. There is a wide selection of plating solutions available, so specialist assistance should be sought in arriving a the correct process for your needs. As a general guide, shown below are the operating conditions for the majority of solutions.

Digital metering is highly recommended as the current (amps) applied can be a fraction of 1 amp

9 to 18K colour hard Gold solutions

Solution type - Acid gold solutions producing between 9 and 18K Gold colours, these liquids are normally of a green or blue colouration
Container - Polypropylene, PVC, Glass..
Anodes - Platinum coated Titanium, Connect to the positive output of DC supply.
Temperature- 35 – 40ºC
DC Voltage - 2 – 4 volts. Correct use is by current (amps) voltage is only a general guide.
DC Amps - 0.008 amps per cm² (0.05 amps per inch²).
Time - 45 seconds to 30 minutes (6 minutes per 1 micron).
Heater - Glass or indirect (water jacket).
Agitation - Horizontal or rotary, speed 150 – 300 cm per minutes.
Availability - Usually supplied in solution form.
Make up - Pour into suitable tank, heat to recommended temperature and use.
Operation - Hang articles on copper wire or specialised jigs and racks, clean through an ultrasonic if work is very dirty. Electrolytically clean articles as recommended, wash in water and hang in gold plating solution, connection the work to the negative output of the DC supply.

Thickness of deposit is dependant on 3 factors:

- Solution temperature
- Time
- Current used, expressed as amps per cm2 or amps per square inch

The first two factors are usually fixed by equipment and thickness required, leaving the only variable as the current setting.

As an indication the following is a guide to different single products being plated in a 5 gram per litre Acid Hard Gold solution at 37ºC, operating at 0.008 amps per cm².

Product	Area (cm²)	Thickness (microns)	Current (Amps)	Time (Mins)
Gents Ring	15	3	0.12	18
Ladies Ring	8	3	0.06	18
Brooch	20	2	0.16	12
Watch Bracelet	50	5	0.4	30
Pendant	25	2	0.2	12
Fashion Bracelet	40	5	0.32	30
Earring	6	2	0.05	12

Replenishment – Hard gold solutions rely on gold input from salts rather than soluble anodes. These salts are normally supplied with a small amount of liquid that contains the necessary additions to keep the solution in good working order.

Gold deposited is a function of time and current, normally expressed as amp minutes per gram of fine gold. Therefore by keeping a log of work done, time in the solution, current applied and totals it is easy to determine when replenishment becomes necessary.

9 to 18K colour hard Gold solutions (cont)

If we take the following as our solution conditions.

Volume of solution = 10 litres
Concentration of gold = 5 grams/litre
Total gold content of solution = *50 grams*

Most solutions allow 20% of the gold to be used before efficiency falls. Amp minutes per gram = 30. i.e. 20% of *50 grams* = 10 grams of gold may be used before replenishment, or 300 amp minutes.

LOG

Descriptions	Current (amps)	Time (mins)	Amp (mins)	Total
50 Gents Rings	6.0	10	60	60
40 Ladies Rings	2.40	5	12	72
20 Brooches	3.20	5	16	88
20 Watch Bracelets	8.00	15	120	208
20 Pendants	4.00	5	20	228
20 Fashion Bracelets	6.40	15	96	324

Add 2 x 5 grams of gold as salt plus liquid additive, ie. Equivalent to 300 amp minutes.
Balance to recommence log 24

OPERATIONAL NOTES

The correct jigging of the work pieces need special attention when electroplating thicker deposits. There are two considerations to take into account.

1. Shielding of items from each other. Imagine the plating tank as “spraying” paint at the work pieces from the anodes. If one of the pieces shields another the shielded item would receive less paint and so it is with electroplating. Try and configure the items so they equally face the anodes or pass by the anodes evenly (circular agitation). The use of soft copper wire to hold the items usually does not stop the gold depositing under the wire as long as the wire is not too thick or wound around several times. Wire around an area that is not likely to be in a high wear rate position.
2. Contact with items that are linked in a chain configuration need special attention. Every link is a potential bad connection and as the voltage applied is small (less than 3 volts dc) there will be no current flow to the lower parts of the chain. To overcome this problem, thread a continuous thin soft copper wire through every 3 cms of chain link and tie to the last link. Long items can be looped up and then both ends of the copper wire connected to the cathode rail.

Care of solution.

Gold plating solutions are very vulnerable to contamination so should be kept clean. Filtration is advisable, continually on larger solutions (over 20 litres), occasional through filter papers on smaller solutions.

22 and 24K colour hard Gold solutions

Solution type - Acid gold solutions producing between 22 and 24K Gold colours, these liquids are normally of a pink to purple colouration
Container - Polypropylene, PVC, Glass..
Anodes - Stainless Steel or Platinum coated Titanium, Connect to positive of DC supply.
Temperature- 23—30ºC
DC Voltage - 2 – 4 volts. Correct use is by current (amps) voltage is only a general guide.
DC Amps - 0.008 amps per cm² (0.05 amps per inch²).
Time - 45 seconds to 30 minutes (8 minutes per 1 micron).
Heater - PTFE, Glass or indirect (water jacket).
Agitation - Horizontal or rotary, speed 150 – 300 cm per minutes.

CAUTION - GOLD SOLUTIONS ARE TOXIC. INGESTIONS MAY CAUSE DEATH.

RED GOLD PLATING

This deposit is a high copper content alloy plating process giving 18K Gold composition.
Because the copper content is high it is *vital that the operational conditions are adhered to.*
Digital metering of the volts and amps are vital and test pieces should be done to achieve the correct finish .
The only solution the author has found to be successful in plating deposits over 1 micron and up to 10 microns is specified below and known by the code AL216.

Solution type	-	"AL218" Alkaline gold solution producing 18K Rose Gold colour. pH 10.5 to 13.
Container	-	Polypropylene, PVC, Glass..
Anodes	-	Stainless steel 316 type, Platinum coated Titanium may be used but not necessary Connect to the positive to the output of DC supply.
Temperature	-	58 to 65ºC (60ºC Optimum)
DC Voltage	-	1.3 to – 1.8 volts. Correct use is by current (amps) voltage is only a general guide.
DC Amps	-	0.005 amps per cm² (0.03 amps per inch²).
Time	-	Variable, 4 minutes per 1 micron.
Heater	-	PVC, PTFE, Glass or indirect (water jacket).
Agitation	-	Horizontal or rotary, speed 150 – 300 cm per minutes.
Availability	-	Usually supplied in solution form, Pour into suitable tank, heat to correct temperature.
Operation	-	Hang articles on copper wire or specialised jigs and racks, clean through an ultrasonic if work is very dirty. Electrolytically clean articles as recommended, wash in water and hang in gold plating solution, connection the work to the negative output of the DC supply.

Thickness of deposit is dependant on 3 factors:

1. Solution temperature
2. Time and 3. Current used, expressed as amps per cm2

The first two factors are usually fixed by equipment and thickness required, leaving the only variable as the current setting. It is important to calculate this as guessing will produce an incorrect finish.

OPERATIONAL NOTES
The correct jigging of the work pieces need special attention when electroplating thicker deposits.
There are two considerations to take into account.

1. Shielding of items from each other. Imagine the plating tank as "spraying" paint at the work pieces from the anodes. If one of the pieces shields another, the shielded item would receive less paint and so it is with electroplating. Try and configure the items so they equally face the anodes or pass by the anodes evenly (circular agitation). The use of soft copper wire to hold the items usually does not stop the gold depositing under the wire as long as the wire is not too thick and is not wound around several times. Wire around an area that is not likely to be in a high wear rate position.
2. Contact with items that are linked in a chain configuration need special attention. Every link is a potential bad connection and as the voltage applied is small (less than 3 volts dc) there will be no current flow to the lower parts of the chain. To overcome this problem, thread a continuous thin soft copper wire through every 3 cms of chain link and tie to the last link. Long items can be looped up and then both ends of the copper wire connected to the cathode rail.
3. The alloy is 25% copper so it is advisable to passivate the surface using a cathodic process (see Silverbrite) or flash gild the items using a rose gold solution, these are 95% Gold 5% copper with a red/rose colour.

Care of solution.
Gold plating solutions are very vulnerable to contamination so should be kept clean. Filtration is advisable, continually on larger solutions (over 20 litres), occasional through filter papers on smaller solutions.
Avoid placing the plating machine near the mop polishing plant as the dust will contain metallic particles.

If the colour is too red, too dark or if the layer gets tarnished the copper content in the layer is too high. Reduce the voltage to 1.3 volts and add some Potassium Cyanide (KCN) (5-10 g/l). The cyanide reduces the copper deposition.

The treated surface should not be too small otherwise the setting of the current is difficult. If it is possible to calculate the items surface work with 0,5 - 0,75 A/dm². On larger solutions, over 20 litres, the copper, gold and cyanide content should be analysed occasionally or when problems occur.

CAUTION - GOLD SOLUTIONS ARE TOXIC. INGESTIONS MAY CAUSE DEATH.

COPPER PLATING

Function - To deposit a layer of copper in various thicknesses, usually as an undercoat to other finishes, for example Gold, Silver or Nickel. Two basic types of solution exist.

Cyanide based solutions, use primarily as a thin undercoat to other finishes. This type of solution plates easily over most metals even if the base metal is in a poor condition. Particularly useful when refinishing antique pieces.
Acid Copper solutions are based on Copper Sulphate or Copper Pyrophosphate and are designed for building heavier deposits of copper than cyanide based solutions.
Acid Copper solutions cannot be used directly on steel, zinc or lead based Alloy due to adhesion problems, a cyanide copper under layer is commonly put down first.

Cyanide Copper Solution

Container - Polypropylene, Glass or Stainless Steel.
Anodes - Copper, Stainless Steel may be used on small solutions. Connect to positive output of DC supply.
Temperature- 55 – 65ºC
DC Voltage - 4 – 6 volts.
DC Amperage- 0.03 – 0.05 amps per cm² (0.2 – 0.3 amps/inch²).
Time - 15 – 60 seconds.
Heater - Stainless Steel, glass or indirect (water jacket).
Agitation - Not essential.
Availability - From leading suppliers
Make up - Normally supplied in salt form, dissolve in Demineralised water.
Operation - Process as gilding.

CAUTION – THIS SOLUTION CONTAINS CYANIDE AND IS HIGHLY TOXIC. INGESTION WILL CAUSE DEATH.

Acid Copper Solution (Sulphate type) INCLUDING ELECTROFORMING (see separate pages on electroforming methods.

Container - Polypropylene, PVC or Glass.
Anodes - Pure copper, connect to positive output of DC supply.
Temperature- Room temperature.
DC Voltage - 2 – 4 volts.
DC Amperage- 0.03 – 0.05 per cm² (0.2 – 0.3 amp/inch²).
Time - 1 – 10 minutes.
Agitation - Gentle horizontal movement 250 – 350 cm per minute or vigorous clean air.
Filtration - Continuous on solutions over 50 litres.
Availability - From leading suppliers.
Make up - Supplied ready made in solution form.
Operation - Suspend and clean work in normal way. Use Cyanide Copper if base material is lead based or steel.
Plate for time required to achieve the desired brightness or thickness of copper.

CAUTION - ACID COPPER SOLUTIONS ARE TOXIC. INGESTION MAY CAUSE DEATH.

Acid Copper solution (Pyrophosphate base)

This process is commonly used to electroplate Zinc die-casting's as the solution will not attack the surface This is a very specialist solution and product assistance should be sought from industrial electroplating chemical suppliers.

CHROME PLATING

Chromium plating is not practical on a small scale as specially " smoothed" currents are necessary and normally 3 phase supplies are utilised to achieve this. The solutions are highly toxic, cannot be discharged into the environment without complex treatment and filtration. The gasses and mist given off during the process cannot be discharged into the atmosphere without being cleaned of any chromium residue.

There are no alternative finishes that give the same blue / white deposit as chromium, the following solutions may be used to produce similar colours and hardness.

Nickel: Hard but a faint yellow white colour in the deposit
Rhodium: Almost the same colour as Chrome and hard. Cost is considerably more.
Platinum and Palladium: Hard but slightly less white in colour and have cost issues.
Iridium: White but soft, and expensive.
Silver: Pure white but oxidises readily.
Tin: White in colour and suitable for low wear surfaces, plates bright.

NICKEL PLATING

Function - To deposit a layer of nickel in varying thicknesses upon normally a base metal product. Nickel is unique in the ability to brighten and level dull surfaces to a high degree or lustre. Virtually all base metal jewellery and watch bracelets were nickel plated prior to a precious metal finish but this is now illegal as skin contact with nickel can cause an allergic reaction.

Nickel can be used on products with no normal close contact with skin and for many industrial applications.

There are many types of nickel solutions available, from simple matt deposit types up to modern self levelling/ brightening types. The early matt types are not normally used today in production but are still available for specialist applications from leading suppliers.

It is generally felt that it is impractical to operate a production nickel solution under a size of 50 litres. This is due to the difficulty in keeping a complex solution in balance when of a small size. Small solutions are possible to operate for small bath or research purposes on a "use to exhaustion" and replace basis.

Container - Polypropylene, PVC, Glass or Rubber line steel tanks.
Anodes - Pure Nickel in sheet or oval anode form, in larger installations over 150 litres, the use of Titanium baskets filled with nickel squares or pellets is recommended on a cost basis. All types of anodes must be inside, polypropylene cloth. bags to stop small particles shedding from the anodes and contaminating the solution. Connect anodes to the positive output of the DC supply.
Temperature- 50 – 55ºC
DC Voltage - 3 – 4 volts. DC Amperage– 0.03 – 0.05 amps per cm² (0.2 – 0.3 amps/inch²).
Time - 1 – 20 minutes.
Agitation - Horizontal movement 250 – 350 cm per minutes or air or by pump circulation.
Filtration - Continuous on solutions over 50 litres. Occasional through filter papers for small solutions.
Make up - Usually supplied ready made, but it is possible to make up from salts and liquid brighteners.
Operation - Suspend and clean work in the normal way. If products are steel, lead based or have been soft soldered, it is strongly recommended to use a thin copper deposit before nickel plating. Plate for desired time to achieve finish required. After plating swill thoroughly in clean water and then go to final finishes as quickly as possible.

Nickel plated products that have been in storage or have been delayed after plating may exhibit the problem of passivity, this shows by streaking and non-uniform appearances after final finish. This can be cured by re-electrolytically cleaning for 15 seconds, or using a dilute (10%) Sulphuric Acid and water mix, merely immersing the nickel plated goods for 10 seconds, washing in water and then going to final finish.

NOTE
There are Nickel Sulphamate solutions available for use in Electroforming to produce low stress thick deposits. Solutions and information is available from electroplating chemical suppliers.

PLATINUM GROUP METAL ELECTROPLATING.

The Platinum group metals (PGM) electro deposit white and dark Grey / black finishes, depending on the solutions.
These are the types in general use. Iridium and Osmium can also be electroplated for specialist applications

Palladium: Slightly less white than Platinum with similar properties. Palladium Nickel alloy solution available.
Platinum: White hard finish of pure Platinum
Rhodium: Whitest of the PGM's plus grey—black hard deposits are available.
Ruthenium: Dark grey—black deposits
Iridium and Osmium can also be electroplated for specialist applications.

PALLADIUM PLATING

Function - To deposit a very thin layer of pure Palladium metal over the surface of a metal article. Used as a final finish and also as a barrier layer between Gold plate and copper alloys to stop the migration of the Gold into the copper base.

Container - Polypropylene, PVC or Glass.
Anodes - Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature- 20—35ºC
DC Voltage - 1.5 – 2.5 volts.
DC Amperage- Irrelevant
Time - 5 – 15 seconds.
Agitation - Occasional sharp movement to dislodge gas bubbles formed on surface.
Make up - Ready made
Filtration - Occasional filtering through filter papers is adequate on small installations.
Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended, wash in water and Palladium plate as directed. Palladium solutions are sensitive to contamination, good cleaning is essential to preserve the quality of finish. Any article or wire dropped into the solution must be removed promptly.
Plating Voltages - To avoid dark deposits and poor coverage, attention to the voltage applied is important. Plate at different voltages for various products. Figures below apply to voltages when the work is in the tank and connected to the DC supply.

Product	Voltage	Time (seconds)
Ring top and claws only	1	5
Ring top and shoulders	1.5	5
Complete Ring	2	10
Bracelet	2..5	15

Other products can be calculated from the above table.

PLATINUM GROUP METAL ELECTROPLATING. Cont.

PLATINUM PLATING

Function - To deposit a very thin layer of pure Platinum metal over the surface of a metal article. Used as a final finish on Platinum, as the deposit is 99.9% + and white.

Container - Polypropylene, PVC or Glass.
Anodes - Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature- 20— 60ºC
DC Voltage - 2.0 – 6.0 volts.(3.0—4.5 volts optimum)
DC Amperage- Irrelevant for flash plating
Time - 5 – 15 seconds.
Agitation - Occasional sharp movement to dislodge gas bubbles formed on surface.
Make up - Ready made
Filtration - Occasional filtering through filter papers is adequate on small installations.
Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended, wash in water and Platinum plate as directed. Platinum solutions are sensitive to contamination, good cleaning is essential to preserve the quality of finish. Any article or wire dropped into the solution must be removed promptly.
Plating Voltages - To avoid dark deposits and poor coverage, attention to the voltage applied is important. Plate at different voltages for various products. Figures below apply to voltages when the work is in the tank and connected to the DC supply.

Product	Voltage	Time (seconds)
Ring top and claws only	2.0	5
Ring top and shoulders	2.5	5
Complete Ring	3	10
Bracelet	3.5	15

Other products can be calculated from the above table.

PLATINUM GROUP METAL ELECTROPLATING. cont

RHODIUM PLATING, WHITE

Function - To deposit a very thin layer of pure Rhodium metal over the surface of a metal article. Used as a final finish on nearly all white gold and platinum goods due to the unattractive colour of these precious metals. Other uses are on silver jewellery as a tarnish preventative and for quality improvement, on watch bracelets and costume jewellery over nickel plating and in the electronics industry as a wear resistant surface on contacts. Rhodium is an extremely hard metal and is virtually unaffected by any chemicals. It is impossible to remove Rhodium from a surface by chemical means, polishing away with abrasive compositions is sometimes possible.

Operational data is based on the Legor product Rhodium RH2M. Check data sheets for other products

Container - Polypropylene, PVC or Glass.
Anodes - Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature- 20—60ºC (Optimum 40—60ºC)
DC Voltage - 2 – 6 volts. (Optimum 3.0—4.5 volts)
DC Amperage- Irrelevant for flash plating
Time - 5 – 15 seconds.
Agitation - Occasional sharp movement to dislodge gas bubbles formed on surface.
Make up - Normally supplied ready to use.

Filtration - Continuous on high use solutions over 50 litres only. Occasional filtering through papers is adequate on small installations.

Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended, wash in water and Rhodium plate as directed. Rhodium solutions are sensitive to contamination, good cleaning is essential to preserve the quality of finish. Any article or wire dropped into the solution must be removed promptly.

Plating Voltages - To avoid dark deposits and poor coverage, attention to the voltage applied is important. Plate at different voltages for various products. Figures below apply to voltages when the work is in the tank and connected to the DC supply.

Product	Voltage	Time (seconds)
Ring top and claws only	2	5
Ring top and shoulders	2.5	5
Complete Ring	3	10
Locket	3.5	10
Bracelet	5	15

Other products can be calculated from the above table.

Maintenance

When the solution fails to deposit Rhodium correctly at the above voltages, add Rhodium concentrate at a rate of 1 gram (as solution) per litre of solution.
When poor coverage is evident the solution changes to a light brown colour from mid-brown. This can also be used as a guide to solution strength.
If the bath produces poor results after Rhodium additions, it is usually a sign of organic contamination. To rectify this, add 25 grams per litre of pure carbon powder, stir and leave heated for 1 hour.
Allow solution to settle and filter or decant clear liquid into container and re-use. Discard carbon as this has absorbed the organic contamination.

PLATINUM GROUP METAL ELECTROPLATING. cont

RHODIUM PLATING WHITE cont.

Care must be taken with Rhodium plating chains to achieve an even finish
Contact with items that are linked in a chain configuration need special attention. Every link is a potential bad connection and as the voltage applied is small (less than 3 volts dc) there will be no current flow to the lower parts of the chain. To overcome this problem, thread a continuous thin soft copper wire through every 3 cms of chain link and tie to the last link. Long items can be looped up and then both ends of the copper wire connected to the cathode rail.

Rhodium solutions are very vulnerable to contamination from both dragged in liquid contamination and dust.

Keep the solution covered when not in use and do not locate the bath near to polishing motors as the dust produced is metal contaminated, causing the Rhodium plate to become dark, particularly is shielded and recessed areas.

Some non metallic contamination can be removed by a carbon treatment and filtration of the solution.

Rhodium solutions must be topped up with demineralised / distilled / de-ionised water only. Tap water must not be used as it may contain hard water salts and Fluorine / Chlorine additives which are detrimental to the solution and Platinum coated anodes.

RHODIUM PLATING, BLACK

Function - To deposit a thin layer of Anthracite black Rhodium metal over the surface of metal articles. Used as a final finish on precious and base metals.

Operational data is based on the Legor product Rhodium RH2B solution. Check data sheets for other products

Container	-	Polypropylene, PVC or Glass.
Anodes	-	Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature	-	25—35ºC (Optimum 30ºC)
DC Voltage	-	1.8 – 3.0 volts. (Optimum 2.5 volts)
DC Amperage	-	Irrelevant for flash plating
Time	-	5 – 15 seconds.
Agitation	-	Moderate to dislodge gas bubbles formed on surface.
Make up	-	Normally supplied ready to use.

Other operational and maintenance information is the same as for White Rhodium.

CAUTION - THESE SOLUTIONS ARE TOXIC. INGESTION MAY CAUSE DEATH.

There are also Rhodium solutions that produce a blue colour deposit. These are very specialised solutions and require considerable skill to operate. Most distributors can provide information on this process.

PLATINUM GROUP METAL ELECTROPLATING. cont

RUTHENIUM PLATING, GREY

Function - To deposit a very thin layer of pure Ruthenium metal over the surface of a metal article. Used as a final finish on specialist products that require a unique titanium grey effect and on copper plated costume jewellery.
It is virtually impossible to remove Ruthenium from a surface by chemical means, polishing away with abrasive compositions is sometimes possible.

Operational data is based on the Legor product Ruthenium RU5GRAY. Check data sheets for other products

Container - Polypropylene, PVC or Glass.
Anodes - Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature- 50—70ºC (Optimum 60ºC)
DC Voltage - 1.8 – 2.2 volts. (Optimum 2.0 volts)
DC Amperage- Irrelevant for flash plating
Time - 5 – 15 seconds.
Agitation - Vigorous to dislodge gas bubbles formed on surface.
Make up - Normally supplied ready to use.

Filtration - Continuous on high use solutions over 50 litres only. Occasional filtering Through papers is adequate on small installations.

Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an Ultrasonic cleaning machine if very dirty.
Electrolytically clean articles as recommended, wash in water and Ruthenium plate as directed. Ruthenium solutions are sensitive to contamination, good cleaning is essential to preserve the quality of finish.
Any article or wire dropped into the solution must be removed promptly.
Plate at different voltages for various products, lower for small items, increase for larger items.

RUTHENIUM PLATING, BLACK

Function - To deposit a layer of Black Ruthenium metal over the surface of a metal article. Used as a final finish on specialist products that require a hard gloss black finish.

Operational data is based on the Legor product Ruthenium RU5BLACK-X. Check data sheets for other products.

Container - Polypropylene, PVC or Glass.
Anodes - Platinum or Platinised Titanium. Connect to positive output of DC supply.
Temperature- 65—70ºC (Optimum 65ºC)
DC Voltage - 2.0 – 5.0 volts. (Optimum 3.5 volts)
DC Amperage- Irrelevant for flash plating
Time - 5 – 15 seconds.
Agitation - Moderate to dislodge gas bubbles formed on surface.
Make up - Normally supplied ready to use.

Operation and other data is the same as Ruthenium RU5GREY.

SILVER PLATING

Function - To deposit a layer of silver on the surface of an article. Used extensively in the plate industry, deposition is normally on copper, brass or nickel plated bases. Much use is made of this solution in the jewellery industry as a final finish in Sterling Silver or costume jewellery. The major advantage of deposited silver is its strong whiteness, far superior to alloyed silvers, and where necessary, the ease of rouge polishing for very high lustre.
Solutions fall generally into two categories:
Light deposit solutions for thin 'colour' deposits on alloyed silver or nickel plated products.
Heavy deposit solutions produce deposits from 1 to 100 microns thick, usually used in the Silver-plate industry. The deposit from these heavy solutions usually requires some mechanical polishing after process when thicknesses in excess of 10 microns.

Light Deposit Solutions (Strike solutions)

Container - Polypropylene, PVC, Glass or Stainless Steel.
Anodes - Stainless Steel. Connect to positive output of DC supply.
Temperature- Room temperature
DC Voltage - 5 – 7 volts
DC Amperage- 0.05 – 0.08 amps cm² (0.3 – 0.5 amps/inch²).
Time - 5 – 15 seconds.
Agitation - Gentle hand movement.
Make up - Dissolve salts in required amount of water, stir and use.
Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended, wash in water and silver plate as directed. This process applies if the solution is to be used as a final finish or as an undercoat to heavier deposits on plate or nickel plated goods.
Replenishment - Add salts at rate of 10 grams/litre when deposit is discoloured.

Heavy Deposit Solutions including ELECTROFORMING (see separate pages on ELECTROFORMING)

Container - Polypropylene, PVC or Glass.
Anodes - Silver or stainless steel, Silver anodes should be used on a high throughput plant because of solution balance and economy. Silver anodes must be pure silver and not alloyed. Connect to positive output on DC supply.
Temperature- Room temperature.
DC Voltage - 1 – 3 volts
DC Amperage- 0.01 – 0.03 amps per cm². (0.06 – 0.02 amp/inch²).
Time - Approx 1 micron in 90 seconds, up to 20 microns.
Agitation - Horizontal or rotary 150 – 300 cms per minute. Pump agitation with inductors.
Make up - Supplied in liquid or salt form.
Filtration - Continuous on solutions over 100 litres. Occasional on smaller solutions, using pumps or filter papers.
Operation - Hang articles on copper or brass wires, jigs or racks. Clean through an ultrasonic cleaner if very dirty. Electrolytically clean articles as recommended, wash in water and process through light deposit solution as previously described if the products are nickel plated or made of copper. Place in heavy silver bath and process as directed.
For medium thicknesses, plate for 5 minutes. Finish using rouge and a soft polishing mop if necessary.

Replenishment - Should be done by analysis only.

CAUTION -SILVER SOLUTIONS CONTAIN CYANIDES AND ARE HIGHLY TOXIC. INGESTION WILL CAUSE DEATH.

SELECTIVE PLATING (STOPPING OFF)

Function - In the jewellery trade it is necessary to deposit a metal (usually Rhodium) to a selective area. A good example of this is a yellow gold ring and white gold setting. This technique can also be used to effect on medals, pendants and bracelets for decoration to produce multi-coloured appearances.

Availability - Stopping off lacquer,
Stopping off remover.
Stopping off lacquer pen.

Operation - Pour a small amount of lacquer into a bottle cap or little container. After ultrasonic cleaning and drying, paint the lacquer onto any area that you do not wish to plate on. Leave to dry for preferably one hour, or less with some gentle heat.
Electrolytically clean and plate as directed ensuring you have a good electrical contact on your work.
Remember to allow for the area that has been stopped off when doing area and current calculations.
Wash work in water and shake off excess. Immerse article in thinners or acetone to remove lacquer and re-dry.
In the absence of the correct lacquer and thinners, nail varnish can be used. Although inferior to the correct material because of weak adhesion, nail varnish is Acceptable.

NOTES.

ELECTROFORMING

Theory

Electroforming is a manufacturing process in which a layer of metal thick enough to be self supporting is electrolytically deposited into a mould or over a “mandrel”.
The thickness can be from 50 to 2000 microns.
A permanent mandrel normally stays inside the electroform, this type of mandrel can be a natural product like a 3D printed item or even a leaf or flower.
A removable mandrel is often made from a wax or low melting point metal which is then removed by melting of dissolving.
A separate mandrel is usually used many times and is used for the manufacture of items that will physically split from the mandrel, ie Vinyl records and hologram tools.

The surface of the mandrel must first be made electrically conductive. This is done by spraying or painting a conductive lacquer containing finely dispersed particles of metal or graphite onto the surface of the non-conductive mandrel.
Other methods of making the surface of plastics etc. conductive include chemical reduction of silver from the nitrate salt, or by vacuum deposition but these are more difficult and involve complex chemistry.
Separate mandrels offer a more accurate reproduction and a higher quality of finish. Frequently stainless steel (F316) is used, which like all metal mandrels, must have its surface made passive. Otherwise the electroform will adhere to the surface, thus preventing its removal.
Porous materials should be sealed before applying the conductive paint.
Moulds are made from a variety of 3D printing, resins and RTV cold curing rubber. Great care should be taken when choosing the mould material as certain resins such as body fillers and heat curing silicone rubbers can contaminate the electrolyte.

Operation

After being made conductive and the initial coating having hardened, the mandrels or moulds are hung on plastic coated brass or copper plating jigs with only the parts connected to the mandrel and the cathode bar and placed in the plating bath.

The electrolyte is either an alkaline or acidic solution of the metal to be deposited, together with other chemicals to improve the surface finish. Anodes, made from this metal, provide both the electrical circuit and also the source of replacement metal ions, removed by deposition.
The anodes are enclosed in bags made from woven polypropylene to prevent particles of metal from being deposited on the mandrel surface which might cause the formation of nodular growth.

The solution has to be continuously agitated by rotational or horizontal movement of the cathode bar on which the jig is hung, or by pump circulation. Air agitation can be used with acid copper solutions but not with alkaline silver solutions. This is necessary for maintaining a constant concentration of metal ions, (electrically charged particles), adjacent to their surface.
Continuous filtration is also required for that reason and for the removing of contamination such as air borne dust and any other particles in the solution. a filter pump with a 5 or 10 micron filter element should be used. However, the use of agitation is delayed until a true metal surface is established, as the conductive lacquer is very delicate.

A rectifier with digital metering will provide the accurate setting of the current (amps) supply necessary for successful electroforming.

The surface area to be electroformed defines the size of the tank and the DC supply.

Solution replenishment is necessary to maintain the chemical balance of the solution. The metal anode will keep constant the metal concentration in the solution but brighteners and additives have to be added at the recommended rate.

ELECTROFORMING SEQUENCE.

Preparing the piece

1. Suspend the piece to be electroformed on insulated copper wire or a hook ensuring that the piece is held firmly and the metal wire core will be in contact with the area to be coated and the cathode bar.
2. If the piece is very porous, spray or paint the surface with a lacquer or primer paint or dip in a Shellac solution to seal the surface and to avoid the excessive use of the conductive paint by absorption into the surface.

Fabrics, leaves and grasses that may wilt can be stiffened by immersion in a saturated solution of Shellac and Methylated spirit or Methyl Alcohol. Allow to dry before proceeding.

Metalising the surface of the piece

1. Painting by brush.

Use the conductive paint directly from the container without the addition of paint solvent, ensuring that the paint comes into contact with the copper wire.
Leave for at least 2 hours at room temperature or 30 minutes at up to 70º C.

2. Painting by spraying

Dilute the conductive paint with 4 times the amount of solvent and spray the area to be electroformed VERY LIGHTLY and allow to dry for 10 minutes, apply another coat and leave to dry for a further 1 hour.
It is preferable to spray several light coats of conductive paint than to try and spray one coat, several light coats uses less conductive paint and produces a finer surface to electroform on to.

Electroforming the piece

1. Calculate the area to be electroformed, ie the area that is coated in conductive paint plus any wire or hook areas. It is not essential to be highly accurate in this calculation + or - 5% does not matter.

The following calculations a re based on typical Copper and Silver solutions, other solutions may require different currents so it is important to read the operational instructions for other solutions.

2. Multiply the area by the relevant factor to give you your TARGET current.
Copper Electroforming: Area in square centimetres x 0.05 = TARGET current
Copper Electroforming: Area in square inches x 0.33 = TARGET current
Silver Electroforming: Area in square centimetres x 0.015 = TARGET current
Silver Electroforming: Area in square inches x 0.1 = TARGET current
Check that you have the decimal point in the right place, most errors in calculation are a factor of 10.

3. Ensure that your solution is at the correct temperature and that the rectifier (Power supply) control is turned to zero, ie Voltage and Amperage reads zero. If a filter pump is fitted, switch the pump on 10 minutes before you intend to start processing and leave running at all times when you are in process.

4. Suspend the piece to be electroformed into the solution and IMMEDIATELY turn the rectifier control to a current of 25% of the TARGET current.
After about 10 minutes, increase the current to 50% of the TARGET current.
After a further 10 minutes increase the current to your TARGET current.

5. Continue the process, occasionally checking that the TARGET current is correct, until the desired thickness has been achieved.
Rate of deposition at the above TARGET currents.
Copper Electroforming =1 Micron in 2.5 minutes (24 microns per hour)
Silver Electroforming = 1 Micron in 1.25 minutes (48 microns per hour)
Note: 1000 microns = 1 millimetre
Normal thickness' used in electroforming are between 50 and 1000 microns depending on the degree of physical strength of the metal coating required and the finishing techniques to be used afterwards. Allow extra thickness' if the pieces are to be coloured or polished.

TARNISH PREVENTION of SILVER, COPPER and LOW CARAT GOLD

The Discolouration of Silver and Copper items is due to the formation of oxides and Sulphides forming on the surface. There a 3 basic methods to slow or stop this process up.
required, in particular,

1. ELECTROPHORETIC COATING. This is the application of a polymer over the product surface deposited electrolytically to produce a sealed surface after curing the polymer in a heated oven. The plant required is complex and the operation requires laboratory support and generally is outside the facilities that a small manufacturer has.?
2. IMMERSION PROCESSES. There are a variety of immersion products available in the market. They work reasonably well but are prone to weaken with any handling.
3. ELECTROLYTIC METHOD. This process will passivate the surface of the products with an invisible film, preventing the formation of oxides and sulphides by restricting contact with the air. The process uses a conventional electroplating system although no metals are deposited..

ELECTROLYTIC METHOD using the SILVERBRITE process

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Container - Glass, Polypropylene, PVC

Anodes - Stainless Steel, connect to positive output of DC supply.

Temperature- Room temperature

DC Voltage - 3 – 4 volts. DC Amperage— Not relevant

Time - 60 to 90 seconds.

Agitation - Gentle horizontal agitation if articles lie together.

Make-up - Dissolve salts in required amount of water, stir and heat to recommended temperature.

Operation - Hang articles on copper, brass or stainless steel wires, jigs or racks. Clean through an ultrasonic cleaning machine if very dirty. Electrolytically clean articles as recommended in the CLEANING SECTION . Wash in water and process by Connecting the work to the negative output of your DC supply.

Rinse the items in water and dry using warm air, do not use very hot water or abrasive cloths.

This process should prevent oxidation for many months in storage ot on display. Excessive handling can weaken the resistance to oxidation but the process can be applied several times if necessary.

CAUTION - SILVERBRITE SOLUTIONS ARE TOXIC.

COLOURING of SILVER AND COPPER PRODUCTS.

Copper, Silver and their alloys can all be coloured by the formation of oxides on the surface to give many antique and other effects.
There are many formulations to achieve these effects, illustrated below are some of the most popular.

PLATINOL
This process produces grey to black deposits at room temperature with almost no odour.

OPERATION.
PLATINOL is used directly from the bottle without heating.

Pour a small amount from the bottle into a PLASTIC container, NOT METAL as this will cause the PLATINOL to decompose giving off a dangerous gas with some metals.

Clean the item to be oxidised in an ultrasonic, electrolytic cleaning bath or scrubbing with detergent. It is important not to have any oil, grease, lacquer or polishing compound on the surface or this may result in a patchy finish.

Using either immersion or a brush to cover the area of Silver, Silver plate or Copper with the liquid for a few seconds.
Rinse in water and relieve back if necessary to expose the base colour of the metal.

DO NOT POUR THE USED SOLUTION BACK INTO THE ORIGINAL BOTTLE,
This will shorten the life of the solution. The used PLATINOL solution can be used over and over again but keep it separate from unused solution in a plastic container with an air tight lid.

HEALTH and SAFETY
PLATINOL is a low risk corrosive material but sensible precautions are advisable, please refer to the PLATINOL Health and Safety data sheet for fuller details. Do not drink. Do not mix with acids. Wear gloves and eye and skin protection, avoid breathing the fumes, keep away from children and pets. Label bottles correctly.

STORAGE
PLATINOL has a long shelf life if it is kept in a sealed plastic container away from sunlight. A cool dark environment helps prolong the operational life of the liquid.

SULPHIDE BASED LIQUIDS, Ammonium Polysulphide types.

These solutions are used at 6 to 25 mls per litre at room temperature for colouring Copper and at 65°C for Silver products. The process may liberate Hydrogen Sulphide (rotten egg) when heated.
The heating container should be Glass or stainless steel.

OPERATION
The items are cleaned to be free of oils or grease and then immersed in the liquid for the required time. The process time depends on the solution temperature and the age of the solution.
Agitate in the tank to ensure uniformity of colour.

After washing and drying, articles can be “relieved” using brass wheels, “Scotchbrite” or other mild abrasives.
Theses solutions do not store well and are best discarded after use.

PROCESS SEQUENCES (TYPICAL)

Product – White gold wedding ring
Finish required – Rhodium plated. Previous work carried out – Resized, pickled and polished

Operation
Ultrasonic clean, 2 minutes, Water rinse
Electrolytically clean 20 seconds, 5 volts
Water rinse (twice)
Rhodium plate 10 seconds, 3 volts, Water rinse and dry

Product – 9K charm bracelet
Finish required – 18k uniform colour
Previous work carried out – new charms added, pickled and barrel burnished for 30 minutes

Operation
Electrolytically clean 20 seconds, 5 volts, Water rinse
Gild in 18k solution, 15 seconds, 7 volts
Water rinse and dry

Product – Silver charms in cast form
Finish required – Bright and white. Previous work carried out – Casting sprue removed

Operation
Electrostrip 45 seconds, 8 volts, Water rinse
Barrel burnish 2 hours. Water rinse
Electrolytically clean 20 seconds, 5 volts. Water rinse
Silver plate 1 minute, 2 volts. Water rinse and dry

Product – Medals made from stamped gilding metal or brass.
Finish required – Bright hard gold plate. Previous work carried out – hand polished

Operation
Ultrasonic clean 2 minutes. Water rinse
Electrolytically clean 20 seconds, 5 volts. Water rinse
Nickel plate (optional) 5 minutes, 3 volts. Water rinse
Gold plate 2 minute, 3 volts. Water rinse and dry

Product – Lead based clock case.
Finish required – deep yellow gilt. Previous work carried out – old lacquer and polish
Removed, hand polished where brightness required.

Operation
Ultrasonic clean 3 minutes. Water rinse
Electrolytically clean 1 minute, 5 volts. Water rinse
Copper plate (cyanide only or cyanide and acid copper plate) 4 minutes, 3 volts
Water rinse
Gild in 22k solution 20 seconds, 7 volts. Water rinse and dry

Note: It is possible to polish the copper deposit before applying the Gold plate. If polishing at the copper stage take care not to polish through the copper. If so, to return to stage 1, work through the sequence ensuring the whole surface is a copper colour.

TECHNICAL DATA

WEIGHT CONVERSION
1 ounce troy = 31.105 grams
1 ounce Avoirdupois = 28.35 grams
1 kilogram = 1000 grams = 32.149 ounces Troy
1 kilogram = 1000 grams = 35.27 ounces Avoirdupois

VOLUMETRIC
Density of Fine Gold = 19.32 grams per cubic centimetre.
Density of Fine Silver = 10.50 grams per cubic centimetre.
Density of pure Platinum = 21.50 grams per cubic centimetre.

MELTING TEMPERATURES (Typical)

9K Yellow Gold	880ºC	0.850 Silver	857ºC
9K White Gold	940ºC	0.925 Silver	893ºC
14K Yellow Gold	879ºC	Fine Silver	961ºC
18K Yellow Gold	927ºC	Platinum	1773ºC
18K White Gold	943ºC		
22K Yellow Gold	1000ºC		
Fine Gold	1062ºC		

TEMPERATURE CONVERSION
Centigrade to Fahrenheit = ºC multiplied by 1.8, then add 32.
Fahrenheit to Centigrade = ºF subtract 32, multiply by 0.555

VOLUME
RECTANGULAR CONTAINER
Length x width x liquid height (in centimetres) = volume in cubic centimetres (cc), divide by 1000 to convert to Litres
Length x width x liquid height (in feet) = volume in cubic feet, x by 28.4 to convert to Litres
CYLINDRICAL CONTAINER
Diameter x 3.14 x liquid height (in centimetres) = volume in cubic centimetres (cc)
Diameter x 3.14 x liquid height (in feet) = volume in cubic feet
Volume in cubic centimetres (cc) divided by 1000 = litres
Volume in cubic feet x 6.23 = imperial gallons
1 Gallon (imperial) = 4.546 litres
1 inch = 2.54 centimetres, 1 foot = 30.48 centimetres

IN CONCLUSION

Chemical finishing techniques require knowledge gained from practical working, this publication contains the basic necessary data to achieve good results. Further skill is best obtained by actually operating the processes, coupled with more detailed reading of the individual processes involved.

Health and safety should always be in the finishers mind, most processes are safe if handled with thought and proper equipment.