Guide to Using the Reactive Metals©

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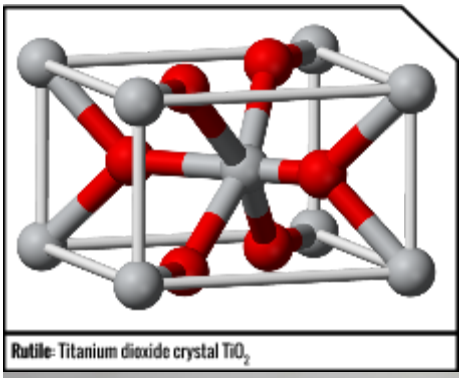
During the past decades there has been a steady growth in the use of the reactive metals in jewelry and art. Within this group of metallic elements the most common are titanium and niobium. **Titanium** remains the most popular for commercial jewelry, followed by an expanding use of niobium. **Niobium** is both more ductile and more colorful. These metals can be cut, formed and finished with standard hand and power equipment. The high colorations can then be achieved through a simple anodizing process.

Note: In the following discussion of the techniques and processes for preparing and coloring these metals, titanium (**Ti**) will be used as the reference metal with notes to any variation as they apply to niobium (**Nb**)

Introduction to the reactive metals


Rutile: Titanium dioxide crystal TiO_2

Titanium [Ti_{22}]

Titanium is the fourth most abundant structural metal and ninth most common element in the earth's crust. It is refined from rutile (TiO_2) ores mined in the United States, Australia, Africa, China and Russia. Rutile is most commonly recognized as the gold color fibrous crystals in rutilated quartz. Ti metal weighs 45% less than steel and melts at 3,045°F. Ti can be TIG and MIG welded in inert gas. Fusion welders are used to attach ear posts and other findings. In most applications, rivets, nuts and bolts, and bezels are used for mechanical joining. Ti cannot be soldered in a studio situation, but can be laser welded. A smooth inert oxide film is present on the surface of the metal and it resists solders.

Due to its high strength (especially the alloys) and light weight, Ti has many applications in the aerospace industry. Excellent corrosion resistance makes this metal highly desirable for chemical and food processing, also bone replacement and other body implants. This hypoallergenic metal is safe for sensitive wearers.

Titanium is available in over 30 standard grades and alloys. Grade #1, commercially pure (CP) Ti is the best suited to jewelry applications. It is ductile and surprisingly slow to work harden. Although the other alloys and less pure grades, such as Grades #5 & #23 will color, they are too hard for jewelry work and are most commonly machined instead.

For body jewelry: Unalloyed Ti should be compliant to ASTM F67 Standard for Surgical Implant Applications, and Grades 5 or 23 must be compliant to ASTM F136. Other alloys with **ASTM** or **ISO** specifications for surgical implant may also be used, such as ASTM F1713, Ti alloyed with Nb and Zirconium, or ASTM F 1295 which is Ti alloyed with Nb and Aluminium.

Note: Ti needs to be freshly polished or etched to produce its most vivid colors.

⚠ **Do not etch skin wear surfaces for body jewelry without extreme precaution!**

Titanium may be either hot or cold forged. At approximately 1640°F Ti goes through a structural phase change and becomes very ductile. As it drops below this temperature it will suddenly harden. The main disadvantage to hot work is the build up of very tough surface oxides. These are dark and may extend deep into the metal surface. They must be ground off and the surface finished before coloring.

Cold forging can be a very rewarding technique. Grade #1 metal will feel very firm under the hammer but it will continue

to move over a very long range. Often a simple design can be completed in a single forging without need to stop, anneal, and clean. Annealing requires inert gases or hard vacuum.

Niobium [Nb_{41}]

Niobium (formerly Columbium) is a light gray, very ductile and highly colorable metal weighing about twice as much as Ti. It is used in electrical devices, high temperature alloys (melting point 4,475°F), chemical handling and superconducting alloys.

Niobium is extremely ductile and slow to work harden. Cold forging can be very fast. Simple die forming can be done with masonite dies and even wood tools. Its formability, price and very broad coloring range make it the friendliest of the reactive metals for jewelry.

For body jewelry, there exists a body of evidence indicating that pure Niobium (Nb) seems inert and well accepted by the human body, along with titanium, tantalum, zirconium, pure refined gold, and platinum as the six most biocompatible elements. Although used in numerous surgical implant alloys Nb has not been used widely by itself for surgical implants, because of its softness. Tantalum, its closest elemental neighbor is a common surgical implant material in use today and makes jewelry that is beautiful to begin with, but the surface finish is easily marred by fingerprints, dirt and grime and is also much softer than Nb.

Interference colors

The colors produced by these metals are known as interference colors. There are no pigments or dyes involved. They are generated by a transparent oxide film grown on the metal surface. The colors develop when part of the light striking the surface reflects and part passes through the film to reflect off the metal below. When the delayed light reappears and combines with the surface light waves they may either reinforce or cancel. This generates a specific color. The thickness of the oxide film dictates the color. In nature these colors can be found in the eddies of an oily wet street and in the iridescent colors of some insects.

Surface preparation and forming

All forming and surface finishing must be done before coloring. Most surface finishing techniques can be adapted to these metals. Die cutting, bending, stamping and surface textures can be achieved with standard tools. Work can be vibrated, tumbled, sanded and polished. Finishing will be more time consuming than with traditional metals. Consideration should be given to sanded and textured surfaces. Light gathering scratches and marks will add flash and variety to the work. Textured surfaces also add some protection against abrasion.

Chemical etching

Unpolished Titanium requires a chemical etch to prepare the surface for high voltage anodizing. Multi-Etch is available in the current Reactive Metals catalog and provides an excellent alternative to hazardous acid solutions. The basic commercial etching solution is: 3% Hydrofluoric acid plus 30% Nitric acid in water. No acid finishing is required by niobium.

⚠ **Note: All chemicals should be used under strictly controlled conditions.**
Hydrofluoric is an insidious acid and requires special handling equipment, safety precautions and disposal.

⚠ ***DO NOT etch** wear surfaces of body jewelry without extreme precaution, as it may make them rough.

Forming

Tools of hardwood, nylon and steel can be used to dap, bend, chase, texture and form Grade #1 annealed Ti and Nb. Nb will easily die form and may be chased or repousséd. Surface textures can be cut with a flex shaft, sandblasted and engraved. Roll printing is most effective with Nb. (Protect the rolls with copper or brass when roll printing Ti.)

Both metals require lubrication when drilling and machining. The low thermal conductivity of Ti can cause heat to build up and damage cutting tools. Use cutting oil or soapy water as a lubricant to lengthen tool life.

Coloring

Coloring can be achieved in two ways; thermal oxidation and electrolytic oxidation (anodizing). Both processes do essentially the same thing. Through electron excitation, the metals react with oxygen to form a thin transparent film. Thermal oxidation (heat coloring) is simple, but difficult to control. Anodizing is infinitely more predictable and is the only effective way to color niobium.

The colors produced appear in up to five repeating orders. Most of the current jewelry is produced with the first two orders. All the colors of the light spectrum are not produced. True red and forest green are not generated.

When the oxide is of a thickness to generate interference colors, its depth is measured in angstroms (Å=1/100,000,000 centimeter). This layer can vary in thickness from 500 to 1,000Å+ depending on the color. It is not the oxide itself that is perceived by the viewer but its effect on light.

Although harder than the parent metal, the extreme thinness of this oxide dictates that it is not a strong wearing surface. Bracelets, belt buckles, rings and items that normally receive heavy abrasion should not be considered unless the metals are protected by other design elements.

Thermal oxidation

This is the type of coloration that most metalsmiths start with on Ti because no special equipment is necessary. At temperatures as low as 640°F Ti will begin exhibit its first golden colors. Then, with increasing temperature and time, a variety of hues will appear. A torch or small kiln can be used.

Throughout the thermal coloring process cleanliness is an absolute necessity. Dirt, dust, oil and fingerprints will discolor the oxide as it is growing. It is possible to contaminate the surface for special effects. Refinishing a piece that has discolored during the heating operation is difficult and time consuming.

Black Niobium

Niobium does not heat color. When heated to a dull red and held for 10-15 seconds it will produce a tough gray/**black** oxide. This is a very hard finish and works well in many applications where a black metal is desirable. The piece must be formed first because heating hardens the metal. The black oxide can be polished, waxed and even engraved and anodized. Quenching in grape seed oil followed by polishing can result in a look similar to hematite.

⚠ ***DO NOT engrave** wear surfaces of body jewelry because it will make them rough.

Flame coloring

Here a torch becomes the artist's brush. A free painterly approach to the work is necessary as precise effects and color control are difficult. Softly shaded washes of color and some rainbow effects can be generated with a little practice. Almost any torch will do, as the temperatures required are not high. Large soft flames will produce areas of even color. A small hot flame will generate rainbows of color radiating out from a point.

Kiln coloring can be done in a standard enameling kiln. Running at temperatures between 800° and 1,200°F, a few minutes in the kiln will produce golds, purples and blues. Actual temperatures and times will relate to the size and thickness of the metal. Solid one color pieces can be produced with this method.

Anodizing

Anodizing most closely resembles standard electroplating. When a reactive metal is suspended in a electrolytic bath as an anode(+) and current is passed through the bath, oxygen is produced at the anode surface. This oxygen reacts with the metal to form a thin oxide film that generates colors. The transparent oxide increases in thickness in relation to the amount of voltage applied. At any given voltage the oxide will grow to a specific thickness (i.e. color) and stop, having reached a stage where current will no longer pass. This phenomenon of voltage controlled growth means that the color is also voltage controlled.

An area of oxide produced with a high voltage will not pass current from a lower voltage. In other words an area anodized at 60 volts will not need masking when an adjacent area is anodized to 40 volts. It follows that multiple anodizing processes should proceed in decreasing voltages. Working in descending order will save masking and generate fewer errors.

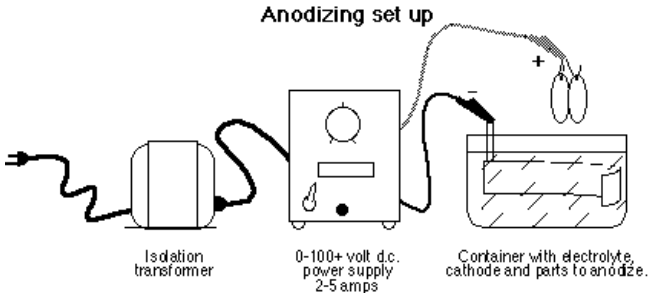
While oxygen is generated at the anode(+), hydrogen is formed at the cathode(-). Titanium and stainless steel make most convenient cathodes. This process does not have much throwing power and it is necessary to have a cathode equal to or larger than the anode, and to have the anode close to the cathode.

The electrolytic solution can be almost any liquid capable of carrying current. Such diverse solutions as Coca-Cola, Sparex, sulfuric acid, ammonium sulfate (fertilizer), magnesium sulfate (Epsom salts), trisodium phosphate, dish detergents and even wine will work. **Recommended here is a solution of 3 to 10% by weight trisodium phosphate (T.S.P.) in solution with distilled water.** The percentage of chemicals in the solution will determine to some extent the length of time for the desired reaction to be completed. Slowing the reaction can be achieved by lowering the concentration of chemical in solution. This is particularly important for high voltage color effects.

Note: This equates to 30 to 50 grams of TSP-PF, TSP or $MgSO_4$ per Liter [or 1/2 cup (4oz) to a gallon]

Power supplies:

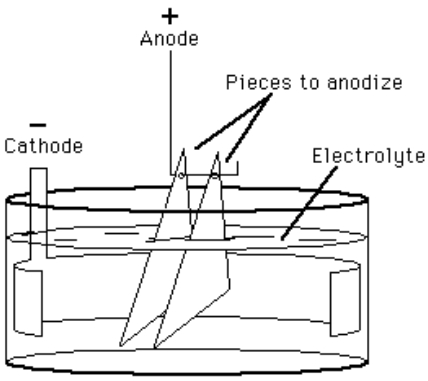
The power supply required for anodizing has a much greater range of voltage control and lower range of current capabilities than plating rectifiers.



The requirements are **0-150** volts DC variable in one volt increments and from 2-5 amps. Larger capacity power supplies may be necessary for work larger than jewelry and in high volume production.

Anodizing procedures

Bath anodizing



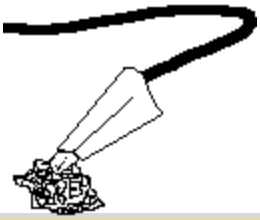
Bath anodizing

This technique is best for one color, rainbow and mass produced work.
You will need: 1) a power supply 2) a plastic or glass container 3) electrolyte 4) a metal cathode and 5) Ti or Nb clips, holders or hooks to hold the work.

With the pieces to be anodized in the bath, turn the anodizer ON and slowly increase the voltage. You may see small bubbles appear on the surface of the **anode**. This is an indication that the anodizing is taking place. The colors will continue to change as the voltage increases. If you do not like the color, increase the voltage and produce a new color. You can never bring the color back down once it is passed. Turn the power OFF, remove the piece, rinse and wipe dry. Only then will you see the true color.

Note: When anodizing slowly, Nb changes evenly, however Ti and Ti alloys should be anodized in short taps or dips, turning up the voltage with the work either not touching the wand, or removed from the bath to avoid resistance.
***This is especially important for consistent results in high voltage colors like teal and green.**

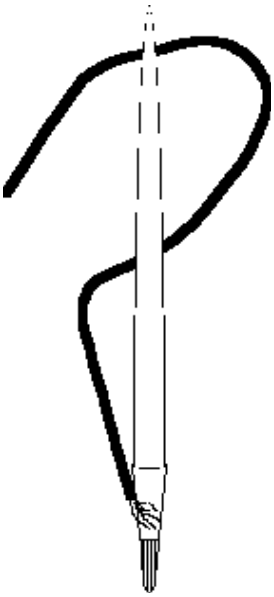
Anodic painting



This is where the real graphic potential of this process comes into play. This technique brings the electrolyte to the work. Applicators can be made by soldering an insulated wire on to the metal ferrule of an artist's brush or clipping on to a sponge with the cathode lead wire.

Note: The metal ferrule of paint brushes, other metals and conductive materials that could come in contact with the operator or cause a short circuit should be covered with electrical tape, heat shrink tubing or a plastic coating.

⚠ **Always wear thick protective rubber gloves and use an insulated work surface such as glass or plastic.**



Connect the **anode(+)** lead from the power supply to a reactive metal workpiece. Connect your applicator to the **cathode(-)** output of the power supply. Moisten the applicator in electrolyte. Turn on the power supply and set the voltage to the desired level. Touch the applicator to the surface and the colors will begin to appear.

If the applicator is held in one position the colors will slowly radiate out from the point of contact. With excess electrolyte and constant movement, even large areas can be evenly colored. Fine detail work can be produced with an almost dry brush.

Masking

Defined areas of color can be achieved with the techniques described above and suitable maskings. Masking agents like asphaltum, lacquer, photo resists and specialty tapes can be applied by a variety of techniques. Multiple anodizing steps are performed as layers of resists are removed for spectacular effects.

More complete information on anodizing can be found in "Studio Preparation and Coloring of Titanium" available in the **Reactive Metals** current catalog: http://www.reactivemetals.com/. Anodizer and other anodizing products come with complete instructions.

Using your anodizer

INSTALLATION AND INSPECTION

When you receive your power supply, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the carrier immediately. Warranty information below. Save the shipping carton and packing materials in case the supply has to be returned in the future. If you need to return the supply for service, call for authorization and instruction. Attach a tag identifying the owner and model number. Also include a brief description of the problem.

Warranty Statement

The manufacturer warrants this product to be free from defects caused by workmanship or production error for a period of 12 months after the initial purchase date. The manufacturer will, at its' option, repair or replace any defective unit with a working unit after the defective product has been returned, freight prepaid.

Location And Cooling

It is shipped ready for bench operation after connection to an ac power source. It is cooled by a thermostatically controlled fan. Sufficient space should be allotted so that a free flow of cooling air can reach the rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 40 degrees C (104°F).

⚠☠ **WARNING:** ☠ **Do not install on a metal work surface or next to metal plumbing fittings!**

Power Cord

This instrument is equipped with a three conductor power cable. The third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three prong connector is the ground connection.
In no event should this instrument be operated without an adequate cabinet ground.

GROUND

This product is a Safety Class I instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the ac power supply mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) a the power outlet. Any interruption of the protective(grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external auto-transformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

⚠ ☠ **WARNING:** ☠ DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE
☠ Do not operate the instrument in the presence of flammable gases or fumes.

⚠ KEEP AWAY FROM LIVE CIRCUITS

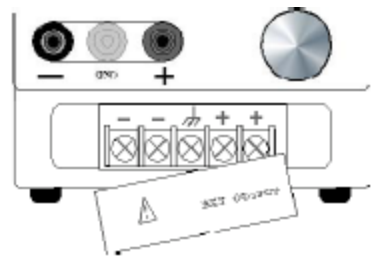
Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

SAFETY SYMBOLS

The ⚠ **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

Specifications

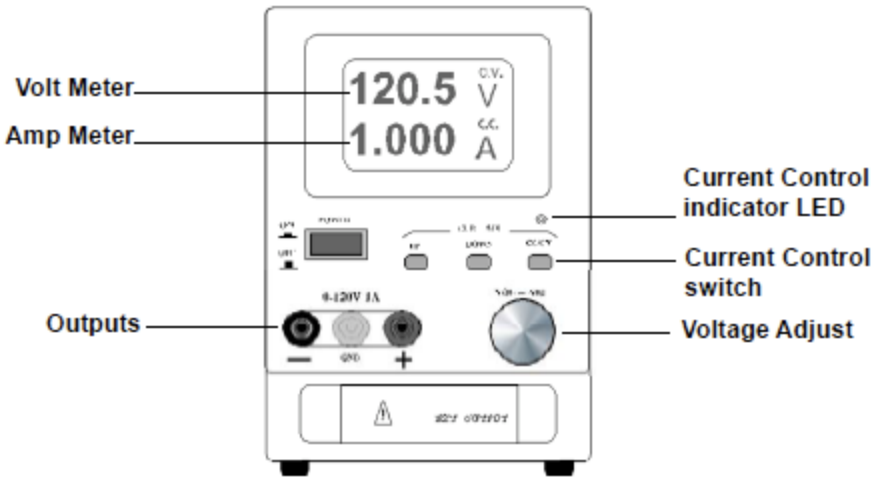
INPUT: **NA unit** 110-127 V AC +/- 10%, 50/60Hz [**EU Unit** 220-240 V AC +/- 10%, 50/60Hz]
OUTPUT: 0-120v, 0 to 1.00a
Refer to the Operating and Service Manual for detailed specification
SIZE: 18.4cmH x 13cmW x 26cmD
FUSE: F4 A, 250 Volts.
The fuse is located above the AC input in the back . Above the plug there is a small indent in the plastic. Lift straight up with a small screw driver. The bottom fuse is the one in service. The top fuse is a spare. Test with a volt meter.



Permanent Installation

There is a removable panel on the front that allows for permanent installation of the leads. To remove the cover slide up and out. *Replace the cover before attempting to use.

Note: For the purposes of these instructions the terms Current, Amp and Amperage are used interchangeably.



The Multimeter shows both **DC VOLTS** and the **AMPERAGE** that are available.

The voltage is set and can be changed by turning the ten turn **VOLTAGE ADJUST** knob.

Voltage can be set accurately and will be indicated on the top row of numerals. The **AMPS/AMPERAGE** is set with the two **UP/DOWN CURRENT ADJUST** buttons. Current output is shown in the bottom row of numerals.

The illustration reads 120.5 volts with an available amperage of 1.000A.

Turn-On Checkout Procedure

The following checkout procedure describes the use of the front panel controls and indicators and ensures that the supply is operational:

1. Attach the power cord to the rear plug. Connect it to a grounded 120 volt wall outlet.
2. Push the **POWER** button to the **ON** position.
3. Turn **VOL-ADJ** control fully counter clockwise to ensure that output decreases to 0 V, then turn fully clockwise to ensure that output voltage increases to the maximum output voltage of approximately 120V. Return the voltage to zero.

⚠ Shock Hazard ☠ Disconnect AC power before making output terminal connections

4. Install the two banana leads in the plugs that match their color.
   Black/cathode or -(negative), Red/anode or +(positive)
5. Clip the two leads together. Turn the voltage up about 1/4 turn. (O volts will be indicated.) Push in the **CC/CV** button, the green light comes on. It is now operating with Constant Current Control. You can now adjust the amperage through its full range with the **UP/DOWN** buttons. It should indicate .00 to 1.00 amps. Some slight variation may appear due to the input voltage.
6. Turn the voltage down and disconnect the two shorted leads.

⚠ WARNING: ☠ LINE-ON/OFF: It is very important to turn the unit OFF and the VOLTAGE DOWN when not in use. It should become a habit! Learning this procedure will help prevent electrical shock.

VOLTAGE: The adjust knob is used to set voltage output. It is a ten turn pot which allows for very accurate control. The voltmeter indicates the voltage available prior to applying a load. The voltage can be adjusted at anytime. During anodizing the voltage will drop and then return as the color comes up. Always turn the voltage ***DOWN*** when you turn the anodizer ***OFF***.

CURRENT: The current or amperage that is available controls the speed of anodizing. High current is fast and is good for bath anodizing. Lower current is slow and good for applicators and brushes. For most anodizing operations you will want to use **CURRENT CONTROL**. The **green CC/CV light should be ON**.

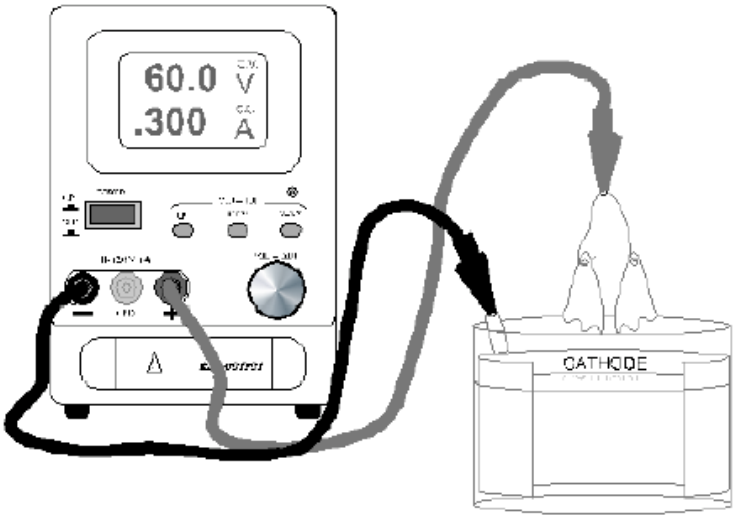
During anodizing the process will draw all the current that is available instantly. As the voltage setting and color nears the current will begin to fall towards 0.

Practice and your own preferences will dictate what current levels you like to work at. The process for checking the current output on the previous page (4 & 5) are the same as used to preset the current for anodizing.

You are now ready to anodize. Current level may be changed at any time.

- **If the anodizing is progressing too fast or heat and steam are being generated, turn the amperage down.**
- It is best to **start slow** and speed things up as you get familiar with the process.

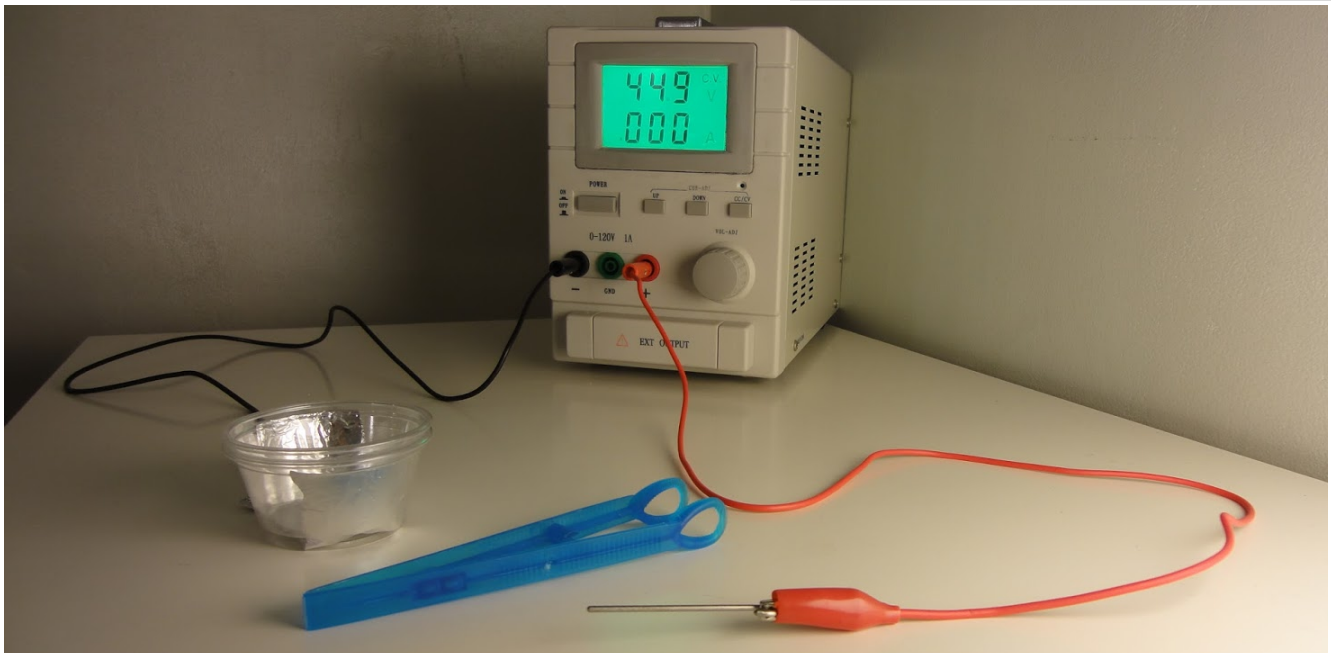
The completed anodizing setup



OUTPUT:

- Plug the **RED** lead into the **+** or **ANODE OUTPUT**. This is the lead that will always attach to your work.
- Plug the **BLACK** lead into the **–** or **CATHODE OUTPUT**. This lead will attach to the metal cathode strip in your anodizing bath. It will also connect to the cathode in applicators like brushes and sponges.

(The **green/center** output is ground and is not used during anodizing.)



An alternate setup with a small bath.

ANODIZING QUICK START

⚠☠ **WARNING : Electrical Shock Hazard!** ☠ **Wear rubber gloves at all times.**

Congratulations, now it is time to experiment with your new anodizer!
The following is a step by step procedure to quick start you into anodizing.

Electrolyte

Many different solutions (electrolytes) may be used for anodizing. We recommend TSP (Tri Sodium Phosphate). This is a low sudsing detergent. Products similar to this include automatic dishwasher detergents and may be substituted. The water can be distilled or demineralized bottled water. Do not use tap or well water. A half cup of dry TSP per gallon of water is sufficient for most anodizing, although as much as two cups can be used. Add the dry ingredient to the water and mix well.

***Note: This equates to 30 to 50 grams of TSP-PF, TSP or $MgSO_4$ per Liter [or 1/2 cup (4oz) to a gallon]**

A lidded plastic container is best suited for an anodizing tank. Pick a small container, no more than a quart (liter). It should relate to the size of your work. Mark the container well, so that it will not be confused with other containers or used for food. Single use containers are described at the end of this document.

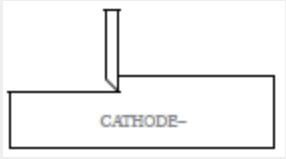
⚠☠ **WARNING : The alligator clips cannot be submerged in the electrolyte. *Only reactive metals can be in the bath.**

Cathode

Trial run with Nb wire or jewelry

1. The bath is ready, cathode is in place and the **BLACK(-)** lead is connected to the cathode.
2. Put on your rubber gloves.
3. Turn **ON** the anodizer.
4. Set the **CC/CV** to **ON.** Set the amperage level at .30a as described on the previous page
5. Set the **VOLTAGE** to 0 Volts.
6. Attach a strip of titanium or niobium to the **RED(+) anode** lead.
7. Submerge the metal in the center of the bath. **(Not the alligator clip!)**
8. Turn the voltage up slowly. As the color begins to appear slowly lift the metal out of the bath.
    a. This will produce a rainbow of color
    b. Practice and you will soon be able to run the full range.
    c. To get a solid color, simply immerse the metal and turn the voltage up to achieve the color.
9. At this point it would be helpful to make a color chart by voltage for reference **(See last page for a print ready color chart)**.

A stainless steel foil strip was included in your package. This will wrap around the inside of your container as shown in the illustration.



Cut a ¼ (5mm) x 2 inch (50mm) long strip along the top edge and fold it up. This should reach above the the tank edge and will be where the **BLACK(-) cathode** lead attaches.

Some frequently asked questions:

Which voltage achieves which color?

The more voltage that is applied during the process, the thicker the oxide layer that is achieved. The voltage range used in this type of anodizing is usually between 15-120V. The colors are in approximate ranges, and will differ slightly for each set up. It is good to start a little lower and turn it up gradually. When we want a piece to look brighter than plain "high polish", we anodize it to about 42V, a shiny near-white blue at the breaking point of the spectrum between light blue and light yellow, and customers are happy. They also like that we can customize it with multicolor effects such as stripes, fades, rainbows, oil slick, or polka dots, etc. in seconds.

Color	Copper	Dark Purple	Dark Blue	Light Blue	Shiny!	Yellow	Fuchsia	Blurple	Teal	Green
Voltage range	8 - 10 V	15 - 16 V	18 - 20 V	27 - 30 V	40-45V	48 - 50 V	62 - 63 V	72 - 75 V	81 - 85 V	91 - 92V

This chart represents the voltage ranges that we use. We can usually achieve the color we are after within these ranges, however it helps to always start out lower and work our way up. This will vary for you based on the solution and size of your cathode and bath, and also with anodic painting..

You can change the color of an anodized piece to another color of a higher voltage. It is possible, for instance, to turn a dark blue anodized piece to light blue, yellow, or to any of the colors of a higher voltage. It is not possible, however, to turn that dark blue piece to a purple or a copper color. If you wanted to do that, the oxide layer would have to be stripped off through polishing/steam cleaning.

The quality and consistency of the oxide layer formed, largely depends on the quality of the surface finish. When we anodize a piece of jewelry to be sent out to a customer, we sometimes do not get the result we want on the first try because Ti oxidizes in air after is is polished. The piece then gets re-polished and steam cleaned, to be anodized a second time. It might be a really good idea, if you are planning to anodize jewelry yourself, to get a polishing wheel and a steam cleaner.

What are the benefits of an anodized surface?

- Pretty colors / color coding to more easily differentiate parts and sizes
- A more durable, smooth, and biocompatible surface
    - Removal of microscopic debris embedded in the surface
    - Passivation according to the **ASTM F 86** Standard Practice for Surface Preparation and Marking of Metallic Surgical Implants

Do I need to use an ultrasonic to clean my jewelry before anodizing?

No, ultrasonic vibrations will damage the polish of body jewelry, unless you disassemble and separate all the pieces such as in plastic cups or hang the pieces from a plastic jig that does not interfere with the ultrasonic action.

If you anodize every piece, you won't have to use an ultrasonic to clean to the appropriate level of the ASTM F86 surgical implant standard, provided that the manufacturer already has cleaned the jewelry appropriately by ultrasonic and steam. Anodizing gets matter off the surface and cleans down to one millionth of an inch, over a thousand times more clean than with an ultrasonic.

We anodize every piece of jewelry right before use, to passivate the surface finish and give my clients a piece free of debris that an ultrasonic alone can't remove. We rinse with a squirt of distilled water, and autoclave sterilize it with my Statim for the cleanest, smoothest finish and fastest healing response. You'll never want to pierce without it, like the Statim :)

*I have manufacturers anodize everything to the first low voltage copper/bronze color that appears before they ship, so that they catch all the mistaken steel bits that could otherwise be mixed in. That makes sure it's all Ti, cleaner than otherwise, and that it does not oxidize in air to a duller finish if it sits around in stock for a long time.

How can I make multicolor patterns?

Masking, such as an o-ring or bit of tape covering a piece of Ti will prevent anodization of the masked area and allow you to create patterns. Only the part of the jewelry exposed to the electrolyte will change color. Contact us or visit the forum for more ideas for patterns.

Do you find a stronger or weaker electrolyte solution works better for you?

- **Stronger** solutions conduct electricity better and work well for lower voltages spectrum colors, **however** this will overexpose Ti at higher voltages, and the colors will etch the surface because of heat and resistance.
- **Weaker** solutions slow the current so you can get higher spectrum colors, especially for anodic painting with sponge or brush for high voltage effects.

I tend to make the solutions at 3 to 5% concentration of electrolyte to distilled water by weight and dilute if needed for anodic painting. Liquid TSP is the easiest we have found to mix for a clear solution, otherwise we mix the powder then let it settle overnight. The solution does not spoil, so we mix several liters at a time.

Was the old type mini anodizer better?

There is not really any difference in getting any of the colors correctly with either older mini anodizers or the new ones with the LCD meter readout and an upgraded dial potentiometer. Basically, after a bit of experimentation with both kinds I like the new anodizers much better. We added them to the line of products that we carry for a fair price that includes training and support.

The valuable differences with the newer anodizers are that the dial on the newer unit turns ten full rotations for finer control and the meter helps you repeat the process more easily. The other big improvement is that the electrical parts are self contained, so there is just a normal grounded power cord coming from the back of the unit, instead of an extra brick of a voltage transformer that takes up more space collects dust.

I'm having trouble obtaining consistent higher voltage colors. Any hints or tricks?

I do note that people might be exposing the pieces for too long at high voltages when they first begin to react, or turning the juice up too slowly. Turning up the voltage while exposing the piece constantly will not get the high voltage colors well with Ti, though it works for Nb. If you maintain the current for too long at high voltages, the piece heats up and resists, and it the surface forms oxygen bubbles. These bubbles will block further anodization by preventing the current to touch the area and allow the piece to heat up. They must be removed by agitation or dipping in and out of the electrolyte.

For best results

Wand method, using a Ti or Nb stirring wire or rod:

1. Set the voltage to just below the color range you are aiming for
2. Anodize the wand to the color you want by dipping it in and out of the batch, adjusting the current to your desired voltage
3. Place the jewelry you want to anodize with plastic or bamboo tweezers or in a plastic mesh basket or small container
4. **Tap** the piece under water with the anode wand for less than a second
5. Agitate the piece to shake off the gas bubbles under the water (stirring with the wand works for both 4 & 5)
6. Increase the voltage as needed
7. Repeat until you get your desired high voltage color results

Instead of overexposing jewelry to high voltage all at once:

- **Dilute** your electrolyte.
- **Dip** the jewelry quickly in and out of the bath to clear the bubbles off as it changes color.
- **Tap** the jewelry quickly with a **Ti or Nb wand** or other jewelry at the desired color held in the grabber or a jig.
    - I like to hold the threaded or threadless end by the thread or pin with the grabber, and use it to stir or tap the other jewelry parts in the plastic mesh basket, once we have first achieved the correct color reaction for the end.

In addition:

- **Polish** the piece before instead, even just with a polishing cloth.
    - For accurate results, polish your Nb or Ti anode wand or wire jig before aiming for high voltage. That way you can see the color prior to making contact with the jewelry.
        - Once your anode is spotty beyond green, it resists more and sometimes needs polishing for a better connection and quicker reaction.
        - React the anode before the jewelry, so that they don't compete for the current.
    - I prefer to use an equal or thicker rod of Ti or Nb as a wand attached to the anode clip. We find easiest to work with 16g or 14g (~1.25, ~1.6mm) or larger >3 inch (>10cm) lengths doubled into a U shape at the tip.
    - A Ti barbell post or tightly folded aluminum foil will do for a temporary wand.
    - The anode wand doesn't need a pretty polish, just enough to strip it to bare metal, sandpaper or ScotchBrite can work for that.
    - Since you only need to polish the first few millimeters you touch with, a Dremel or other small rotary polishing wheel should suffice.
    - A polishing wheel is a must for jewelry. We use a polishing wheel with a felt and a muslin wheel, a grinder and a belt and disc sander along with a flex shaft and bench vise for basic jewelry work.
- **Degrease** using an alkaline cleaner (soap and water), followed by steam **or** an alcohol rinse.

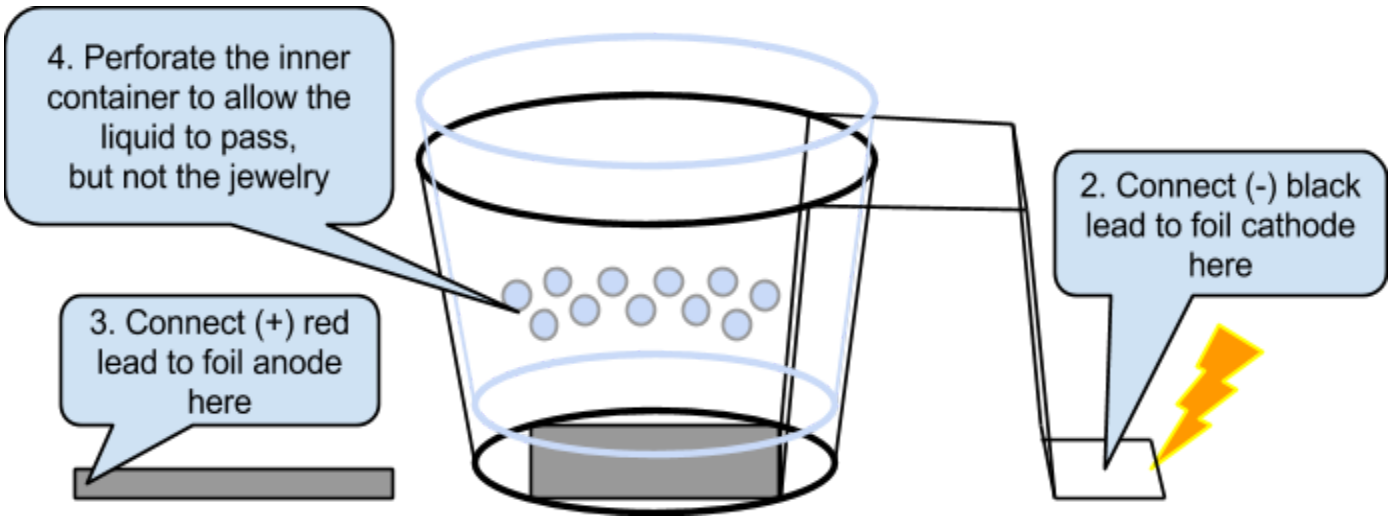
How do I re-anodize worn body jewelry (for the original wearer)?

Follow this single use anodization protocol:

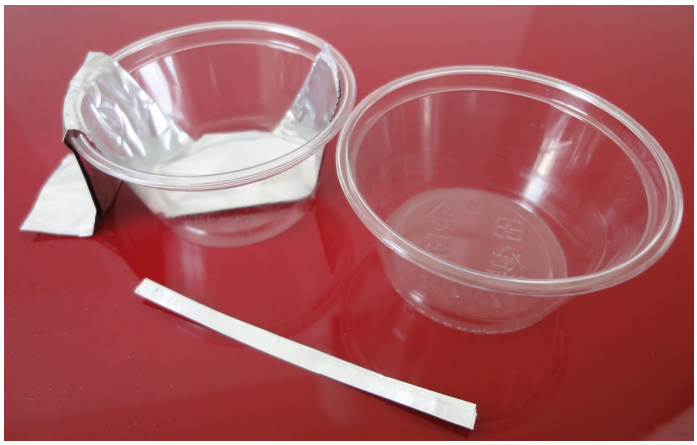
Requires: two single use plastic containers, aluminum foil, electrolyte solution, enzyme cleaner, 70% or stronger alcohol

1. Clean the jewelry with gauze or a paper towel and an enzyme solution followed by a alcohol rinse as a solvent to remove visible oil and debris from the surface.

2. Make a small cathode to fit in the container from aluminum foil with enough extra foil to clip the - black lead to.
3. Make a small anode from aluminum foil by folding it into a flat, stiff rod to clip the + red lead to.
4. Perforate 10 or more holes smaller than the jewelry in the side of the second container and place it inside the first container, with the foil cathode in between the plastic to shield from a short circuit.
5. Add enough electrolyte to cover the jewelry completely.
6. Anodize the aluminum foil at the desired voltage range for a few seconds until it stops reacting.
7. Place jewelry in electrolyte.
8. Anodize jewelry by a series of quick taps with the foil anode until it stops reacting.
9. Adjust the voltage higher and repeat steps 6 to 8 until you get the desired color.
10. Remove jewelry from electrolyte and rinse it with alcohol.
11. Dispose of containers, foil and electrolyte.
12. Steam sterilize jewelry for reuse only by the original wearer.



⚠ **SINGLE USE ONLY** FOR PREVIOUSLY WORN JEWELRY! ☠ NEVER REUSE!



*A similar setup can be made with a steel or Ti cathode metal and Ti or Nb wand for regular use with new jewelry **only**.

General Description of your anodizer:

S**ingle Output DC Bench Power Supplies With Large LCD, 0-120VDC/0-1A Regulated Power Supply:** Your new DC Regulated Power Source provides accurate & stable DC power. It is ideal for body jewelers, laboratories, schools, test benches & repair facilities. The multi-turn voltage control knob helps the user accurately dial in a precise voltage. The large easy to read LCD accurately displays the outputs (voltage & current). This product incorporates SMT PC boards & a built in cooling fan for reliable performance & long life.

Features:

- SMD adhesive sheet element technology for internal pcb
- Attractive large yellow backlit liquid crystal display shows voltage & current
- Built in cooling fan
- Multiloop high precision voltage regulation
- Progressive current regulation
- Dual terminal system. Safety banana style or expandable screw terminals
- Overload protection circuit
- Low ripple voltage: < 1mV P-P
- Output polarity: positive or negative
- Rugged reinforced metal frame construction

Specifications:

- Display 0-120VDC 0-1A 100mV 1mA
- Source effect: 5 x 10–4 = 2mV
- Load effect: 5 x 10–4 = 2mV
- Ripple coefficient: < 250uV, Stepped current: 30mA +/- 1mA

General Specifications:

Description: Utilizes SMD technology

- Single/ Dual Output Light and Compact
- Output Polarity: Positive and Negative
- LCD Display showing Voltage and Current value
- Low Ripple Voltage Less Than 1mV P-P
- Overload Protection Circuit
- Input Voltage 110-127VAC +/- 1 60hz +/- 2% 50Hz +/- 2Hz
- Voltage Regulation CV </= 5x10 -5 mV CV </= 5x10 -5 mV
- Load Regulation CV </= 5x10 -5 mV CV </= 5x10 -5 mV
- Ripple & Noise CV < 0.5mV r.m.s. CC < 2mA r.m.s.
- Protection Current Limiting
- Voltage Indication Accuracy LCD +/- 1% + 2 Digits
- Current Indication Accuracy LCD +/- 2% + 2 Digits
- Ambient Temperature 0 ~ +40 o C
- Humidity < 90%
- Dimensions (Single) 18cm(W) x 13cm(H) x 26cm(D)Weight 6.8kg

Accessories: Instruction Manual, Power cord, 1 set of Banana plug to Alligator Clips, 1 set of hook up wires for external hook up.

2. Operation

2.1 Front Panel Controls.

1. Current Indication
2. Voltage Indication
3. Fine (10 Turn) adjustment of Voltage
4. Up/Down Adjustment of Current
5. Power On/Off
6. Negative Output Terminal
7. Positive Output Terminal
8. Ground Connection
9. Constant Current Indicator
10. Constant Current Switch
11. External Power Output Connection

2.2 Operating Procedure

2.2.1 For constant Voltage mode make sure #10 is depressed and the LED #9 is off.
Rotating the knob of #3 to the right increases the voltage output and rotating it to the left decreases the voltage output

The unit has one output display. The display has 2 readings. One is Voltage and the second is Current. The Voltage is 0-120 Volts with 0-1Amps.

This unit has a fan that turns on when the temperature reaches 140°F(60°C).

*__NA Unit__ takes a standard US 110VAC input only and is fuse protected.

*__EU Unit__ takes a standard 230VAC input only and is fuse protected.

3. Attention:

3.1 The mains power must be switched off before servicing and servicing should be referred to a qualified person.
3.2 The unit should be stored in a dry and well ventilated place and the power cord removed for long periods.

Color Chart	Voltage Reference	Our Pure Niobium	Our ASTM F67 Pure Titanium	Our ASTM F136 Alloy Titanium
Light Bronze	12-15v			
Dark Bronze	18v			
Eggplant	20v			
Dark Purple	22v			
Purple	25v			
Dark Blue	28v			
Blue	30v			
Medium Blue	33v			
Light Blue	35-38v			
Ice Blue	40v			
Silver Blue	42v			
Silver/Pale Yellow	48-50v			
"High Polish"	53v			
Light Yellow	55-58v			
Yellow	60-63v			
Golden Yellow	65v			
Copper	68v			
Rose Gold	70v			
Light Pink	72v			
Pink	75v			
Fuschia	80v			
Dark Fuchsia	85v			
Vibrant Purple	90v			
Purple/Blurple	92v			
Blurple	95v			
Blurple/Teal	98v			
Teal	100v			
Teal/Green	103v			
Green	105v			