High Quality (and Safe) Nickel Plating

by **A_Steingrube** on November 2, 2013

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I'm an Electrical Engineering student with interests in everything science, technology, and music. I am currently working on a variety of new, novel machine vision algorithms that allow for object recognition in real time.

Intro: High Quality (and Safe) Nickel Plating

Just like my very popular copper plating instructable, the aim of this is to do high quality, low cost, and safe electroplating. We will also be making our own electrolyte from scratch instead of buying chemicals online.

If you've looked at my copper plating instructable, note that the process here is different. The nickel will not dissolve very well if at all in the vinegar without special help and adding hydrogen peroxide will destroy your electrolyte.

Nickel plating can be used for a variety of different things.
- It creates a corrosion resistant coating that will protect the base metal from oxidizing and rusting. It is frequently used in food processing to prevent contamination with iron.
- It can increase the hardness and thus the durability of mechanical parts and tools.
- It can allow you to solder to difficult metals.
- It can create a variety of beautiful decorative finishes that range from a chrome-like gleam, to brushed stainless steel color, to a metallic black. It just so happens that black nickel plating is used frequently in aerospace applications
- In thicker platings, it can make the object magnetic.

Note that to get different finishes and properties, you may need to add other chemicals and metals to your plating solution (see the Post Prep stage). These chemicals will change the way the atoms arrange themselves and/or add other metals to your plating. If you are looking for corrosion-resistance, do not add any other chemicals to your electrolyte as they may cause the end plating to stain or tarnish.

For a copper plated finish, be sure to check out my copper plating instructable :)
http://www.instructables.com/id/High-Quality-Copper-Plating/

Image Notes
1. End result
2. Comparison, standard penny

Step 1: Materials

Nearly all of the supplies can be found at your local supermarket. Finding a pure source of nickel is a little trickier, but should not cost more than a couple dollars. To keep from draining your battery in later steps, I very highly suggest finding an AC/DC power supply around the house.

Materials you can find at your local supermarket:
>Distilled Vinegar - 5% acidity or higher (grocery)
>Salt (grocery)
>Mason jar (canning)
>6V Lantern Battery (camping)
>Alligator Leads (electrical)
>Nitrile gloves (pharmacy or DIY)
>Paper towels (paper products)
>Cameo Stainless Steel and Aluminum Cleaner (cleaning supplies)

Materials you will likely need to buy online, at a good hardware/welding supply store, or a music shop.
Pure Nickel - You can get this a few different ways. I bought my nickel in the form of two 4oz plates on eBay for ~$5. A good hardware store should carry nickel welding

rods. Most music shops will carry Ernie Ball "Pure Nickel" guitar strings.

You can also try to remove the nickel windings from old guitar strings if you are strapped for cash. It takes a bit of time, wire cutters, and pliers, but it can be done. Note that most nickel-wound strings contain a steel core that will pollute your electrolyte later on (Ernie Ball "Pure Nickel" strings should be pure nickel).

You can also try to use solid nickel door knobs and the like. I would warn you to be careful when trying this because a good chunk of "nickel" decorative items are plated themselves.

Optional, but highly recommended materials (also at the supermarket or a local electronics store):
A higher voltage, DC power supply - I am using an old 13.5V laptop charger. You can use "wall warts" (the ugly black AC/DC power supplies that come with some consumer electronics) or an old ATX (computer) power supply. Just make sure that it does in fact output DC.
A fuse holder
A fuse that is rated slightly less than the max current rating on your power supply.

Image Notes
1. Distilled Vinegar
2. Salt - I'm using sea salt, but your "flavor" shouldn't matter all that much as long as it has sodium chloride (normal table salt).
3. Mason jar - I'm using a 1 pint, wide mouth jar. The wide mouth makes it easier to plate in.
4. Optional - AC/DC power supply with a fuse. This particular one is a laptop power supply that runs at 13.5VDC.
5. 6V Lantern battery and alligator leads.
6. Paper towels and nitrile gloves
7. A nickel source (see my notes in the text)
8. Acidic abrasive

Step 2: Preparing Your DC Power Supply (Optional)

In the next step, we will make our electrolyte. In order to do this, we will need a significant amount of electricity. Instead of wasting a moderately expensive batteries, it is much cheaper to use an old wall wart, laptop charger, or computer supply (assuming they aren't already being used).

My version is rather crude, but effective. You could (and probably should) make a little project box with a DC barrel jack, internal fuse, and two terminals poking out to clip the alligator leads to.

Wall Warts (the ugly black things that come with some electronics)
Cut the barrel jack off of the end of your DC power supply. Pull the two wires apart and cut one of the wires two or three inches shorter than the other - this will help prevent you from accidentally shorting wires together later. Strip about a quarter inch from each wire. Solder in your fuse holder and pop in the fuse! You are done! (see polarity notes below).

Laptop Charger
Cut the barrel jack off of the end of the DC power supply. Use a razor blade with light pressure to remove the outer jacket - you do not want to cut through to the inner core. Most chargers will have one insulated wire that is wrapped in many other bare copper wires. Twist the bare copper wires together to form a single wire. This should be your negative. Solder your fuse holder here. Strip about a quarter inch from the insulated wire and tie it back with a zip tie or electrical tape so it cannot short with your bare wire. Pop in a fuse. You are done! (see polarity notes below)

ATX/Computer Power Supply
These are a tad bit more complicated to turn into a useable benchtop power supply. Google or search here on instructables for "DIY benchtop power supply" or "ATX benchtop power supply". You should find a few different tutorials that will explain everything well :)

Lab Benchtop Power Supply
If you are super fancy and have the money, a standard adjustable power supply (which is what you would find in a lab) will work just as well. Just make sure you set aside your banana plugs for electroplating only.

Notes on Polarity
You will need to know which wire is positive, and which side is negative. If you are a pro with a multimeter, this should be pretty easy. If you don't know how to use a multimeter or don't have one, you can do this: Mix a pinch of salt into a little bit of water in your jar. Connect one alligator lead to the fuse and drop it into the water. Connect the other alligator lead to the non-fused wire and drop that in the water. The alligator lead that starts to bubble like mad is your negative.

Step 3: Make Your Electrolyte

It is definitely possible to buy different nickel salts online, but what is the fun in that? Here, I'll show you to make your own nickel acetate solution for a lot cheaper than buying chemicals online.

Fill your mason jar with distilled vinegar leaving about an inch from the top. Dissolve a pinch or so of salt into the vinegar. The amount of salt is not all that important as long as you don't go crazy with it. The purpose of the salt is to increase the electrical conductivity of the vinegar. The more current that flows through it, the faster we can dissolve the nickel. However, too much current will lead to poor plating results. Use sparingly.

Unlike in the copper plating instructable I've done, the nickel will not dissolve into the solution just by letting it sit for a while. We need to electro-dissolve the nickel.

Place two pieces of pure nickel into the vinegar and salt solution such that part of both stick out and into the air and that they don't touch. Clip one alligator lead to one piece of nickel and then to the positive terminal of the battery or the DC power supply we made in the last step. Clip the other alligator lead to the other piece of nickel and to the negative lead of your battery or DC power supply. Make sure that the alligator clips don't touch the vinegar as they will dissolve as well and ruin your chemical.

The nickel source connected to the negative lead should start to create hydrogen bubbles and the positive lead should make oxygen bubbles. Truth be told, a very minute amount of chlorine gas (from the salt which is sodium chloride) will also form on the positive lead, but unless you put in huge amount of salt or are using a lot of voltage, the chlorine will just dissolve into the water like what you find in a swimming pool. The minute amounts excess sodium, in case you are wondering, will react with the water to create sodium hydroxide.

For this step, I very highly suggest using a DC power supply that plugs into the wall (see the previous step). Dissolving the nickel will take a while and you don't want to drain your battery more than you need to - DC power supplies are reusable, most batteries are not.

After a little while (mine took about two hours), you'll notice the solution has turned a light green. This is nickel acetate. If you get blues, reds, yellows, or any other color, it means that your nickel source wasn't pure. You also should also get a clear (though green) solution - if it was cloudy, your have an impure nickel source. The solution and nickel sources may become warm during this process - **this is normal** . If they get hot to the touch, you should disconnect your circuit, let it cool for an hour, and then reconnect it (repeat as necessary). It is possible that you added too much salt, which increases the current, which increases the power dissipated as heat.

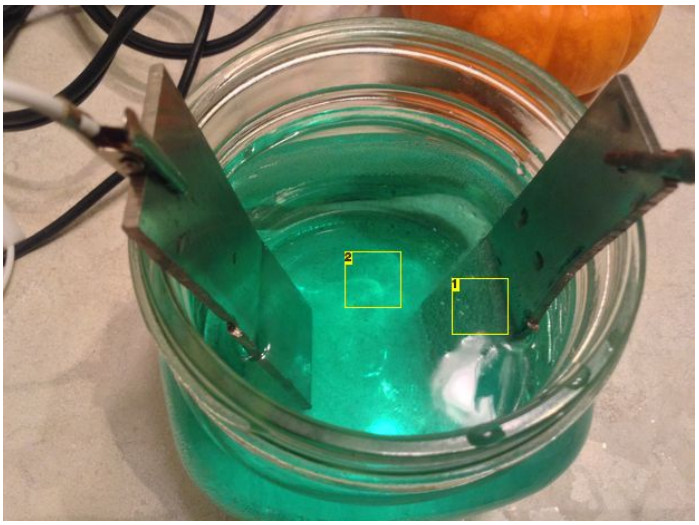


Image Notes
1. Hydrogen Bubbles
2. The finished product should be a light green color.

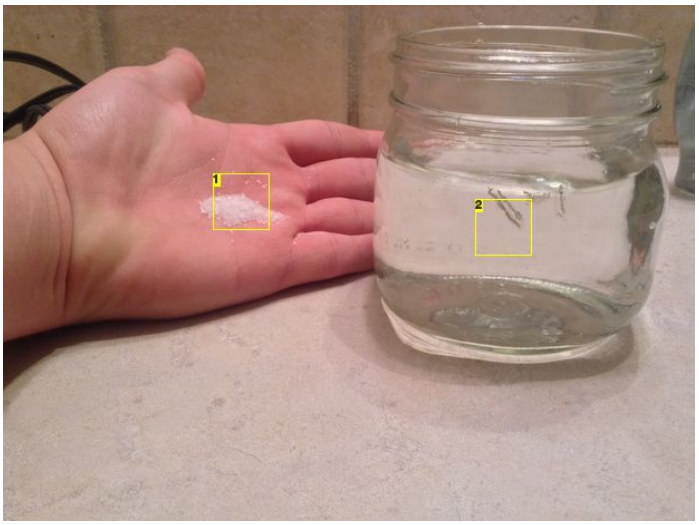


Image Notes
1. Dissolve a small amount of salt into the jar of vinegar.
2. Straight, distilled vinegar

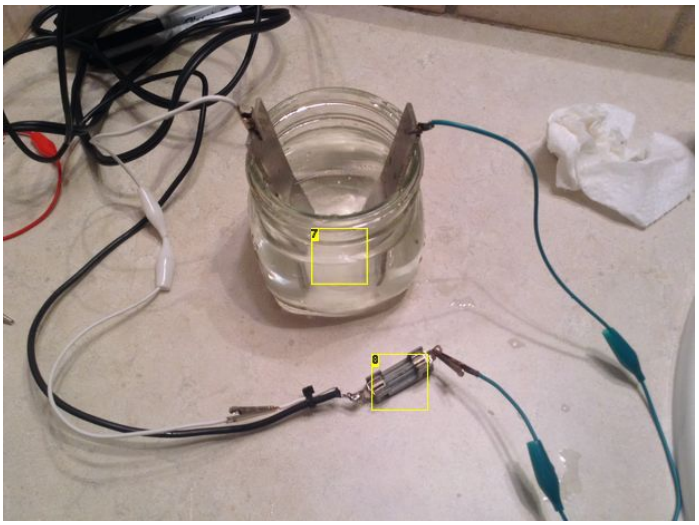


Image Notes
1. Nickel plates aren't touching
2. Nickel plates aren't touching
3. Nickel plates aren't touching
4. Nickel plates aren't touching
5. Nickel plates aren't touching
6. Nickel plates aren't touching
7. Nickel plates aren't touching
8. Fused, DC power supply

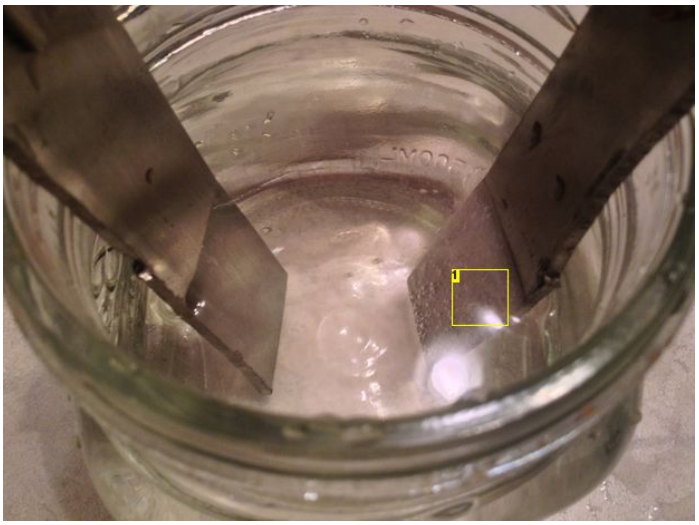


Image Notes
1. Hydrogen bubbles!

Step 4: Preparing Your Object to be Plated

NOTE: Some materials, such as stainless steel, will not accept direct nickel plating. You will need to copper plate them first. See my copper plating instructable to learn how to copper plate: http://www.instructables.com/id/High-Quality-Copper-Plating/

The above being said, the cleaner your conductive object, the better it will plate. You don't want any grease, oxidation (rust, tarnish, patina, ect), or general grime on your surface. Even if your surface looks good, you should clean it anyways.

Remove general grime and dirt with a little bit of dish soap and elbow grease.

Remove the oxidation and tougher grime with an acid-based abrasive such as Cameo. Don nitritle gloves and just mix the powder with a few drops of water on your glove and go to town!

You can further clean your object by reverse electroplating (ie "electrocleaning") it for a few seconds. Hook your object up to a negative voltage, a wire to the positive voltage, and drop them both in a vinegar salt solution for 10-30 seconds. This will remove any left over oxidation.

For larger surfaces, try scrubbing them with fine steel wool and vinegar.

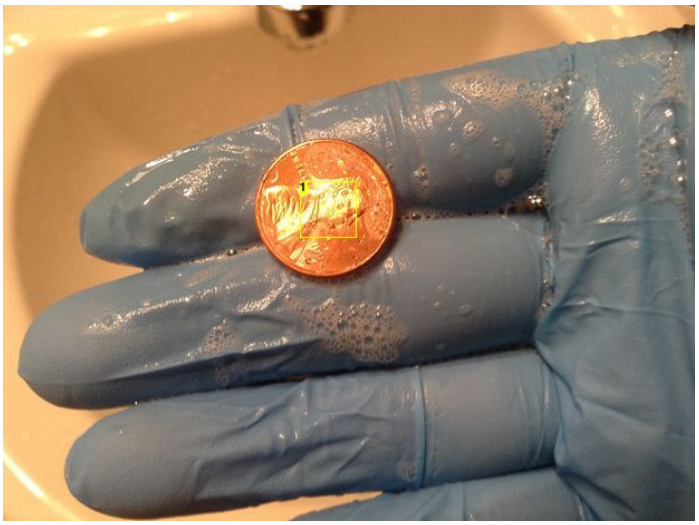


Image Notes
1. Dish soap suds

Image Notes
1. Cameo cleaning

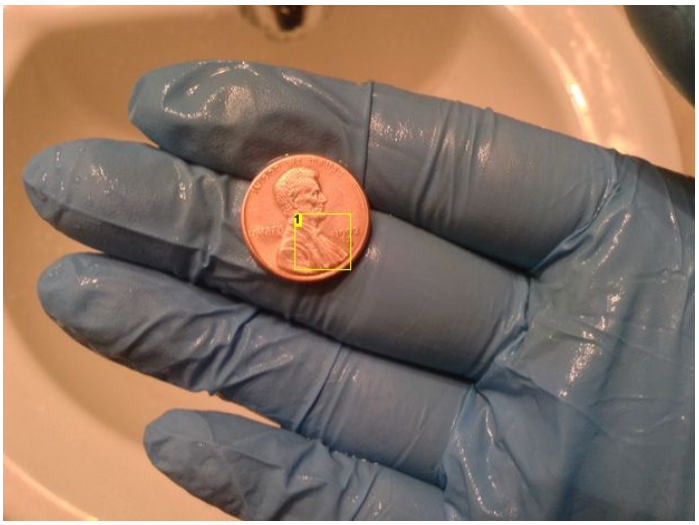


Image Notes
1. Chemically cleaned penny. Notice the dark areas - that is left over oxidation I didn't get off. I could remove it with electrocleaning.

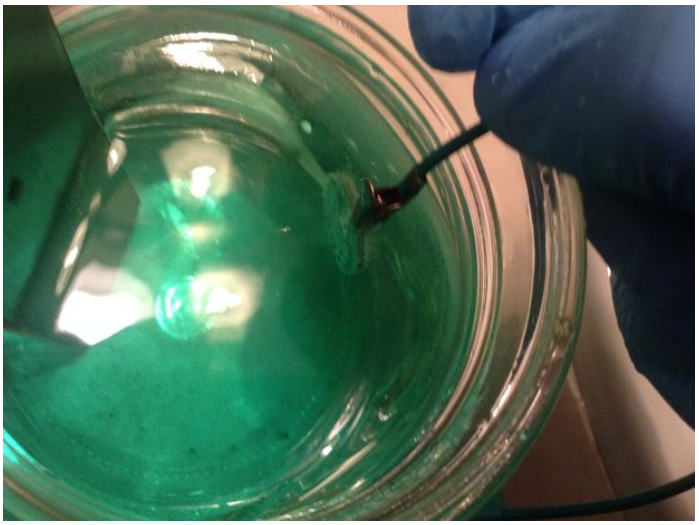
Step 5: Time to Electroplate!

For this step, you want to use your 6V battery. Even lower voltages (down to around 1V) will give you a better, shinier, smoother finish. You can use a higher voltage DC power supply for electroplating, but you won't get good results.

Place a nickel source into your green nickel acetate solution and connect it to the positive lead of your battery with an alligator clip. Clip the other alligator clip to the object to be plated and connect it to the negative lead of your battery.

Drop the object to be plated into the solution and wait for around 30 seconds. Take it out, rotate 180 degrees, and drop it back into the solution for another 30 seconds. Repeat as necessary. You should move the alligator clip a new location after a couple dips so that the entire surface gets plated. Unlike in copper plating, the alligator clip shouldn't leave "burn" marks.

The object being plated should bubble. There should be enough bubbles being created that you won't need to agitate or swirl your object in the electroplating solution. For larger objects and containers, you may want to include a small aquarium pump (~$15) to circulate the solution.



Step 6: Post Prep

Now for post prep....Generally speaking, NONE! Nickel doesn't oxidize at room temperature and shouldn't tarnish. You can polish your end product with a light polish to get a bright gleam.

If your nickel plating is not as shiny as you'd like, polish it up with a light polish that doesn't leave waxes or oils behind, and then electroplate it again.

Adding small amounts of other metals such as tin during the initial electroplating will change the color of the plating (tin will give you a white colored metal like silver). Many metals can be electrically dissolved into vinegar just like nickel. The two main metals that cannot be electrically dissolved into vinegar are gold and silver (trust me, I've tried). Since I had some copper plating solution left, I mixed in a little bit of it with my nickel plating solution. The result is a matte, dark grey, very hard finish that feels like a chalk board (it squeaks like one too if you scratch it <evil laugh>). See the picture.

Unless you are an experienced chemist or have a friend who is, I would be very careful when adding random chemicals to your electroplating bath - you may just end up creating some toxic gas that isn't good for you, kids, or fido.

Image Notes
1. Untreated, pure nickel plating
2. Unplated penny for reference

Image Notes
1. Copper acetate (from my copper plating instructable) was added to the nickel acetate bath. This is the result.

Related Instructables

High Quality (and Safe) Copper Plating by A_Steingrube

Clean and Simple Electroplating by nf119

DIY Battery: Power an LED Flashlight with Pocket Change! by GuiltyPixel

Chrome Plating of Car Headlights and Parts by kjegelan

How to Electroplating A Quarter (video) by kentchemistry.com

How To Remove Brass Finish While Channeling MacGyver (Photos) by rustyknuckles