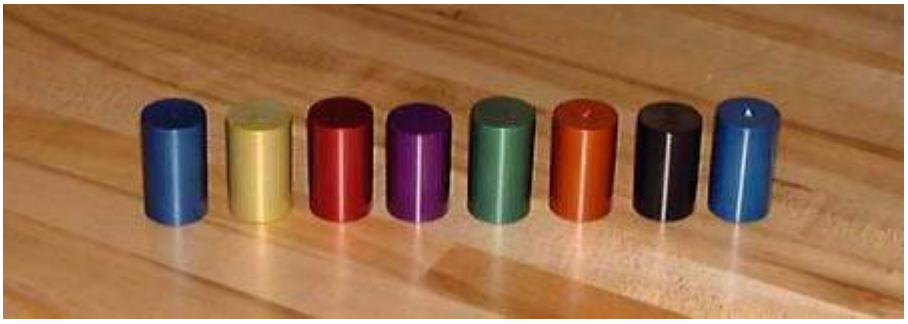
Anodizing Aluminum

By Ron Newman - www.focuser.com



The following procedure is for anodizing aluminum parts. Anodizing will protect the aluminum parts by making the surface much harder than natural aluminum. Aluminum oxide is grown out of the surface during anodizing and is extremely hard. The porous nature of the anodized layer allows the product to be dyed any color that is required. The method I describe is type II anodizing (room temp) and gives an anodized layer of .0002" to .0009". Type III (hard coat) anodizing is done at a much lower temperature and higher current level. It gives an anodized layer up to .002 but is normally at .0005" (Mil spec) in most anodizing shops. Type III anodized surfaces can typically only be dyed black or dark green. I will show you how to perform type II anodizing using the home brew hanging wire method and materials found at typical hardware and auto parts stores (bare bones method). I will also show you how to set up a semi-professional line using some of the anodizing kits for sale on the internet today.

Please email any suggestions or questions concerning this procedure to Ron Newman

If you want more info on anodizing, I'm offering a small booklet for $12. "A Practical Guide to Anodizing Aluminum at Home Nov-2002 Edition

It has detailed info on anodizing plus sections on Tumblers and media, Brite Dip electro polishing, and fade/splash anodizing methods. This would be handy for anyone wanting to set up an anodizing line. If you would like a copy (USA only), just send a check for $12 plus $3 shipping along with your return mailing address to:

Ron Newman 114 Ardmoor Ave. Danville PA 17821

The following photos show my anodizing station set up:

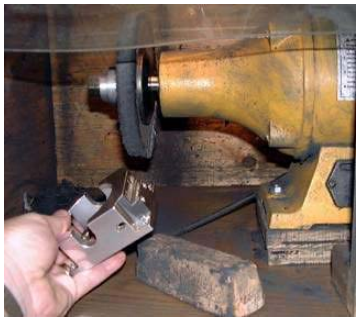
A plastic tank for sulfuric acid in a sealed vented wood box, power supply, and AC unit.

A cleaner, desmut, and sealer tank along with a sink.

A tank for each color dye.

Before we get to the anodizing, let's talk about prepping the aluminum part first.

Anodizing hides no sins, so put a good finish on your parts before anodizing them. A good general rule is.... what you see is what you get after the part is anodized; however, anodizing does tend to slightly magnify the surface texture so lean toward a smoother finish when prepping the part. Know that a small amount of the gloss will be lost after it is anodized. For a brite glossy surface on your anodized part, steel wool or wet sand it and then polish it with a buffing wheel using Tripoli compound.



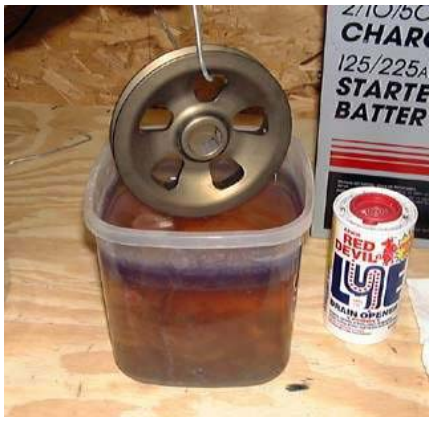
For a matte finish, just steel wool or sand it using an emery cloth.

There are other non-manual ways to prep the parts surface before anodizing. I use vibratory tumblers with different grades of media for sanding and polishing the parts before anodizing them. This allows a large quantity of parts to be done easily. But for quick "one off" parts, buffing on a polishing wheel using Tripoli compound is the quickest way. Or, you can just anodize the part right after machining it. Just make sure you clean the part first. Here is a photo of parts that came right off my homemade CNC lathe. They were cleaned and anodized. No other prep work was done.

This is my vibratory tumbler set up. I use three vibratory tumblers. Each tumbler is dedicated to a different type of media. The first tumbler has 40 lbs of 1/4" plastic triangle media impregnated with silicon carbide to sand the parts. This tumbler runs wet and requires a flow through water system to flush the debris out of the media. It runs any where from 12-24 hours, depending on the surface required. It will remove mill/machine marks and deburs all edges. The second and third tumblers use dry polishing media. Rouge treated walnut shell produces a bright mirror-like surface after about 72 hours. Each tumbler sequence takes between 12-96 hours to prep the surface. It is a slow process but many parts can be done without supervision or sweat. The tumblers and the media used in them are not cheap, so unless you need to do hundreds of parts at a time, I would suggest buffing them by hand.

Stripping or restoring existing anodized parts

You can strip off the existing anodized layer from any anodized part by placing the part in a Lye solution for an hour or so. Just mix up a few tablespoons of lye and water in a plastic container. Wear eye protection and rubber gloves for this procedure!! Place the part in the solution and monitor its progress. Most anodizing kits supply stripper. It works a little better than Lye and will not pit the part as easily as lye can if left unattended for too long.



The lye will dissolve the old anodized layer, about .0005" thick. It takes a while for it to start breaking through the layer. It's a little slow at first. The first ten minutes or so not much action will be seen. Bubbles and smut will rise up as an indicator of its progress.

It is a good idea to help the process along by wiping the smut off of the part to allow the acid to get to fresh aluminum. Just wipe off the part with a rag every 5-10 minutes until the old layer is completely gone (wear gloves and goggles). Only bare aluminum should be seen when the part is finished. Again, anodize stripper works harder on the oxide surface and less on raw aluminum. This is why it will not pit the part as easy. Once the solution breaks through to raw aluminum the process slows down. This is not the case with Lye. Lye starts dissolving the bare aluminum and can cause pits once it breaks through the anodized layer.

When the part is completely uniform (no remaining spots), rinse it off and buff it back to a shine. Stripping aluminum this way will create a matte finish. Polishing it back to its original surface is up to you. At this point, the part can be re-anodized and dyed any color just like a freshly machined part. Note: if the aluminum part has other metal steel parts pressed into it, do not re-anodize the part. Metals other than aluminum will dissolve away during the anodizing process.

Here is the re-anodized part!

Enough about prepping and stripping parts. Let's get to the anodizing.

PROCEDURE

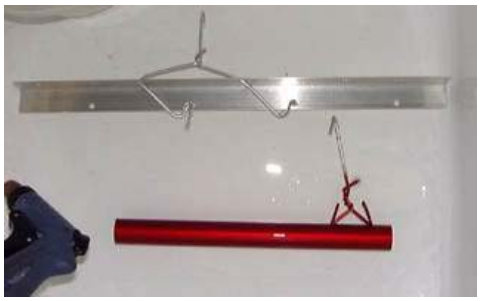
The aluminum parts need to be clean. Oil from machining, polishing compound and fingerprints from handling the parts must be cleaned off.

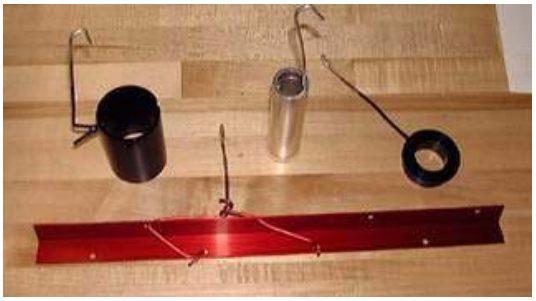
The cheapest way of cleaning the part is to use dish detergent with hot tap water and scrubbing the part. Use a toothbrush to get into any tight corners if needed. Or you can use a cleaner that comes with most anodizing kits. Here I'm using a cleaner that requires the parts to soak for 5-10 minutes at 140 deg F. I use thermostatic controlled 1100-watt submersible heating elements in my tanks. A cheaper alternative is to use glass fish tank heaters or simply microwave a plastic container of the solution up to the desired temperature. The cleaner solution can be reused hundreds of times. Note: most of my tanks use simple "aquarium" air pumps to act as a re-circulating system and have aluminum hanging racks to hang the parts from. You may also notice I'm using the same size 5 gallon coolers for all of my tanks. This would be considered a 5-gallon anodizing line. My main anodizing tank is much larger. More on this later----

The hanging wire method requires----you guessed it, a wire connected to each part.

You can buy aluminum 12-gauge wire from Radio Shack for this purpose.

Connect an aluminum hanging wire to the part. This will provide the electrical connection when anodizing. The wire also provides a way of suspending the part in the various tanks (cleaner, dye, etc.) and keeps the part from being touched or handled. I force thread the wire into an existing tapped hole. Just double the wire up, or pound it to a point to fit your tapped hole. This connection must be very tight or it will fail during the anodizing process. Use pliers if needed to crank the wire into the hole. The wire is softer than the aluminum alloy and will simply take the shape of the hole without damaging the threads in your part. Remember, wherever the wire touches the part it will not anodize and will not take any dye. Pick the connection spot so it will not show on the finished part. If the part does not have a tapped hole then you need to get creative by pinching the wire against the aluminum or wrapping it around or through a hole. Just remember where the wire touches it will not anodize or take any dye.



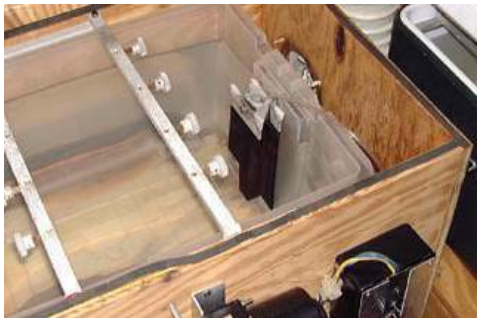


Setting up an ANODIZING tank

Mix up a solution of sulfuric acid in a plastic container. The mixture should be anywhere from 15%-25% sulfuric acid to water ratio. However, if you are using battery acid, it already has some water in it so mix 50% battery acid to water (equal amounts). You can measure the specific gravity using a battery acid tester if you really want to. It should display about 1100. That reading, if testing a real battery would indicate a discharged battery. Adjust the solution as needed, but a wide range will work. You can source sulfuric battery acid at your local auto parts store. Wear eye protection and rubber gloves when working with sulfuric acid. Remember the 3As rule!!!!! Always ADD ACID!!!! Never add water to acid. Please put a good amount of water in your tank first, then slowly add the acid to the water. If you add water to pure acid it could blow (boil) up. A good amount of heat will be noticed when adding the acid. I now use pure acid. When I first added water to get the mixture correct, the tank temperature went from room temperature up to 160 degrees due to the reaction. WOW!!! By the way, the acid will last many years if you are careful about rinsing your parts before putting them in it. Dragging chemicals over from previous steps is really the only way you will contaminate your acid solution. With a little care it could last a very long time.

Next you'll need a cathode or cathodes. Two cathodes, one on each side of the tank works well. The cathode is connected to the negative side of the power supply. The cathodes can be lead or 6061/6063 aluminum alloy. Both work well but lead lasts longer. Lead sometimes has unknown alloy metals in it. If you want to be sure just use 6061 or 6063 aluminum. The cathodes should stick out of the acid so a heavy gauge ALUMINUM wire can be connected from the cathodes to the negative side of the power supply. The size of the cathodes can have up to 4 times the surface area of the size of the parts you are anodizing. I break this rule all the time. I routinely anodize one small part with the large cathodes in place without any ill effect. Remember, no other metal should touch the acid!

The cathodes used in this tank are lead sheet.



6061 aluminum is used as cathodes in this configuration. It is recommended that the cathodes should be removed when not in use, however I don't bother. The aluminum ones here are turning black after about 4 months in the acid without being removed. The lead ones were in the acid for more than 4 years!

This configuration was one I used for small parts years' ago. It used small lead cathodes wired to the negative side of the battery charger using aluminum wire. Note the alligator clips for hanging the parts.

A battery charger or a DC power supply capable of providing at least a few Amps of current is required. A small set up can use a manual 12 volt 6 amp battery charger, but I would recommend using a manual 12 volt 50 amp charger/starter. DO NOT try and use an automatic battery charger. The automatic chargers get fooled by anodizing and ramp down the current, they simple do not work! The manual one used in this example puts out about 20 volts on the highest setting and will provide up to 50 amps. Next to the battery charger is a rectifier designed for plating and anodizing. It is a 15 volt 50 amp adjustable supply. It cost $500; the simple battery charger cost $80. You do the math.

The larger the current draw, the faster the part will anodize. But too much current can burn off the hanging hookup wire. Anodizing at a high current can also "burn" the part. Well, it's not really burning it but the problem is caused by bubbles etching the top or edge of the part making it look pitted. High current anodizing also causes higher temperatures in the tank that can cause the parts to pit. Localized heat around the part in the acid can cause pitting! Again, use air bubble lines in the tank to keep things stirred up and temperatures uniform. Don't try anodizing too fast at high current levels unless you have some experience with the process. Follow the current/time guideline below.

Depending on the number of parts anodized at a time, between 5 to 35 amps is drawn on most occasions. That seems to be a good all around range for the size of parts I do. It takes between 35-75 minutes depending on the acid temperature, size, and quantity of parts being done. Adjusting the acid ratio and cathode size will affect how much current is drawn during anodizing. Of course, the voltage produced by the battery charger has a great deal to do with current draw as well. Use the max setting on the charger and adjust the cathode size if needed.

The anodizing tank also has an electronic temperature gauge to provide a means of monitoring the temperature of the acid to make sure it does not exceed more than 78 degrees F while anodizing. The temperature of the acid rises while anodizing. The larger the tank of acid, the slower the temperature will rise during anodizing. Small tanks may only be able to do one run at a time before being forced to wait for the acid to cool back down. The anodized part will not take the dye well if the temperature of the part is too high while anodizing, or if it is rinsed with hot water after anodizing. The ideal temperature range is between 65-75 degrees for type II anodizing, and around 40 degrees for hard coat anodizing. If the temperature gets too high while anodizing the parts may start to pit. I have an AC unit blowing into the sealed box to cool the acid down to around 65 degrees before starting an anodizing run. I can then maintain a normal temperature range with the AC running while anodizing. You don't need to have an AC unit like I do if you are only doing a few parts. I use the AC unit due to anodizing all day long during the summer. Most people would just do one run and then wait for the temperature to cool back down before starting the next. But too much of a "cold thing" is bad. Don't go below 65 degrees! The colder you make the bath, the less current will be drawn for a given size part. Anodizing at 50 degrees would require double the voltage coming out of the power supply. A typical battery charger is only going to put out between 15 to 20 volts so it will not work. Stick with the normal range of 65 to 75 degrees for type II anodizing.

A fish tank temperature gauge works well for monitoring the acid.

Next, suspend the aluminum part in the acid using the attached aluminum hanging wire. Connect the positive terminal of the charger to the wire holding the part and turn on the charger. The part should not touch the plastic container or be placed too close to the cathodes in the tank.

If the electrical connection to the part is not tight, it will fail during the process and only the aluminum hook up wire will be anodized, not the part. The current should rise then level off in the first few minutes of anodizing. As the anodized layer builds on the part you may notice a small drop in current. This is normal; however, if the current drops suddenly during the process that indicates that the connection to the part has failed. If the current is too high, the connection wire may burn off. Use

a 12-gauge wire when possible for the hanging wire. If the current keeps rising as the part anodizes then check the temperature. The hotter the acid gets the more current will be drawn. Remember, the temperature has to be kept within limits or your part may become pitted and won't take the dye well.

Bubbles will start foaming off both the cathodes and the part. I would advise not breathing the fumes, and would suggest some way of venting them away from your work area. I put the plastic tank in a sealed wooden box with a fan to vent the fumes out a nearby window using a simple dryer hose. Some anodizing kits provide fume control balls that take care of the problem. I have not tried them, but hear they work well.

Figure out how long to anodize the part using the following rule- 900 amps per minute per square foot of part.

The Crayford focuser tube has 42.4 sq " of surface and is drawing 5 amps according to the meter on the power supply. 900/5 =180 amp min, and 42.4/144 = .294 sq'. So 180 times .294 = 53 minutes in the tank. This part anodized for 1.2 hours. Give extra time for parts that have a matte finish. Due to the larger surface area of a matte part, it will take a little longer to anodize than the same size part with a polished surface. To be honest, I don't even bother to figure out the time required for parts anymore. I know my set up well enough to just set the timer for 65 minutes for black dyed parts and about 50 minutes for all other color parts. The current will automatically adjust for more or less parts. Other anodizing set ups will differ due to different battery chargers, tank sizes, acid ratio, and cathode sizes. Calculating the time to get close would be a good idea until you gain a little experience.

Notice the color of the anodized part. It should have a pale lemon tint if it is a 6000 series alloy, or a chalky white look for other types of aluminum alloy. Don't pull it out of the tank until it changes color. The following photo shows the color of 3 samples - natural aluminum, anodized, and dyed black.

Can you tell which part lost its electrical connection during anodizing by looking at the color?

The 2nd from top failed during anodizing. See the lighter shade, unlike the others.

Rinse the part with COLD water after removing it from the acid tank. Do not use hot water, as it will start to seal the pores in the aluminum oxide layer before you have a chance to dye it.

Once the part is rinsed well in cold water, it is time to dye the part to your desired color. I use different colored anodizing dyes from Caswell. Click the Caswell banner below to see the different color dyes that they offer. They also sell anodizing kits, plating kits and vibratory tumblers as well. For the first time anodizer, the anodizing kit may not be a bad idea!

Caswell will pay me a small percentage for any sales I send them from my page. So if you are going to order something from them, please link to them by clicking the Caswell banner on this page and then place your order, instead of from a bookmark- Thanks! (End of shameless plug)

Mix 2 gallons of water to one bottle of dye, other brands may vary. Heat the dye to about 140 degrees F. Hang your anodized parts in the dye bath for anywhere from 15 seconds to 15 minutes depending on the shade. If you want a light pastel shade of the color, keep the time short. If a deep solid color is what you are after, let it in the dye for the full 15 minutes. Anodizing dye will last years if you are careful not to cross contaminate it with sulfuric acid from the anodizing step. Remember to rinse well between tanks. Also, don't forget to seal the dye container when not in use to prevent evaporation. By the way -just add water to the dye, anodizing, cleaner, and all other baths. I adjust mine before each use.

Here is a 5-gallon blue dye tank with the heater pulled out and hanging rack installed. You can simply use a plastic container and microwave it to heat up the dye if needed. It does not have to be anything fancy.

Rinse the parts after removing them from the dye tank. Now it is time to seal the pores and lock in the dye by sealing the part. Heat can be used to seal the part. Either boil the part in water for 20 minutes or steam the part for 30 minutes.

The best way to seal the part is to use a Nickel Acetate sealer. It produces a better quality surface then using heat. This sealer comes with most anodizing kits. I use a room temperature sealer of this type. Just place the dyed part in the room temperature bath for 5-10 minutes, then rinse and hang to dry for about 10 hours. No heat needed and the quality is great! There are some nickel acetate sealers that require some heat, but again, the surface quality is much improved when using Nickel

Acetate for sealing over boiling or steaming. I have a 5-gallon tank of sealer with a rack just like all the other dye tanks.

If you do not want to dye the part and just want to seal the natural anodized color, just skip the dying step and seal it as outlined. The natural anodized color will change slightly.

If the part does not take the dye, it means it is not anodized fully. Look for--- failed electrical connections, to little current draw, not long enough anodizing time, to small of cathode size, Automatic battery charger or too weak acid.

Note the middle part failed to take the black dye due to not being fully anodized. The electrical connection was at fault. The part was returned to the anodizing tank BEFORE sealing. It was then anodized fully after fixing the connection and re-dyed.

For other aluminum alloys such as cast or 2024 alloy, use a desmut/deoxidizer as a pre step before anodizing. This step comes right after the cleaning step and before anodizing. It prepares the alloys surface for anodizing by removing other NON-aluminum metals from the surface. Example: 2024 alloy has 5% copper. This alloy along with others should be desmutted before anodizing so a pure surface is presented to the anodizing tank. When doing 6000 series it is not as important, but I use a desmut step no matter what alloy I am anodizing. Desmut is a mixture of sulfuric and ferric acid. It is mixed with water to make a bath just like the cleaner is. Desmut is done at room temperature for 1-5 minutes depending on the alloy. Desmut comes with most anodizing kits. It you are just anodizing 6061, then you can skip this step. However, it improves the quality of 6061's anodized surface. Get an anodizing kit if you are thinking of anodizing cast aluminum. You will need to do every step and will need all of the chemicals for good results when anodizing cast aluminum. There is no free lunch on that one----

Plastic Coolers, buckets, storage containers all work well for setting up an anodizing line.

The finished product!

www.focuser.com